

**Fabrication and Analysis of Natural Air Ventilation Nozzle****Prof.K.D.More<sup>1</sup>, Sandip Z.Rajput<sup>2</sup>,Vaibhav N. Harishchandre<sup>3</sup>,Prathmesh K.Belhekar<sup>4</sup>****Sandip p. Pawar<sup>5</sup>**

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**ABSTRACT**

*In the natural ventilation of building wind energy is used to drive air into building through small opening. In low velocity regime, continuity equation governs the nozzle processes. Optimization of nozzle shape is must as a requirement of large driving force as well as minimum energy losses due to stagnation and minimum air leakage from main air stream. In the present study, we are dealing with rectangular hyperbolic nozzles. Beta ( $\beta$ ) is an angle between two asymptotes of rectangular hyperbola. This angle has a major influence on nozzle geometry. For analysis purposes  $\beta$  is limited in the range of  $0^\circ$  to  $180^\circ$  and Nozzle Inlet conditions of air are taken from standards as pressure 1 bar, temperature 308 K, wind velocity 3 m/s, density 1.123 kg/cubic meter in summer season for Ahmednagar city. In this case, Optimization of nozzle shapes is carried out for maximum driving force at the outlet of nozzle and minimum energy lost and minimum air leakage. Experimental and theoretical calculation results for velocity, area, pressure, temperature, density distribution along the horizontal axis of the nozzle show that energy head loss and boosting of air is maximum at  $\beta=0^\circ$ , both continuously reducing up to  $\beta=180^\circ$ . Nozzle shapes when  $\beta < 90^\circ$  having practical limit because of the leakage of airstream. But air leakages are maximum at  $\beta=0$ , then after it reduces up to  $\beta=90^\circ$ , then after no air leakages, Therefore unit rectangular hyperbolic nozzles (i.e.  $\beta=90^\circ$ ) are optimum nozzle shape.*

**Keywords:** Asymptotes, DBT, Natural Ventilation, Nozzle, WBT

**INTRODUCTION**

In the world of engineering, gears are used for offering an elegant solution to the problem of effective power transmission. Gear is the internal part of machine which transfer power from one to other elements and helps to reduce and increase as per requirement speed and torque due to reliability factor. Manufacturing of machine element required greater accuracy with zero defect detection of fault and measurable reduction in the chances of failure of product during service life. In era of modernization, humans are more inclined towards comfort and modern lifestyle. It creates more challenges to World of engineering. Manufacturing of articles required cost-effective advance and precise machineries and automation. With the rapid development of modern industrial technology, gear design, manufacturing, and testing levels have been a hot issue in the engineering field. With the continuous progress of measurement technology, gear measuring instruments have undergone great changes. Over the years, hundreds of gear measuring devices have been

developed. Some of these measurement methods require manual operation and high work intensity..

**LITERATURE REVIEW**

In “**Gear technology, gear inspection and measurement**” [1], The purpose of gear inspection is to: Assure required accuracy and quality, Lower overall cost of manufacture by controlling rejects and scrap, Control machines and machining practices and maintain produced accuracy as machines and tools wear, determine heat treat distortions to make necessary corrections.

**G. Goch, “Gear metrology”** [2] states that Gear drives represent key components for all kind of vehicles, machine tools, aircrafts, household appliances as well as a broad variety of industrial equipment. This paper reviews the state-of-the-art of gear metrology. It summarizes new modelling and measuring principles, enabling a superficial description and inspection of gears. It reports the actual accuracy limits of gear measurements. It points out that a significant reduction of the

measuring uncertainty associated with gears, standards and instruments is an urgent need for the production of high-precision gears.

**Frazer RC. "Measurement uncertainty in gear metrology" [3]** has mainly discussed about the role of gears and why there is necessity of bringing certainty in gear measurements. Gears play an important role in mechanical power transmission systems. They enable the prime mover characteristic (a gas turbine for example) to be matched to the characteristic of the driven load (say, a slow speed propeller), thus reducing the cost of both manufacturing and operating the system. The customer requirements for higher power density and lower noise demands more accurate gears.

This imposes more stringent requirements on the measuring equipment that controls the quality of the manufacturing machines. Thus, the need to accurately quantify the measurement uncertainty of inspection machines is of paramount importance if costly mistakes are to be avoided. The work was mainly experimental in nature.

Gear precision is the key factor that influences behavior in mechanical transmission. **Palermo et al. [4]** demonstrated that gear transmission error is often considered as the main cause of gear whine. Different errors may be introduced in each link of gear manufacturing. Gear Transmission Error (TE) is often considered as the main cause of gear whine. TE represents the difference between the perfectly kinematic transmission of motion and the one actually achieved. TE vibrations are extremely small and pose significant measurement challenges. This article demonstrates how low-cost digital encoders can be successfully used together with the Elapsed Time Method to simplify TE measurement with respect to the traditional Direct Method. A precision gear pair test rig is exploited to compare the two methods from a theoretical and an experimental point of view. Following the observations drawn from such comparison, a measuring chain is set up to validate the proposed procedure on a real case all-electric vehicle gearbox.

**Palermo et al.** told us that different errors may be introduced in each link of gear manufacturing. So, in continuation of that **A. Olofsson et al. [5]** specify that the quenching

treatment of gears may lead to the problem of gears radial runout (eccentricity). Gear radial runout is a positioning error, which determines the precision of the upper tooth position or tooth position of the gear, thus affecting the transmission precision.

Runout refers to the radial position of the gear relative to the circular pitch error. It is the maximum difference between the nominal or theoretical radial position of all the teeth and the actual measured position, as indicated in "**Dudley's Handbook of Practical Gear Design and Manufacture, second ed. [6].** Dudley's Handbook of Practical Gear Design & Manufacture, Third Edition, is the definitive reference work for gear design, production, inspection, and application. This fully updated edition provides practical methods of gear design, and gear manufacturing methods, for high, medium, and low volume production. Comprehensive tables and references are included in the text and in its extensive appendices, providing an invaluable source information for all those involved in the field of gear technology. **N. Gao et al. [7]** the radial runout (eccentricity) should be controlled within a reasonable range and then an available high precision measurement is very important in the production process.

**Muto, G. Nishimura et al. [8],** Here they told how they obtained an efficient mesh tester. By using only one set of datum circular plates, the single flank gear mesh test can be done easily and efficiently for any kinds of gear ratios of test gears and also for all types of test gears such as circular and noncircular gears. The present tester can be used for testing fine pitch gears, testing medium size ones, and furthermore it is able to reduce remarkably the time necessary for testing.

**S. D Kalander Saheb and K. Gopinath et al. [9]** have done a survey in which they have performed the gear testing experiment and concluded that this test rig is the easiest to use equipment for checking any irregularity in gear tooth.

After that, **M. Akerblom** in "**A STUDY OF GEAR NOISE AND VIBRATION**" [10], mainly investigated the influence of gear finishing method and gear deviations on gearbox noise in this experimental study. Eleven different test gear pairs were

manufactured using three different finishing methods as well as different gear tooth modifications and deviations. The surface finish and geometry of the gear tooth flanks were measured. Transmission error, which is considered to be an important excitation mechanism for gear noise, was predicted and measured. LDP software from Ohio State University was used for the transmission error computations. A specially built test rig was used to measure gearbox noise and vibration for the different test gear pairs. The measurements show that disassembly and reassembly of the gearbox with the same gear pair can change the levels of measured noise and vibration considerably. The rebuild variations are sometimes in the same order of magnitude as the differences between different tested gear pairs, indicating that other factors besides the gears affect gear noise.

Most of the experimental results can be understood and explained in terms of measured and predicted transmission error. However, it does not seem possible to find one single parameter, such as measured peak to peak transmission error, that can be related directly to measured noise and vibration.

**S. Ito, W. Gao et al. [11]** presented gear pitch deviation measurement for an involute spur gear. A rotary profiling system, which consists of an air-bearing spindle and a displacement sensor with a diamond stylus, was employed to measure gear pitch deviation. In measurement of gear pitch deviation, an eccentric error between a gear axis and a motion axis of the rotary stage in the profiling system would affect accuracy of gear profile measurement. In this paper, at first, the influence of the eccentric error on measurement of gear pitch deviation is estimated in computer simulation based on a geometric model of the profiling system. For compensating distortions in the measured gear tooth profile, which are induced not only by the eccentric error but also by a probe offset introduced by the proposed scanning method, a self-calibration and compensation method is applied. To verify the feasibility of the proposed method, measurement of gear pitch deviation of a master involute spur gear with a certificate data is carried out. Measurement uncertainty of the proposed method is also analyzed.

In “**Technology of tooth pitch deviations measurement for master gears of precision grade 1**” [12], it is stated that with the rapid development of modern industrial technology, gear design, manufacturing, and testing levels have been a hot issue in the engineering field. Especially in the military and aerospace industry, the demand for precision gear is increasing, which is both an opportunity and a challenge for the gear manufacturing industry. In order to solve the difficult problem of detection of pitch deviations of high-precision master gears, a new measuring instrument is developed. Detail description about measuring apparatus of pitch deviations developed for master gears was presented in the paper. Computer aided technology was used to deal with data collected by computer, and error analysis about the measuring apparatus was introduced, which affected measurement accuracy. The results confirm that the measuring apparatus is able to meet measurement requirement and improve efficiency through the measuring experiments on master gears of precision grade 2 and 1 with modulus 2 mm and 2.5 mm, respectively. And the uncertainties of single pitch deviation and total cumulative pitch deviation are 0.07 and 0.26, respectively.

**Mats Åkerblom et al. [13]**, has designed the test rig which will be used for gear noise and vibration testing. In addition to noise and vibration testing the gear test rig can be used for gear life testing and measurement of efficiency. The measurement of efficiency is possible by measuring the torque and rotational speed of the shaft from the electric motor.

Finite element analysis has been used to predict the natural frequencies and mode shapes for individual parts and for complete gearboxes. Experimental modal analysis has been carried out on the gearbox housing and the results show that the FE predictions are in good agreement with measured frequencies.

Whereas nearby 1999, **V. Manoj et al. [14]**, states that Parkinson gear tester is most suitable equipment which can be used for determination of errors in flank surfaces.

In order to evaluate the performance of gears, a power re-circulating test rig has been designed and developed. The test rig consists of one pair of test spur gears and one pair of helical

loading gears. The variation in gear loading is achieved by axial loading of the helical gear using a pneumatic actuator. The no load-starting feature in the test rig reduces the size of the motor. The features of the test rig and advantages are discussed in detail in this paper.

**AGMA 931-A2, “Calibration of gear measuring instruments and their application to the inspection of product gears” [15]** have highlighted the drawbacks of ISO standards and presented a new calibration method in 2002. The ISO standard regulating gear-rolling measurement does not specify in detail the calibration and verification procedures for this type of equipment. This may be one of the reasons for the lack of reproducibility in these rolling tests. The uncertainty budget method, which is the most appropriate way to know the accuracy of this dynamic measurement, shows that the measuring sensors’ accuracy is only a part of the total measurement process uncertainty. In this work, a new calibration and verification procedure for a worm gear rolling tester is presented, based on machine tool, coordinate measuring machine and gear measuring instruments’ calibration techniques. And then in 2003, **ISO 18653:2003 [16]** also specifies methods for the evaluation of measuring instruments used for gear measurements of involute, helix, pitch and runout. It is applicable both to instruments that measure runout directly and to those that compute it from index measurements. It also gives recommendations for the evaluation of tooth thickness measuring instruments and, of necessity, includes the estimation of measurement uncertainty with the use of calibrated gear artifacts.

In 2006, **AGMA ISO 10064-5-A06. Code of Inspection Practice [17]** specifies methods for the evaluation of measuring instruments used to measure cylindrical gear involute, helix, pitch and runout. It includes instruments that measure runout directly, or compute it from index measurements. Of necessity, it includes the estimation of measurement uncertainty with the use of calibrated gear artifacts. It also gives recommendations for the evaluation of tooth thickness measuring instruments. The estimation of product gear measurement uncertainty is beyond its scope (see AGMA

ISO 10064-5-A06 for recommendations). This standard is an identical adoption of ISO 18653:2006. It replaces ANSI/AGMA 2010-A94, ANSI/AGMA 2110-A94, ANSI/AGMA 2113-A97 and ANSI/AGMA 2114-A98.

**M.E. Niza et al. [18]** developed the test rig to evaluate the performance of a micro involute gear with a diameter below 1 mm. In this research, the measurement and adjustment method of gear assembly condition and an in-situ observation system of gear condition are proposed, that are appropriately designed for micro gears. The meshing condition of micro involute gears is investigated experimentally. One-sided support structure of large diameter gear shaft and ball bearing with preload is proposed as an appropriate support method of micro gear in terms of stiffness and rotational accuracy. Measurement method of gear assembly condition is proposed by using laser displacement sensor and XY stage. Relative position and posture of the drive and driven gears are estimated through fitting the theoretical 3-D form into the measured one. Gear support base integrated with magnetic base is presented, which has advantages in multi degree of freedom (DOF) adjustment and high stiffness. For the in-situ observation system, a high-power stereo microscope integrated with digital camera is introduced, which enables the observation of the gear tooth condition without disassembling the gear parts. “Power-circulating form” test rig is built for vibration tests of the thin walled gears by **Shuting Li [19]**. This paper is a fundamental study on resonance frequency behaviour of three dimensional, thin-walled spur gears from experimental tests and finite element analyses. “power-circulating form” test rig is built for vibration tests of the thin walled gears at the speed range 500–3000 rpm and then strain phase method is presented in this paper to identify the resonance mode shapes of the thin-walled gears when they are running in a complete resonance state. In recent years, these gears have been finding wide applications in general machines for weight reduction and compact design. Though applications of the thin-walled gears are increased in general machines, vibration and dynamic strength design problems of the gears have not been solved so far. This paper attempts to solve

some of these problems stated above through experimental investigations and FEM analyses. In this paper, firstly, “Power-circulating Form” gear test rig is built to test resonance frequencies, mode shapes and dynamic load factors of two thin-walled spur gears with different wall thickness in speed range 500–3000 rpm. Dynamic behaviour of the thick-walled gears in the test rig is also investigated at the same time for comparisons.

**N.A. Wright et al. [20]**, this paper focuses on the aspects of the performance of polymeric gears have been studied by a number of workers and efforts have been made to simulate the contact conditions during gear running. However, until now the wear performance of gears made from polymer matrix composites has not been studied systematically. While such materials have been studied using pin-on-disc or twin disc roll/slide wear techniques, no attempt has ever been made to directly compare the results from such studies with those from gear tests. This paper attempts to explain the comparative methods of measurement of various polymer matrix composite gear materials and to relate their performance to results obtained in contact simulation experiments by other workers. Methods of wear testing are compared including direct gear testing and disc testing, together with electronic (displacement) measurement, weight loss and direct measurement. A new method of characterizing the wear of gears is presented, which relates actual contact conditions and gear tooth wear.

**Stewart Denny, “Test Gear and Measurements” [21]** book provides a clear introduction to test gear in the field of electronics. As well as being a first guide to test gear and its use, the book includes much practical information and reference material for the more experienced electronics enthusiast or student. Details of all the common (and some not-so-common) items of test gear are included, alongside information regarding its use in various measurement situations.

**R.K. Jain et al. [22]**, have presented Parkinson gear tester as an efficient one for checking the flank surfaces of the gear and determine the error significantly. For efficient performance of the gear, this test rig is used they have performed three levels of test experiments

considering flank surface. It was observed that this test rig can improve the life of gear.

In order to check the combined tooth error different types of gear testing machines are used, stated by **Tharesh K. Gawande et al. [23]**. Various machines have its ability to check specified parameters only. Highly precise machine required special installation and space. For the purpose of checking gear in machine shop while performing machine required such an arrangement which is robust and quick one. This purpose can be solved using gear test rig.

This type of gear test rig can be used for mass production of gears of a particular gear box.

**International Gear Conference 2014, 1st Edition [24]**, This book presents papers from the International Gear Conference, held in Lyon, 26th-28th August 2014. Mechanical transmission components such as gears, rolling element bearings, CVTs, belts and chains are present in every industrial sector and over recent years, increasing competitive pressure and environmental concerns have provided an impetus for cleaner, more efficient and quieter units. Moreover, the emergence of relatively new applications such as wind turbines, hybrid transmissions and jet engines has led to even more severe constraints.

The main objective of this conference is to provide a forum for the most recent advances, addressing the challenges in modern mechanical transmissions. The conference proceedings address all aspects of gear and power transmission technology and range of applications (aerospace, automotive, wind turbine, and others) including topical issues such as power losses and efficiency, gear vibrations and noise, lubrication, contact failures, tribo-dynamics and nano transmissions.

Then **Omkar B Agashe et al. [25]** have discussed that Gear roll testers are used to measure and analyses functional performance of gears. Gear testing is a technique that has been used in the gear industry to identify potential manufacturing defects in the design intent of the gear. It is a practical, fast and effective screening tool that can identify when

the gear manufacturing process has deviated from an ideal condition that could result in a change in backlash, or an unwanted noise and vibrations in a gear mesh therefore, in the present work it was decided to develop a gear roll tester to analyse effects of different types of defects in gear on its functional performance in terms of run out, pitch errors, backlash, profile errors, noise and vibration. For the present work a spur was selected with the specifications matching with the gear used in automobiles. A test rig was designed and developed for the functional testing of spur gears.

They have presented that Parkinson gear tester is most suitable equipment which can be used to measure deflection of gears. In this they use plastic gears in order to reduce material cost and also by using manually adjustable spring load errors could be defined. They conclude that in case of dry condition of gear mating part friction is more which gives more deflection.

We observe a Parkinson gear tester to be extending gear life and reducing error, stated by **Shinde Tushar. B. et al. [26]**. Their work aims to understand the accuracy of flank surfaces. This test rig is useful to find out the flank surface and irregularities in gear tooth with ease. Gear test rig is such arrangement which simplifies the measurement and saves the labour time and labour cost with greater accuracy. In gear test rig all the gears will be mounted on a plate which may be fixed or stationary as per the requirement of the measurement. While measuring the one gear remaining will act as a master gear. This will help in finding the composite error. This test rig can be used in shop floor as it requires less space and operator can use it as per need without wasting much time. The test rig can be developed for different parameter as per measurement requirement. There are various test rigs which can be used for that particular designed condition.

With the continuous progress of measurement technology, gear measuring instruments have undergone great changes. Over the years, hundreds of gear measuring devices have been developed. Some of these measurement methods require manual operation and high work intensity, and they are greatly affected by

human factors; some require expensive equipment, and for contact measurement, different gear surfaces require path planning and probe radius compensation. It may even damage the surface of the workpiece. Moreover, **L. Qiu [27]** presented a gear non-contact laser measuring device, where the measuring data is sampled by placing the laser beam through the gear rotating center. With the advantages of low cost, high precision, and universal applicability, a non-contact measuring method for the radial runout of cylindrical gear tooth profile is proposed only using a single laser displacement sensor in this paper. A theoretical optimization model is established according to the measurement principle and the laser sensor characteristics, and the optimal installation position and angle of the laser sensor are presented for measurement arrangement.

But, **A. Zbrowski & K. Matecki et al. [28]** stated that According to laser displacement sensor's measurement principle and working characteristics, this measuring method will cause the laser spot on gear tooth profile to be elongated, thus affecting the sensor's measurement accuracy seriously. The article presents the methodology, test stand and results of noncontact tests conducted using a laser sensor-equipped system for measuring displacement. The tests were carried out in an attempt to determine the sensitivity of the measurement system to the angular position of the sensor against the surface onto which the laser spot was projected.

The tests were executed in the measurement range between 5 and 50 mm taking into account 5 angular positions of the laser sensor. The readings of the laser head were referred to the value of displacements adjusted with the use of a micrometric head. In the case of the tested system, the dispersion of measurement deviations was estimated as a function of the measured distance. In continuation of this, as the gear tooth profile's optical characteristics are mainly mirror reflection, there is a case where laser displacement sensor cannot obtain the measuring signal, presented by **B. Sun et al. [29]**.

During this in 2017, **Dattatray Knannavare** came up with “**Modified Parkinson’s gear tester**” [30]. They have presented Modified Parkinson gear tester. In order to check the combined tooth errors, different types of gear testing machines were used. Various machines have its ability to check specific parameters only. They used springs and slider table with roller these will provide flexibility of checking composite error of different types of gears. This concludes that modified test rig can check composite error with higher accuracy. This gear test rig will check the gear in minimum time which results in decrease of Productive time & improve efficiency of inspection.

**Nishant Devkate et al.** [31] have presented that Parkinson gear test rig is the easiest to use equipment for checking any irregularity in gear tooth. In Parkinson test rig, three rectangular plates were used which is mounted on liner guide ways. In working condition of test rig, the movements of the plate will response the error in gear. It was observed that the locking and jamming of gears can be easily detected from this technique.

Gears are the crucial element of any transmission system which generally used for power transmission. Such type of part must be check by using the highly accurate methodology in order to assess its functional performance in advance. The inspection methodology of gears should be accurate with less time-consuming procedure for its inspection. This gear test rig will check the gear in minimum time which results in a decrease of non-productive time and improves plant efficiency.

The benefits and need of gear test rigs were discussed by **Ganesh Bagade et al.** [32]. Gears are the crucial element of any transmission system which generally used for power

transmission along with other applications depending upon working requirements. Such type of component must be check by using highly accurate methodology in order to assess its functional performance in advance. The inspection methodology of gears should be accurate with less time-consuming procedure for its inspection. This objective is easily obtained by using Gear Test Rig.

**Gawade Tanmay, “Automation of Parkinson’s Gear Tester”** [33] have discussed that constant change is observed in manufacturing sector in accordance with the trouble of passing on new arrangement into reality. New machines and the frameworks are being made constantly to makes diverse thing at less costly rates and with high precision. Gear is most important component in to the power transmission method. The gear profile is very is important factor of gear application at different area like automobiles, machine tools & other area power transmission. Hence the gear shape & accuracy is very important. Model of Parkinson gear tester testing includes the gear tooth profile through dial indicator. It can be very useful for gear testing laboratories, gear modification industries.

**V Shinde et al.** [34] aims to understand the accuracy of flank surfaces. They have presented that the various test rig which is used for measurement of particular parameter like gear tooth alignment, gear tooth surface and pitch circle these are to be tested. This test rig differs as per the requirement of application and as per requirement of parameter to be tested.

## CONCLUSION

Our intent behind all of this was to make you aware of how the evolution has taken place in field of gear testing and what should be done to achieve higher accuracy as well as precision in gear testing equipments.

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## Review on Gear Testers

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### ABSTRACT

Constant change is observed in manufacturing sector in accordance with the trouble of passing on new arrangement into reality. New machines and the frameworks are being made constantly to makes diverse thing at less costly rates and with high precision. Automation is the creation and application of technologies to produce and deliver goods and services with minimal human intervention. The implementation of automation technologies, techniques and processes improve the efficiency, reliability, and speed of many tasks that were previously performed by humans. New machines and the framework are being made constantly to makes diverse things less costly rates and with high precision. Gear is the most important element in the power transmission method. The gear profile is very important factor of gear application at different area like automobiles, machine tools and other area power transmission. Hence the gear shape and accuracy is very important. The customer requirements for higher power density and lower noise demands more accurate gears. By the time, there were various gear testers has introduced in the field of gear testing till now. In this paper, we will see the work done by various researchers and the evolution that we got to see in gear measuring equipments in the previous years.

**Keywords:** Gear, Gear testers, Accuracy, Automation, Efficiency

### Introduction

In the world of engineering, gears are used for offering an elegant solution to the problem of effective power transmission. Gear is the internal part of machine which transfer power from one to other elements and helps to reduce and increase as per requirement speed and torque due to reliability factor. Manufacturing of machine element required greater accuracy with zero defect detection of fault and measurable reduction in the chances of failure of product during service life. In era of modernization, humans are more inclined towards comfort and modern lifestyle. It creates more challenges to World of engineering. Manufacturing of articles required cost-effective advance and precise machineries and automation. With the rapid development of modern industrial technology, gear design, manufacturing, and testing levels have been a hot issue in the engineering field. With the continuous progress of measurement technology, gear measuring instruments have undergone great changes. Over the years, hundreds of gear measuring devices have been developed. Some of these measurement

methods require manual operation and high work intensity..

### LITERATURE REVIEW

In “**Gear technology, gear inspection and measurement**” [1], The purpose of gear inspection is to: Assure required accuracy and quality, Lower overall cost of manufacture by controlling rejects and scrap, Control machines and machining practices and maintain produced accuracy as machines and tools wear, determine heat treat distortions to make necessary corrections.

**G. Goch, “Gear metrology”** [2] states that Gear drives represent key components for all kind of vehicles, machine tools, aircrafts, household appliances as well as a broad variety of industrial equipment. This paper reviews the state-of-the-art of gear metrology. It summarizes new modelling and measuring principles, enabling a superficial description and inspection of gears. It reports the actual accuracy limits of gear measurements. It points out that a significant reduction of the measuring uncertainty associated with gears, standards and instruments is an urgent need for the production of high-precision gears.

**Frazer RC. “Measurement uncertainty in gear metrology” [3]** has mainly discussed about the role of gears and why there is necessity of bringing certainty in gear measurements. Gears play an important role in mechanical power transmission systems. They enable the prime mover characteristic (a gas turbine for example) to be matched to the characteristic of the driven load (say, a slow speed propeller), thus reducing the cost of both manufacturing and operating the system. The customer requirements for higher power density and lower noise demands more accurate gears.

This imposes more stringent requirements on the measuring equipment that controls the quality of the manufacturing machines. Thus, the need to accurately quantify the measurement uncertainty of inspection machines is of paramount importance if costly mistakes are to be avoided. The work was mainly experimental in nature.

Gear precision is the key factor that influences behavior in mechanical transmission. **Palermo et al. [4]** demonstrated that gear transmission error is often considered as the main cause of gear whine. Different errors may be introduced in each link of gear manufacturing. Gear Transmission Error (TE) is often considered as the main cause of gear whine. TE represents the difference between the perfectly kinematic transmission of motion and the one actually achieved. TE vibrations are extremely small and pose significant measurement challenges. This article demonstrates how low-cost digital encoders can be successfully used together with the Elapsed Time Method to simplify TE measurement with respect to the traditional Direct Method. A precision gear pair test rig is exploited to compare the two methods from a theoretical and an experimental point of view. Following the observations drawn from such comparison, a measuring chain is set up to validate the proposed procedure on a real case all-electric vehicle gearbox.

**Palermo et al.** told us that different errors may be introduced in each link of gear manufacturing. So, in continuation of that **A. Olofsson et al. [5]** specify that the quenching treatment of gears may lead to the problem of gears radial runout (eccentricity). Gear radial runout is a positioning error, which determines

the precision of the upper tooth position or tooth position of the gear, thus affecting the transmission precision.

Runout refers to the radial position of the gear relative to the circular pitch error. It is the maximum difference between the nominal or theoretical radial position of all the teeth and the actual measured position, as indicated in **“Dudley’s Handbook of Practical Gear Design and Manufacture, second ed. [6].** Dudley's Handbook of Practical Gear Design & Manufacture, Third Edition, is the definitive reference work for gear design, production, inspection, and application. This fully updated edition provides practical methods of gear design, and gear manufacturing methods, for high, medium, and low volume production. Comprehensive tables and references are included in the text and in its extensive appendices, providing an invaluable source information for all those involved in the field of gear technology. **N. Gao et al. [7]** the radial runout (eccentricity) should be controlled within a reasonable range and then an available high precision measurement is very important in the production process.

**Muto, G. Nishimura et al. [8],** Here they told how they obtained an efficient mesh tester. By using only one set of datum circular plates, the single flank gear mesh test can be done easily and efficiently for any kinds of gear ratios of test gears and also for all types of test gears such as circular and noncircular gears. The present tester can be used for testing fine pitch gears, testing medium size ones, and furthermore it is able to reduce remarkably the time necessary for testing.

**S. D Kalander Saheb and K. Gopinath et al. [9]** have done a survey in which they have performed the gear testing experiment and concluded that this test rig is the easiest to use equipment for checking any irregularity in gear tooth.

After that, **M. Akerblom** in **“A STUDY OF GEAR NOISE AND VIBRATION” [10],** mainly investigated the influence of gear finishing method and gear deviations on gearbox noise in this experimental study. Eleven different test gear pairs were manufactured using three different finishing methods as well as different gear tooth

modifications and deviations. The surface finish and geometry of the gear tooth flanks were measured. Transmission error, which is considered to be an important excitation mechanism for gear noise, was predicted and measured. LDP software from Ohio State University was used for the transmission error computations. A specially built test rig was used to measure gearbox noise and vibration for the different test gear pairs. The measurements show that disassembly and reassembly of the gearbox with the same gear pair can change the levels of measured noise and vibration considerably. The rebuild variations are sometimes in the same order of magnitude as the differences between different tested gear pairs, indicating that other factors besides the gears affect gear noise.

Most of the experimental results can be understood and explained in terms of measured and predicted transmission error. However, it does not seem possible to find one single parameter, such as measured peak to peak transmission error, that can be related directly to measured noise and vibration.

**S. Ito, W. Gao et al. [11]** presented gear pitch deviation measurement for an involute spur gear. A rotary profiling system, which consists of an air-bearing spindle and a displacement sensor with a diamond stylus, was employed to measure gear pitch deviation. In measurement of gear pitch deviation, an eccentric error between a gear axis and a motion axis of the rotary stage in the profiling system would affect accuracy of gear profile measurement. In this paper, at first, the influence of the eccentric error on measurement of gear pitch deviation is estimated in computer simulation based on a geometric model of the profiling system. For compensating distortions in the measured gear tooth profile, which are induced not only by the eccentric error but also by a probe offset introduced by the proposed scanning method, a self-calibration and compensation method is applied. To verify the feasibility of the proposed method, measurement of gear pitch deviation of a master involute spur gear with a certificate data is carried out. Measurement uncertainty of the proposed method is also analyzed.

**In “Technology of tooth pitch deviations measurement for master gears of precision**

**grade 1” [12]**, it is stated that with the rapid development of modern industrial technology, gear design, manufacturing, and testing levels have been a hot issue in the engineering field. Especially in the military and aerospace industry, the demand for precision gear is increasing, which is both an opportunity and a challenge for the gear manufacturing industry. In order to solve the difficult problem of detection of pitch deviations of high-precision master gears, a new measuring instrument is developed. Detail description about measuring apparatus of pitch deviations developed for master gears was presented in the paper. Computer aided technology was used to deal with data collected by computer, and error analysis about the measuring apparatus was introduced, which affected measurement accuracy. The results confirm that the measuring apparatus is able to meet measurement requirement and improve efficiency through the measuring experiments on master gears of precision grade 2 and 1 with modulus 2 mm and 2.5 mm, respectively. And the uncertainties of single pitch deviation and total cumulative pitch deviation are 0.07 and 0.26, respectively.

**Mats Åkerblom et al. [13]**, has designed the test rig which will be used for gear noise and vibration testing. In addition to noise and vibration testing the gear test rig can be used for gear life testing and measurement of efficiency. The measurement of efficiency is possible by measuring the torque and rotational speed of the shaft from the electric motor.

Finite element analysis has been used to predict the natural frequencies and mode shapes for individual parts and for complete gearboxes. Experimental modal analysis has been carried out on the gearbox housing and the results show that the FE predictions are in good agreement with measured frequencies.

Whereas nearby 1999, **V. Manoj et al. [14]**, states that Parkinson gear tester is most suitable equipment which can be used for determination of errors in flank surfaces.

In order to evaluate the performance of gears, a power re-circulating test rig has been designed and developed. The test rig consists of one pair of test spur gears and one pair of helical loading gears. The variation in gear loading is achieved by axial loading of the helical gear

using a pneumatic actuator. The no load-starting feature in the test rig reduces the size of the motor. The features of the test rig and advantages are discussed in detail in this paper.

**AGMA 931-A2, “Calibration of gear measuring instruments and their application to the inspection of product gears” [15]** have highlighted the drawbacks of ISO standards and presented a new calibration method in 2002. The ISO standard regulating gear-rolling measurement does not specify in detail the calibration and verification procedures for this type of equipment. This may be one of the reasons for the lack of reproducibility in these rolling tests. The uncertainty budget method, which is the most appropriate way to know the accuracy of this dynamic measurement, shows that the measuring sensors’ accuracy is only a part of the total measurement process uncertainty. In this work, a new calibration and verification procedure for a worm gear rolling tester is presented, based on machine tool, coordinate measuring machine and gear measuring instruments’ calibration techniques. And then in 2003, **ISO 18653:2003 [16]** also specifies methods for the evaluation of measuring instruments used for gear measurements of involute, helix, pitch and runout. It is applicable both to instruments that measure runout directly and to those that compute it from index measurements. It also gives recommendations for the evaluation of tooth thickness measuring instruments and, of necessity, includes the estimation of measurement uncertainty with the use of calibrated gear artifacts.

In 2006, **AGMA ISO 10064-5-A06. Code of Inspection Practice [17]** specifies methods for the evaluation of measuring instruments used to measure cylindrical gear involute, helix, pitch and runout. It includes instruments that measure runout directly, or compute it from index measurements. Of necessity, it includes the estimation of measurement uncertainty with the use of calibrated gear artifacts. It also gives recommendations for the evaluation of tooth thickness measuring instruments. The estimation of product gear measurement uncertainty is beyond its scope (see AGMA ISO 10064-5-A06 for recommendations). This standard is an identical adoption of ISO

18653:2006. It replaces ANSI/AGMA 2010-A94, ANSI/AGMA 2110-A94, ANSI/AGMA 2113-A97 and ANSI/AGMA 2114-A98.

**M.E. Niza et al. [18]** developed the test rig to evaluate the performance of a micro involute gear with a diameter below 1 mm. In this research, the measurement and adjustment method of gear assembly condition and an in-situ observation system of gear condition are proposed, that are appropriately designed for micro gears. The meshing condition of micro involute gears is investigated experimentally.

One-sided support structure of large diameter gear shaft and ball bearing with preload is proposed as an appropriate support method of micro gear in terms of stiffness and rotational accuracy. Measurement method of gear assembly condition is proposed by using laser displacement sensor and XY stage. Relative position and posture of the drive and driven gears are estimated through fitting the theoretical 3-D form into the measured one. Gear support base integrated with magnetic base is presented, which has advantages in multi degree of freedom (DOF) adjustment and high stiffness. For the in-situ observation system, a high-power stereo microscope integrated with digital camera is introduced, which enables the observation of the gear tooth condition without disassembling the gear parts.

“Power-circulating form” test rig is built for vibration tests of the thin walled gears by **Shuting Li [19]**. This paper is a fundamental study on resonance frequency behaviour of three dimensional, thin-walled spur gears from experimental tests and finite element analyses. “power-circulating form” test rig is built for vibration tests of the thin walled gears at the speed range 500–3000 rpm and then strain phase method is presented in this paper to identify the resonance mode shapes of the thin-walled gears when they are running in a complete resonance state. In recent years, these gears have been finding wide applications in general machines for weight reduction and compact design. Though applications of the thin-walled gears are increased in general machines, vibration and dynamic strength design problems of the gears have not been solved so far. This paper attempts to solve some of these problems stated above through experimental investigations and FEM analyses.

In this paper, firstly, “Power-circulating Form” gear test rig is built to test resonance frequencies, mode shapes and dynamic load factors of two thin-walled spur gears with different wall thickness in speed range 500–3000 rpm. Dynamic behaviour of the thick-walled gears in the test rig is also investigated at the same time for comparisons.

**N.A. Wright et al. [20]**, this paper focuses on the aspects of the performance of polymeric gears have been studied by a number of workers and efforts have been made to simulate the contact conditions during gear running. However, until now the wear performance of gears made from polymer matrix composites has not been studied systematically. While such materials have been studied using pin-on-disc or twin disc roll/slide wear techniques, no attempt has ever been made to directly compare the results from such studies with those from gear tests. This paper attempts to explain the comparative methods of measurement of various polymer matrix composite gear materials and to relate their performance to results obtained in contact simulation experiments by other workers. Methods of wear testing are compared including direct gear testing and disc testing, together with electronic (displacement) measurement, weight loss and direct measurement. A new method of characterizing the wear of gears is presented, which relates actual contact conditions and gear tooth wear.

**Stewart Denny, “Test Gear and Measurements” [21]** book provides a clear introduction to test gear in the field of electronics. As well as being a first guide to test gear and its use, the book includes much practical information and reference material for the more experienced electronics enthusiast or student. Details of all the common (and some not-so-common) items of test gear are included, alongside information regarding its use in various measurement situations.

**R.K. Jain et al. [22]**, have presented Parkinson gear tester as an efficient one for checking the flank surfaces of the gear and determine the error significantly. For efficient performance of the gear, this test rig is used they have performed three levels of test experiments considering flank surface. It was observed that this test rig can improve the life of gear.

In order to check the combined tooth error different types of gear testing machines are used, stated by **Tharesh K. Gawande et al. [23]**. Various machines have its ability to check specified parameters only. Highly precise machine required special installation and space. For the purpose of checking gear in machine shop while performing machine required such an arrangement which is robust and quick one. This purpose can be solved using gear test rig.

This type of gear test rig can be used for mass production of gears of a particular gear box.

**International Gear Conference 2014, 1st Edition [24]**, This book presents papers from the International Gear Conference, held in Lyon, 26th-28th August 2014. Mechanical transmission components such as gears, rolling element bearings, CVTs, belts and chains are present in every industrial sector and over recent years, increasing competitive pressure and environmental concerns have provided an impetus for cleaner, more efficient and quieter units. Moreover, the emergence of relatively new applications such as wind turbines, hybrid transmissions and jet engines has led to even more severe constraints.

The main objective of this conference is to provide a forum for the most recent advances, addressing the challenges in modern mechanical transmissions. The conference proceedings address all aspects of gear and power transmission technology and range of applications (aerospace, automotive, wind turbine, and others) including topical issues such as power losses and efficiency, gear vibrations and noise, lubrication, contact failures, tribo-dynamics and nano transmissions.

Then **Omkar B Agashe et al. [25]** have discussed that Gear roll testers are used to measure and analyses functional performance of gears. Gear testing is a technique that has been used in the gear industry to identify potential manufacturing defects in the design intent of the gear. It is a practical, fast and effective screening tool that can identify when the gear manufacturing process has deviated from an ideal condition that could result in a

change in backlash, or an unwanted noise and vibrations in a gear mesh therefore, in the present work it was decided to develop a gear roll tester to analyse effects of different types of defects in gear on its functional performance in terms of run out, pitch errors, backlash, profile errors, noise and vibration. For the present work a spur was selected with the specifications matching with the gear used in automobiles. A test rig was designed and developed for the functional testing of spur gears.

They have presented that Parkinson gear tester is most suitable equipment which can be used to measure deflection of gears. In this they use plastic gears in order to reduce material cost and also by using manually adjustable spring load errors could be defined. They conclude that in case of dry condition of gear mating part friction is more which gives more deflection.

We observe a Parkinson gear tester to be extending gear life and reducing error, stated by **Shinde Tushar. B. et al. [26]**. Their work aims to understand the accuracy of flank surfaces. This test rig is useful to find out the flank surface and irregularities in gear tooth with ease. Gear test rig is such arrangement which simplifies the measurement and saves the labour time and labour cost with greater accuracy. In gear test rig all the gears will be mounted on a plate which may be fixed or stationary as per the requirement of the measurement. While measuring the one gear remaining will act as a master gear. This will help in finding the composite error. This test rig can be used in shop floor as it requires less space and operator can use it as per need without wasting much time. The test rig can be developed for different parameter as per measurement requirement. There are various test rigs which can be used for that particular designed condition.

With the continuous progress of measurement technology, gear measuring instruments have undergone great changes. Over the years, hundreds of gear measuring devices have been developed. Some of these measurement methods require manual operation and high work intensity, and they are greatly affected by

human factors; some require expensive equipment, and for contact measurement, different gear surfaces require path planning and probe radius compensation. It may even damage the surface of the workpiece. Moreover, **L. Qiu [27]** presented a gear non-contact laser measuring device, where the measuring data is sampled by placing the laser beam through the gear rotating center. With the advantages of low cost, high precision, and universal applicability, a non-contact measuring method for the radial runout of cylindrical gear tooth profile is proposed only using a single laser displacement sensor in this paper. A theoretical optimization model is established according to the measurement principle and the laser sensor characteristics, and the optimal installation position and angle of the laser sensor are presented for measurement arrangement.

But, **A. Zbrowski & K. Matecki et al. [28]** stated that According to laser displacement sensor's measurement principle and working characteristics, this measuring method will cause the laser spot on gear tooth profile to be elongated, thus affecting the sensor's measurement accuracy seriously. The article presents the methodology, test stand and results of noncontact tests conducted using a laser sensor-equipped system for measuring displacement. The tests were carried out in an attempt to determine the sensitivity of the measurement system to the angular position of the sensor against the surface onto which the laser spot was projected.

The tests were executed in the measurement range between 5 and 50 mm taking into account 5 angular positions of the laser sensor. The readings of the laser head were referred to the value of displacements adjusted with the use of a micrometric head. In the case of the tested system, the dispersion of measurement deviations was estimated as a function of the measured distance. In continuation of this, as the gear tooth profile's optical characteristics are mainly mirror reflection, there is a case where laser displacement sensor cannot obtain the measuring signal, presented by **B. Sun et al. [29]**.

During this in 2017, **Dattatray Knannavare** came up with “**Modified Parkinson’s gear tester**” [30]. They have presented Modified Parkinson gear tester. In order to check the combined tooth errors, different types of gear testing machines were used. Various machines have its ability to check specific parameters only. They used springs and slider table with roller these will provide flexibility of checking composite error of different types of gears. This concludes that modified test rig can check composite error with higher accuracy. This gear test rig will check the gear in minimum time which results in decrease of Productive time & improve efficiency of inspection.

**Nishant Devkate et al.** [31] have presented that Parkinson gear test rig is the easiest to use equipment for checking any irregularity in gear tooth. In Parkinson test rig, three rectangular plates were used which is mounted on liner guide ways. In working condition of test rig, the movements of the plate will response the error in gear. It was observed that the locking and jamming of gears can be easily detected from this technique.

Gears are the crucial element of any transmission system which generally used for power transmission. Such type of part must be check by using the highly accurate methodology in order to assess its functional performance in advance. The inspection methodology of gears should be accurate with less time-consuming procedure for its inspection. This gear test rig will check the gear in minimum time which results in a decrease of non-productive time and improves plant efficiency.

The benefits and need of gear test rigs were discussed by **Ganesh Bagade et al.** [32]. Gears are the crucial element of any transmission system which generally used for power

transmission along with other applications depending upon working requirements. Such type of component must be check by using highly accurate methodology in order to assess its functional performance in advance. The inspection methodology of gears should be accurate with less time-consuming procedure for its inspection. This objective is easily obtained by using Gear Test Rig.

**Gawade Tanmay, “Automation of Parkinson’s Gear Tester”** [33] have discussed that constant change is observed in manufacturing sector in accordance with the trouble of passing on new arrangement into reality. New machines and the frameworks are being made constantly to makes diverse thing at less costly rates and with high precision. Gear is most important component in to the power transmission method. The gear profile is very is important factor of gear application at different area like automobiles, machine tools & other area power transmission. Hence the gear shape & accuracy is very important. Model of Parkinson gear tester testing includes the gear tooth profile through dial indicator. It can be very useful for gear testing laboratories, gear modification industries.

**V Shinde et al.** [34] aims to understand the accuracy of flank surfaces. They have presented that the various test rig which is used for measurement of particular parameter like gear tooth alignment, gear tooth surface and pitch circle these are to be tested. This test rig differs as per the requirement of application and as per requirement of parameter to be tested.

## CONCLUSION

Our intent behind all of this was to make you aware of how the evolution has taken place in field of gear testing and what should be done to achieve higher accuracy as well as precision in gear testing equipments.

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## Design and Experimental Analysis of Tooth Impact Test Rig for Spur Gear

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### ABSTRACT

*This project is about the design and analysis of a prototype of tooth impact test rig for spur gear. The test rig was fabricated and analysis was conducted to study its' limitation and capabilities. The design of the rig is analyzed to ensure that there will be no problem occurring during the test and reliable data can be obtained. From the result of the analysis, the maximum amount of load that can be applied, the factor of safety of the machine, the stresses on the test rig parts were determined. This is important in the design consideration of the test rig. The materials used for the fabrication of the test rig were also discussed and analyzed. Static analysis of spur gear will be perform using ANSYS 19 workbench. Modeling of test rig and spur gear will be design using CATIA V5R20 software. Based from the results, there were limitations found from the initial design and the test rig design needs to be improved in order for the test rig to operate properly. Experimental study using strain gage to determine the strain at the gear tooth can be conducted with the availability of this test rig.*

### Introduction

The common impact tests that can be found are Charpy and Izod. These tests date back to late 1800s and early 1900s. In 1901, Charpy proposed a standardized testing method known as Charpy impact test which is still used widely till today.

Another test which is widely known is Izod impact strength test. Both are an ASTM standard method of determining the impact resistance of materials. The energy absorbed by bending or fracturing of the test piece is calculated from the mass of the pendulum, initial angle of swing, and the recorded angle of rise after the impact. This will give out an energy amount, which is empirically related to the ductility or brittleness of the material. Usually, the material is steel which have undergone heat treatment.

During the years, several standard test methods such as ASTM, ISO and SAE begin to emerge to become a guideline in testing materials.

Ziegler and Eberhard did a finite element analysis and experiment to investigate the impact on gear wheels subjected to force. In the FEA, ABAQUS is used and SIMPACK is used for the rigid body model. They simulated contact on 6 potential contact points. The result obtained using are almost similar, thus showing that the elastic multibody analysis is highly accurate.

Experiments were made to validate the data obtained from the simulation. Two-impact body are used, spherical and cuboid. Both present different results due to the contact condition. They concluded that the experimental results validate their finite element model and elastic multibody model.

Studies done by Gonzalez et al involves creating a virtual impact test rig to study the effects of the test on a set of elements with intraluminal failure model. The impact energy is varied and the results were compared with experimental values. Two laminates were considered in their study. However, they did not analyses the effects on the virtual test rig.

### Objective

- Build a functioning test rig for spur gear.
- Modeling of test rig and spur gear will be design using CATIA V5R20 software
- Redevelop the test rig setup based on Pneumatic cylinder and control valve.
- Design and analysis of test rig setup using ANSYS 19 workbench.

### Conclusion from Literature Review

In this report we successfully develop spur gear tooth impact test rig using CATIA model. We analyze the spur gear using ANSYS software.

And find out Total deformation and equivalent stress using static analysis.

### Methodology

Step 1- Initially research paper is studied to find out research gap for project then necessary parameters are studied in detail. After going through these papers, we learnt about Tooth impact test rig for spur gear.

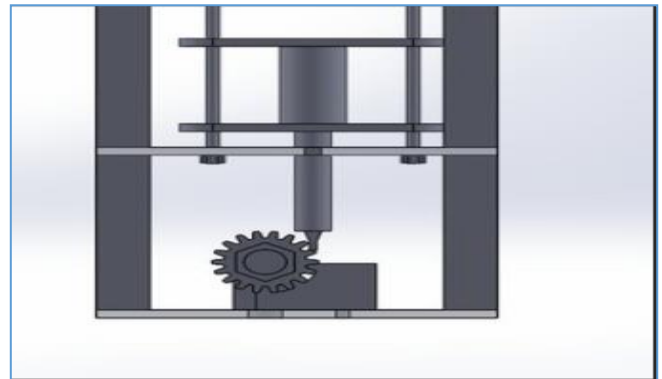
Step2 - Research gap is studied to understand new objectives for project.

Step 3-After deciding the components, the 3D Model and drafting will be done with the help of CATIA software.

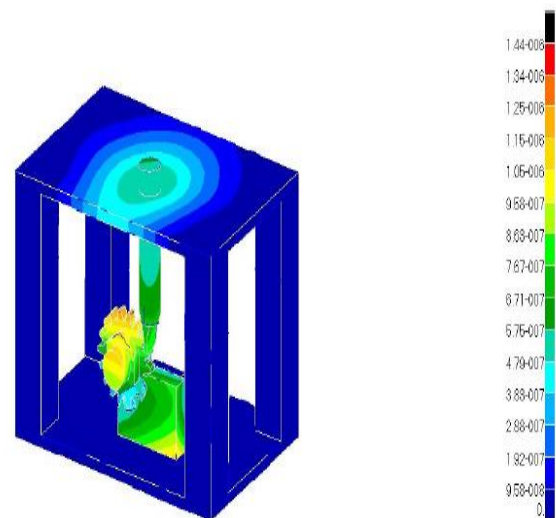
Step 4 - Redevelop the test rig setup based on Pneumatic cylinder and control valve. Design and analysis of test rig setup using ANSYS 19 workbench.

Step 5 - Comparative analysis between the experimental and analysis result.

### CAD Model



### Analysis of CAD Model



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2. Development and application of a test rig for tribological investigations under impact loads by Florian Böhmermann\*, Oltmann Riemer.
3. Design and Analysis of Tooth Impact Test Rig for Spur Gear by Wafiuddin Bin Md Ghazali<sup>1</sup>, Ismail Ali Bin Abdul Aziz<sup>1</sup>, Daing Mohamad Nafiz Bin Daing Idris<sup>1</sup>, Nurazima Binti Ismail and Azizul Helmi Bin Sofian

**Design and Development of Machine Generating Water from Air****A.S.Dube<sup>1</sup>, Prof. P.A. Karole<sup>2</sup>, Aniket shitole<sup>3</sup>, Bhiraj sonewane<sup>4</sup>, Milind patil<sup>5</sup>, Yatin sarode<sup>6</sup>**<sup>1</sup> Professor (Mech), SIEM, Nashik, <sup>2,3,4,5,6</sup> BE Mech.Students, SIEM, NashikEmail: <sup>1</sup> anil.dube@siem.org.in, <sup>3</sup> aniket.shitole15051999@gmail.com, <sup>4</sup> bhirajsonawane0099@gmail.com, <sup>5</sup> mppatil245@gmail.com, <sup>6</sup> yatinsarode8@gmail.com**ABSTRACT**

*In many countries like India it is difficult to obtain water resources for irrigation or other purposes, especially in the arid regions. The problem of water scarcity is also observed in other places of the world due to lack of rainfall. However, in highly humid areas such as places close to the sea, water can be obtained by condensing the water vapour present in air. Here, the paper presents the method to develop a water condensation system based on a thermoelectric cooler. The system consists of cooling elements, heat exchange unit and air circulation unit. Atmospheric Water Generator is a device that can convert atmospheric moisture directly into usable and even drinkable water. It is such a device which uses the principle of latent heat to convert molecules of water vapour into water droplets. It has been introduced a bit before, though it is not very common in India and some other countries. It has a great application standing on such age of technology where we all are running behind renewable sources. This paper also describes the experimental results and the system's performance.*

**Keywords:** Thermoelectric peltier, Dew condensation (latent heat)

**Introduction**

Atmosphere contains large amount of water in the form of vapour, moisture etc. Within those amounts almost 30% of water is wasted. This amount of water can be used by implementing a device like Atmospheric Water Generator. This device is capable of converting atmospheric moisture directly into usable and even drinking water.

The device uses the principle of latent heat to convert water vapour molecules into water droplets. In many countries like India, there are many places which are situated in temperate region; there are desert, rain forest areas and even flooded areas where atmospheric humidity is eminent. But resources of water are limited. In the past few years some projects have already been done to establish the concept of air condensation as well as generation of water with the help of peltier devices, such as harvesting water for young trees using Peltier plates that are powered by photovoltaic solar energy, etc. So, this project will be helping to extend the applications of such devices further in the near future. According to previous knowledge, we know that the temperature require to condense water is known as dew point temperature. Here, the goal is to obtain that specific temperature practically or experimentally to condense water with the help of some electronics devices. This project

consists of a thermoelectric peltier (TEC) couple, which is used to create the environment of water condensing temperature or dew point, indeed conventional compressor and evaporator system could also be used to condense water by simply exchanging the latent heat of coolant inside the evaporator. The condensed water will be collected to use for drinking purpose and various other uses.

**Peltier couple**

The peltier thermoelectric device has two sides( a p-type and an n-type semiconductor), and when DC current flows through the device, it brings heat from one side to other, so that one side gets cooler while the opposite one gets hotter. This is called Peltier effect and electron hole theory. Peltier coolers consist of a Peltier element and a powerful heat sink/fan combination. Peltier elements come in various forms and shapes. Typically, they consist of a larger amount of thermocouples arranged in rectangular form and packaged between two thin ceramic plates. This type of device is so powerful that it can freeze good amount of the water within several minutes.

A conventional cooling system contains three fundamental parts-the evaporator, compressor and condenser. A TEC also has some analogous parts. Energy (heat) is absorbed by

electrons at the cold junction, as they pass from a low energy level in the p-type semiconductor element, to a higher energy level in the n-type semiconductor element. It is the power supply that provides the energy to make those electrons to move through the system. At the hot junction, energy is expelled to a heat sink as electrons move from a high energy level element (n-type) to a lower energy level element (p-type).

**Working Features**

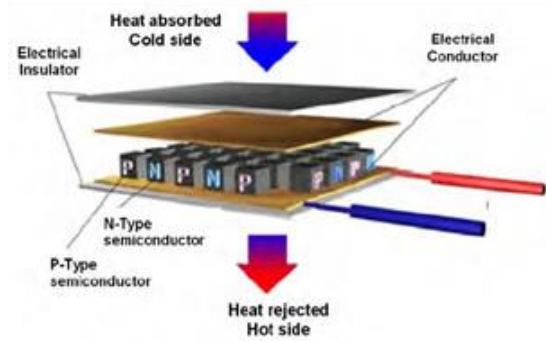
Practically TE couples are combined in a module, connected electrically in series and thermally in parallel to obtain a promising output. But it will be inconvenient to use such a device that has less advantageous work done to power ratio. There are modules available in the market according to variety of sizes, shapes, operating voltages-currents and ranges of heat pumping capacity. The present trend, however, is towards a larger number of couples operating at lower currents; before choosing an efficient device, some parameters must be determined. These are:

- TC: Temperature at Cold Surface.
- TH: Temperature at Hot Surface.

This TH incorporates two major parameters:  
 1. The efficiency of the device i.e. between the hot surface of the TEC and the ambient environment.  
 2. The temperature of ambient environment into which the heat is being rejected.  
 QC: The heat to be absorbed at the Cold Surface.

The object to be cooled is intimately confined with the cold surface of TEC, thus the temperature of that object starts falling until it is as same as the temperature of the cold surface of the TEC. Now,  $\Delta T$  can be defined as:

$\Delta T = TH-TC$  (1) This conflict should be accurately determined if the design is to operate as desired.



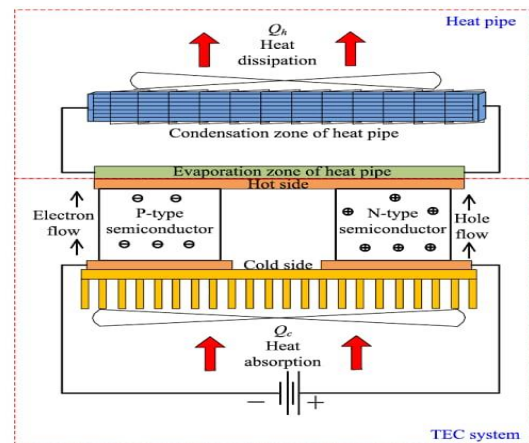
**Figure 1: Overview of peltier device**

The ratio of QC to P is the heat absorbed at the cold junction, divided by the input power i.e.  $QC / P$  is known as COP [5] which is often used to pick out better device.

Advantages of this device over conventional device:

There are lot of advantages of TEC over the conventional refrigeration system.

- No moving part, so maintenance is required less frequently.
- No use of chlorofluorocarbons.
- Temperature control within fractions of degrees can be maintained.
- Flexible shape (form factor); in particular, they can have a very small size. Ideal for modern technology trends.
- Can be used in environments that are smaller or more severe than conventional refrigeration.
- Has a long life, with mean time between failures (MTBF) exceeding almost 100,000 hours.
- Controllable via changing the input voltage/current very easily.
- Draw comparatively low current than a compressor based refrigeration system.



**Figure 2: Working of Peltier Device**

### 3. Literature Review

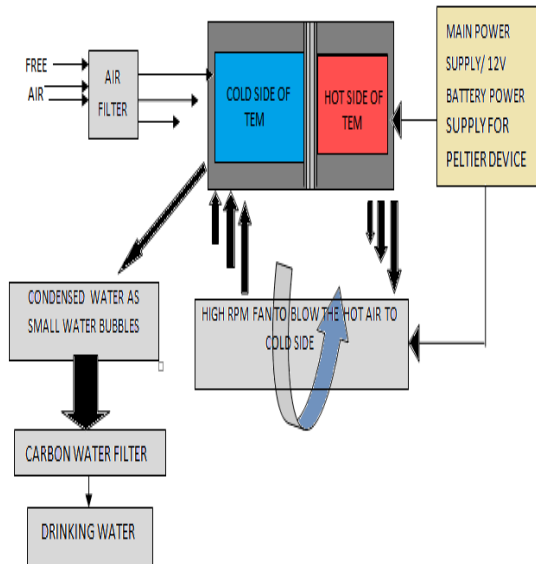
Anbarasu and Pavithra in (2011), done the work on Atmospheric water generator & publish his research paper title of the paper is "Vapour Compression Refrigeration System Generating Fresh Water from Humidity in the Air". This paper infers that dehumidifying unit using vapour compression refrigeration system will be more effective than the Peltier system but it lacks in the sense that it is not portable and it generates a lot of sound. And also this system is more costlier than any. [1]

Niewenhuis et.al., 2012, done the work on "Water generator water from air using liquid desiccant method", there in that work observed that even though this dehumidification by liquid desiccant method is new and it possess a lot of potential theoretically but when the researchers made a prototype and put it for testing, it was found that the result was not satisfactory. The device could produce only 72.1 mL of water per kW-hr. Along with Niewenhuis many have tried to use the same liquid desiccant method for dehumidification. After they built the prototype and put it into testing it was found that water created from the gadget was very dismal. Hence from this paper we got to know that not to use this method of dehumidification for our prototype. [2]

Kabeela et.al. (2014), has done the work on "Solar-based atmospheric water generator utilization of a water recovery", during this study they used the tactic of dehumidification unit using Peltier device, it had been found that the device is extremely portable and environment friendly. It consists of straightforward design with high capabilities. This sort of device are often implemented in extreme situations like during floods or in desert and rural areas. This device has greater advantages because it works sort of a renewable source of atmosphere water and doesn't need an important power source. Applying this technique during a highly humid region almost 1 Litre of condensed water during the day time. Hence due to these many advantages we decided to use the Peltier device which is more portable and eco friendly. [3]

### System assembly

The matter of the performance is to be accomplished. when this device is kept within a comparatively humid environment and air is pushed towards the cooler side of TEC device, so that the water vapour gains its latent heat, required for the dew point temperature and thus water condensation takes place; this process can be enhanced if same hot air is passed through the cold side of TEC, so that water droplets doesn't form ice and generation of water takes place. It is imperative to keep in mind the purpose of the assembly, so the technique to be used is as important as the selection of the proper device. All of the mechanical interfaces assembled within the objects are to be cooled as well as the ambient. It's quite natural that all thermal-mechanical interfaces tend to inhibit the flow of heat by adding thermal resistance. The consideration of assembly techniques should be highly optimized to minimize thermal resistance. Mechanical tolerances of heat exchanger [6] surfaces should never surpass 0.001 in/in with a ceiling of 0.002" of total Indicated Reading. When it is essential to use more than one module between common plates, the variation of height between modules, it should not go beyond 0.001" (request tolerance lapped modules when ordering). Generally most TE assemblies make use of "thermal grease" interfaces. The thickness of the grease should be limited to  $0.003 \pm 0.0006$ " [7]. In order to incorporate these types of tolerances, certain levels of cleanliness must be maintained; as grease has high affinity to such pollutant elements like dirt, grit, and toxic powder of Sulphur, Carbon compounds etc., and these elements can increase the level of impurity inside the water pouring from the adjacent places of grease joints.



**Figure 3: Schematic Diagram of System Assembly for Drinking Water**

### Description

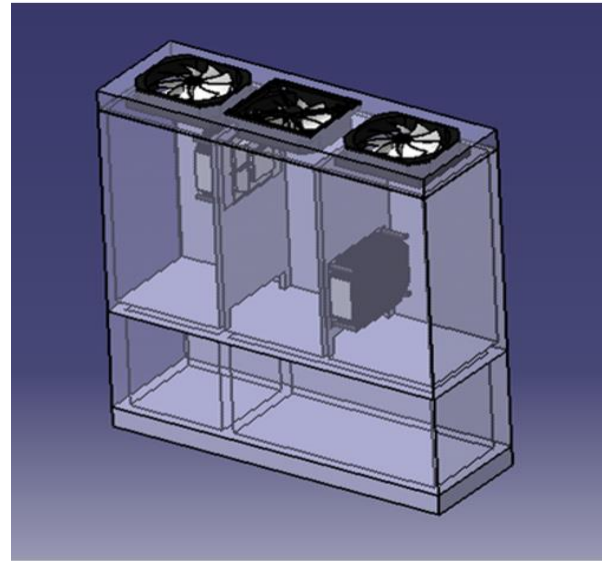
As can be seen from the CAD model the casing consists of three parts.

The upper part consists of three draft fans. The middle draft fan draws air from atmosphere into the device while the other two are used to expel the dehumidified air.

The middle part of the casing is further divided into three chambers. The inlet air is passed through the middle chamber where it comes in contact with the cold surface of the Peltier device. The inlet atmospheric air thus loses heat and its temperature falls to that of the dew point temperature and thus water starts condensing. The dehumidified air is then expelled from the device by the left and right chambers.

The lower part acts as a water collecting unit. Condensed water from the middle part is collected in this lower part by dripping action as water droplets are pulled down by gravitational force.

### CAD Model



**Fig. CAD Model of Final Product**

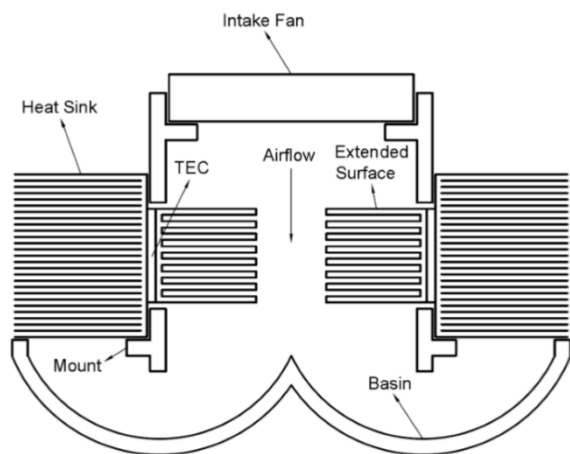
### Working

The upper part consists of three draft fans. The middle draft fan draws air from atmosphere into the device while the other two are used to expel the dehumidified air. As soon as the device is powered, the hot side of peltier device starts getting hotter and cold side cooler; reaching the dew point temperature. The cold side of Peltier device starts to cool the air passing through its heat sink area and water vapours start to condense just like the water condensation happens outside a glass full of ice. The middle part of the casing is further divided into three chambers. The inlet air is passed through the middle chamber where it comes in contact with the cold surface of the Peltier device. The inlet atmospheric air thus loses heat and its temperature falls to that of the dew point temperature and thus water starts condensing. It is important to keep in mind that when Peltier device starts it takes a longer time to actually produce water, though it reaches the dew point temperature readily, but after some time the process acquires the speed to produce sufficient water according to the experiment result of this project. Peltier is a device that is used for average efficiency requirement according to the power is fed and time taking to reach its optimum level of cooling effect. As this project mainly lies on the uses of Battery, it is immediately not possible to use higher



Peltier device will require higher voltage rating. The inlet atmospheric air thus loses heat and its temperature falls to that of the dew point temperature and thus water starts condensing. The dehumidified air is then expelled from the device by the left and right chambers. The lower part acts as a water collecting unit. Condensed water from the middle part is collected in this lower part by dripping action as water droplets are pulled down by gravitational force.

**Working Related Diagram**



3.5.1 1 – 2D sketch of the AWG conceptual design

**Component**

Sl. no.	Component name	Quantity	Specification
1.	Draft fan	3	DC 12V 0.16 Amp
2.	Peltier	2	TEC 12706
3.	Heat sink	2	Heat sink of Pentium 4 motherboard
4.	Casing		Acrylic sheet
5.	400W PSU	1	Zebronics

**Calculation**

- Dew-point temperature (T<sub>dp</sub>) is the temperature at which humidity in the air starts condensing at the same rate at which it is evaporating at a given constant barometric pressure.
- Dry-bulb temperature (DBT) is the temperature of air measured by a thermometer freely exposed to the air but shielded from radiation and moisture. DBT is the temperature that is usually thought of as air temperature, and it is the true thermodynamic temperature
- Relative humidity (RH) is the ratio of the partial pressure of water vapour to the

equilibrium vapour pressure of water at the same temperature.

- A well-known approximation used to calculate the dew point, T<sub>dp</sub>, given just the actual ("dry bulb") air temperature, T and relative humidity (in percent), RH, is the Magnus formula:

Where, b = 17.67 & c = 243.50C and T is in 0C  
 Sample Calculations: (for DBT=300 c and RH=45%)

Amount of water (in L) present in 1 m<sup>3</sup> of air for different humidity and temperature conditions Saturation Pressure (P<sub>s</sub>) is the pressure of a vapour which is in equilibrium with its liquid.

Partial Pressure of water (P<sub>w</sub>) is the pressure of water vapour present in a mixture of air and water vapour.

$$RH = (P_w / P_s) \times 100$$

Thus from saturation pressure (P<sub>s</sub>) and relative humidity (RH) data partial pressure of water (P<sub>w</sub>) can be obtained as

$$P_w = (RH / 100) \times P$$

Humidity Ratio gives the volume of water (in m<sup>3</sup>) present in 1m<sup>3</sup> of air.

Humidity ratio can also be expressed in terms of partial pressure of water (P<sub>w</sub>) as

$$HumidityRatio = 0.622 \times P_w / (P_a - P_w)$$

(Where P<sub>a</sub> = 1.01325 bar)

Sample Calculations:

(For atmospheric temperature 250C and relative humidity 35%)

Saturation Pressure of water vapour (P<sub>w</sub>) at 250C is obtained from steam table as 0.03167 bar.

$$P_w = RH / 100 \times P_s$$

$$= 35 / 100 \times 0.03167$$

$$= 0.0110845 \text{ bar}$$

$$Humidity Ratio = 0.622 \times P_w / (P_a - P_w)$$

$$= 0.622 \times 0.0110845 / (1.01325 - 0.0110845)$$

$$= 0.006879661$$

Therefore amount of water (in litres) present in 1m<sup>3</sup> of atmospheric air

$= \text{Humidity ratio} \times 1000 = 0.006879661 \times 1000 = 6.879661 \text{ litres}$

### Application

- It has great advantages as it works like a renewable source of atmosphere water and doesn't need a heavy power source
- Atmospheric Water Generator is the device which can be implemented for extreme situation, to use during flood, in desert areas, and in rural areas.
- It can be implemented for Industrial development where the water is a matter of crisis.

### Conclusion

By applying this system we have conclude that from highly humid region we can extract more amount of drinking water from atmospheric air. The use of this system may result in solution for drinking water problem in many situations without high infrastructure setup cost and time needed. It could create additional portable

drinking water without any external sources like compressor, condenser, etc.

- Low maintenance and easy to operate.
- Design is simple and very efficient.
- Cost is less than other conventional machine.

### Future Scope

1. This idea can likewise be utilized as a superior option in refrigeration science against traditional frameworks.
2. RO water filter which kills the bacteria and also UV water filter which kills all the pathogens present in the water can be used for large scale implementation for producing such water that meets the standard of WHO water guidelines.
3. As this project aims at producing water from atmosphere, small sized scrubber can be used to remove all oxides from the air and made it portable for drinking and other purpose.

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**Design and Development of Automated Solar Panel Cleaner****Anil Dube<sup>1</sup>, Manasi Deshpande<sup>2</sup>, Sarthak Patil<sup>3</sup>, Kunal Bhandure<sup>4</sup>, Kunal Gaikhe<sup>5</sup>**<sup>1</sup> Professor, Mechanical Department, SIEM, Nashik,<sup>2,3,4,5</sup> Scholar, Dept of Mech. Engg., Sandip Institute of Engineering and Management, SIEM, Nashik**ABSTRACT**

*The solar panel works by allowing the light into solar cells. The more the light impacts on a panel, the more power it will generate. Due to the upwards angle of solar panels, they are more likely to build up the dust and bird dropping. The dirt which cannot be cleaned with just rain. This is reducing the amount of light impact on the panel which also reduces panel output. The solar panel manufacturers and installers are claims about the projected energy figures that are based on the optimum performance of clean solar panel. Due to build up the dirt on solar panel can adversely affect the panel's ability to meet those projected figures. So, it is necessary and important to clean the solar panel in order to protect and get more power output. So, we are design and develop the automatic machine which is clean the solar panel and improve the panel efficiency. All of the tests showed that cooling the module improves its efficiency. The mean efficiency increase is about 50% and it is expected that it can be even more for high-efficiency modules. The investigation of new commercially available Photovoltaic modules could show how high the appropriate additional income would be. On the other hand, this increases the cost and requires energy to operate the pump in the hydraulic circuit of the coolant. These efforts are particularly advantageous in a limited space because the electrical power generated per square meter increases and thermal energy can be produced without the installation of additional devices. Although cooling of PV panel with hollow fibers is feasible (up to 1 kW of heat can be removed by cooling system reducing the module temperature from to about 50 °C) further research is still required.*

**Keywords:** PV solar panels, Solar cells, Energy figures, Cleaning, Cooling, Efficiency improvement, Photovoltaic modules, Hydraulic circuit.

**Introduction**

Green technologies are becoming more and more common. Thousands of photovoltaic (PV) panels and solar collectors have been installed all over the world. In 2013, 39 GW of solar PV system installations were completed, with reporting growth of 139% in solar PV installation on a year-to-year basis. The desire to increase the effectiveness of PV panels led to the development of so-called photovoltaic thermal hybrid solar collectors, sometimes known as PVT Systems. These systems combine photovoltaic cells, converting electromagnetic radiation into electricity, with a solar thermal collector, capturing the remaining energy and removing waste heat from the PV module. The main advantage of this design is that coupling these two devices (PV system and solar collector) decreases the temperature of PV cells, thus increasing their electrical efficiency and Operational life.

PV Cell is a semiconductor device that generates electricity when light falls on it. A PV cell converts only a small fraction (approximately less than 20 %) of the irradiance into electrical energy. The balance is

converted into heating of the cell. As a result, cell can be expected to operate above ambient temperature. If the temperature is increased, there is marked reduction in the cell voltage. Cell voltage decreases by approximately 2.2 mV per 0C rise in operating temperature. In March 2003, BP Solar announced an efficiency of 18.3%, while Sanyo has already put on the market a cell with an efficiency of 19.5%. Overheating of a PV module decreases performance of output power by 0.4-0.5% per 1°C over its rated temperature (which in most cases is 25 degrees C). This is why the concept of 'cooling of PV' has become so important. To reduce this phenomenon can be applied on the back to panel a cooling water system, which can provide hot water for domestic applications Hybrid Photovoltaic/Thermal (PV/T) solar system is one of the most popular methods for cooling the photovoltaic panel nowadays. The hybrid system consists of a solar photovoltaic panel combined with a cooling system.

The sun offers the most abundant, reliable and pollution-free power in the world. However, problems with solar energy, namely the expensive cost and inconsistent availability,

have prevented it from becoming a more utilized energy source. Another problem, it is well known that a decrease in the panel temperature will lead to an increase in electrical efficiency, so in recent years different cooling techniques have been proposed and tested experimentally. The efficiency drops with the rise in temperature, with a magnitude of approximately  $0.5 \text{ } \%/^{\circ}\text{C}$ . Increase in electrical efficiency depends on cooling techniques, type and size of the module, geographical position and the season of the year, and usually corresponds with a rise of 3-5 % in overall efficiency. In water cooling technique, amount of water consumption plays an important role. So, in this work, efficient water-cooling technique is proposed to improve solar panel life time along with reduced power to drive the water-cooling system. Hence to overcome this problem cooling & cleaning system of the panels to be developed for increases the efficiency of PV System.

1. To design a mechanism to detect obstructions on solar panels causing significant loss of power.
2. To design a cleaning mechanism that runs across the length of the panels.
3. To improve overall solar panel efficiency.
4. To increase the efficiency of the plate.
5. To increase life of the plate.
6. To reduce cleaning cost of the cleaning process.
7. To reduce the labor cost.
8. To reduce the time of the cleaning.
9. Automatic cleaning system.
10. Controlling by itself.
11. To remove dust particles.

- 1) Literature survey on solar PV panel cleaning & cooling system in India.
- 2) Identify the different ways to solar PV panel cleaning & cooling system.
- 3) Design development and fabrication of solar PV panel cleaning & cooling system.
- 4) Testing of solar PV panel cleaning & cooling system in different conditions.
- 5) Analysis of performance of the solar PV panel cleaning & cooling system. With regards to power, efficiency and cost.

This report discusses about how the constraints such as dust, overheating affect the output of the solar PV panels and the automated technologies that are involved in solar PV panel cleaning system that help in maximizing the output by minimizing the effect the constraints have on solar panels.

The scope of this project is to enhance the efficiency of solar panel using a cooling & cleaning system. This project is that it will help in use of effective solar energy with higher efficiency for the solar panel output.

## 2. LITERATURE REVIEW

Raudensky M et.al, they've worked on Solar Panel Cooling System with Hollow Fibers. In this when Solar panel is over heated drastically it reduces their efficiency and lifespan. This overheating is mainly associated with temperature fluctuations that occur under severe weather conditions. Overheating also has the potential to form electric arcs that can start to melt metal fixtures and burn away the module & insulating materials. The efficiency of electric solar panels is strongly dependent on temperature regime (especially in Hot climates). For this reason, the introduction of cheap and light water-cooling, or a more general liquid-cooling system inside the solar panel, appears reasonable. Hollow fiber cooling systems consisting of plastic tubes of a small diameter (less than 1 mm) are one possible and simple solution. Fibers placed inside solar panels can be glued or otherwise connected to the surface and coolant flowing through them provides efficient and uniform cooling of all photovoltaic cells. Hollow fibers have very thin walls (about 0.1 mm) to transfer heat easily, and the system is light, compact and resistant to corrosion. Heat removed from the panel may be used for domestic or industrial needs or transferred to the atmosphere by cooling towers or dry-coolers.

Nair Milind et.al, the research they've conducted focuses on Enhancing the Efficiency of Solar Panel Using Cooling Systems, the recent upsurge in the demand of photovoltaic systems is due to the fact that they produce electric power without causing much damage to the environment by directly converting the solar radiation into electric power. Solar energy

is completely natural, it is considered as a clean energy source. So, the study on enhancing the efficiency of solar panel is very necessary. Photovoltaic cells get overheated due to excessive solar radiation and ambient temperature. Therefore, to rectify this problem different cooling systems are used so as to maintain the temperature of the cells. Free flow front water cooling of PV panels can improve the efficiency and reliability of photovoltaic energy conversion – the open voltage of the panels is increasing when its temperature decreasing and due to the lower operating temperature, its life cycle could be increase.

Abhishek Naik et.al, they've conducted their research on Automatic Solar Panel Cleaning System, the solar PV modules are generally employed in dusty environments which is the case in tropical countries like India. The dirt is accumulated on the panels which in turn reduces their efficiency. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. In order to regularly clean the dust, an automatic cleaning system has been designed, which senses the dust on the solar panel and also cleans the module automatically. In terms of daily energy generation, the presented automatic-cleaning scheme provides about 30% more energy output when compared to the dust accumulated PV module. Existing automated cleaners mainly focus on large arrays and in general are unsuitable for installing on smaller arrays namely residential roofs. For those with limited space this means that a smaller array only needs to be installed, hence our idea serves as a huge advantage for those smaller sites. Our system can be installed for roof top solar panels. The solar panel cleaning system was first designed taking into consideration the design parameters. Our model was tested and the following observations were made. The rack and pinion mechanism work as it was designed to do.

Swanand S. Wable & Somashekhar Ganiger have worked on Design & Manufacturing of Solar Panels Cleaning System. In their work, The Solar Panels Farms are generally situated in dirt and dust areas which are mostly in case

of tropical countries. The performance of solar panels depends on various factors, the power generated by farm can decreased if there is dust and dirt on panels and this

is the main factor for reduction. One can generally assume a reduction of about 40% - 50%, if the panels are not clean properly for 1-2 months. So, to overcome this problem and to increase the efficiency of power production cleaning of module on regular basis is necessary. To clean the dust, an automatic cleaning robot is developed, which will clean the panels on regular interval of time. The mechanism is based on control circuit, DC motor; microfiber (bristles) to clean the panels. The paper provides you with the idea how the robot will work and its effect on the energy production by solar farms. It will also to help to understand the problem

Arise due to not cleaning of solar cells. Dust accumulation on PV panels can significantly reduce their power output. While the Geographic region is solar-energy rich, the desert conditions are quite dusty threatening the PV systems power

generation potential. The robotic system proposed by me with the help of company is a simple way to tackle this challenge effectively. Although promising results will be obtained. Here we are going to set a new benchmark by using latest technology and replacing the conventional methods of cleaning the solar panels. We are saving water, time and money. In general, the technique used by other method explain above total cost of solar panel maintenance goes around 5% of total plant cost annually but cleaning done by robot reduced it by 2%. The robot of this kind can clean the solar farm as and when require very easily without man power thus saving the cost and waste age of water. Further we can add very interesting features in our system like de-ionized water cleaning; camera for inspection and climate-based cleaning. The major advantage of this robot is that we can inspect the farm without going on actual site. Also, in future we can reduce the weight and can made compact design of the system with the help of booming technology. Also, now a day there is increase in use of solar system in industries as well as at homes, thus giving a bright future scope for this system.

Rutvij P. Kulkarni et.al., have conducted research on automatic solar panel cleaning system, according to their work, the solar PV modules are generally employed in dusty environments which is the case in tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. In order to regularly clean the dust, an automatic cleaning system has been designed, which senses the dust on the solar panel and also cleans the module automatically. This automated system is implemented using ATMEGA 328 microcontroller which controls the DC gear motor. This mechanism consists of a sensor (LDR). While for cleaning the PV modules, a mechanism consists of a sliding brushes has been developed. In previous technology, PV panel is fixed on the roof top and it detects solar rays only in east west direction. But in this technology that we had developed the PV panel detects solar rays not only in east west direction but also in north-south direction. To achieve this feature the PV panel rotates in  $180^\circ$  and the base of whole assembly rotates in  $360^\circ$  with the help of DC motor. In Heliotex technology, cleaning of PV panel was done manually. But for this technology, cleaning is done by automatic system i.e., spray mechanism. DMU will activate the spray mechanism through microcontroller by using a timer. In this paper we discuss about new mechanism for solar panel cleaning to achieve better efficiency. The losses of the output power of the fixed solar panel can be higher depending on the dust form. The dirt and bird drop make a hot spot in the panel, and it can make temporary fail in the panel. Cleaning solar panel with water increases cleaning efficiency by removing majority of the dirt deposited on the panel. Comparing the costs of cleaning by manual operation and automatic operation the costs of automatic cleaning is proved to be more economic and significantly less difficult particularly in systems having large number of solar panels. Also, frequent periodic cleaning ensures that the solar panel works with agood consistency at all times.

Nasib Khadka et.al, have done their research on: Solar Panel Cleaner Technology: A Review, according to his work, Solar Photovoltaic systems have long been used to produce energy for different applications since 1990s. The efficiency of solar photovoltaic model is determined by the available Sun's irradiance along with various environmental factor like humidity, temperature, dust, snow, bird excrement etc. These environmental factor decreases the performance of the photovoltaic modules. This paper discusses on different technologies used for PV panel cleaning with their performance in different types of environments. It also discusses about the problems associated with different types of cleaning system. This review discusses effects of various parameters on the solar Photo Voltaic panel, and various cleaning systems that is developed and being used in present days.

Dabhi Chirag et.al. have published their work on Design and Development of Solar Panel Cleaning Machine, the solar panel is work by allowing the light into solar cells. The lighter that impact on a panel, the result more power it will be generate. Due to the upwards angle of solar panels, they are more liable to a build up the dust and bird dropping, the dirt which is not clean with just rain. This is reducing the same amount of light impact on the panel and reducing panel output. The solar panel manufacturers and installers are claimed about the projected energy figures that based on the optimum performance of clean solar panel. Due to build up the dirt on solar panel, that can adversely affect the panel's ability to meet that projected figure. So, it is necessary and important to clean the solar panel in order to protect and get more power output. So, we are design and develop the automatic machine which is clean the solar panel and improve the panel efficiency. The effects of presence of dust were studied using falling leaves, dust, bird dropping. The dust has a major impact on the efficiency and performance of the solar panel. The reduction in the peak power generates can be up to 10 to 30%. By the observation, it is observed that power reduction due to dust accumulated on the panel and it can be improved by using the cleaning method, there is increase in power and efficiency of solar

panel. This is easily maintainable and low of cost. Power consumption is also less for this process. Finally results showed that reduction in the peak power generated. In the future, the machine software can be developed to be smarter, such as that when it cleans any solar panel surface, it will save the information about size, its location and its ledges. We can use solar panel energy instead of individual battery. We can also attach camera for perfect wireless operation.

Manju B, Abdul Bari and Pavan C M have done the work on, Automatic Solar Panel Cleaning System. Energy is one of the major issues that the world is facing in India; the supply of energy has been one of the major problems for both urban and rural households. About 60% to 70% of the energy demand of the country is met by fuel wood and agriculture residues. Solar energy is a renewable source of energy, which has a great potential and it is radiated by the sun. Renewable energy is important to replace the using of electric energy generated by petroleum. Solar power has become a source of renewable energy and solar energy application should be enhanced. The solar PV modules are generally employed in dusty environments which are the case tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. The cleaning system has been designed cleans the module by controlling the Arduino programming. To remove the dust in the PV modules to improving the power efficiency.

From above literature it is observe that there is lot of work was to be done regarding to individual solar panel cleaning or cooling it should be costlier alteration & modification in existing solar panel system for increasing PV system output but by considering low cost alternatives for design & modifying simple fabrication in solar panel cleaning and cooling, we will increase the output of this solar photovoltaic system for which gives maximum output to reduce gap between old literature & method.

## EXPERIMENTAL SETUP

Components of automatic solar panel cleaning cooling system is given below,

**Table.3.1: List of Component of system.**

Sr No	Components	Quantity
1	Solar Panel, 5 watts	2
2	Solar charger Unit	1
3	12V Transformer	1
4	DC Motor , 60 rpm	4
5	Ball Bearings 10mm	2
6	Shaft, foam shaft roller 10mm	1
7	Fasteners	10
8	Supporting Frame	1
9	Electronic Temperature Controller	1
10	Water Tank	1
11	Water Pipe& connections	1
12	DC Submersible Pump, 12V	1
13	Cleaning Foam/ cloth bundle	1
14	Wheels	4

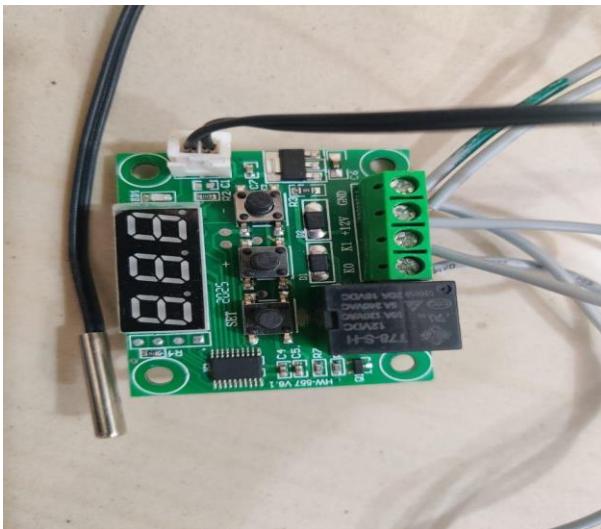
**Fig.3.1.2. Solar Panels**



The cleaning unit moves on the central part of the panel in a back-and-forth motion.

The wiper mounted on the fixture and tool unit reciprocates in the forward and backward direction. The cleaning unit along with the wiper moves along the central panel spraying the water droplets towards the other end of the panel. It forces the dust to move in the direction of the motion of the cleaning unit and finally flows it away at the edge of the panel. Once the cleaning unit reaches the other end, the water spraying stops and it again returns back. Once it reaches the home position, it sends the signals to the PLC. The cleaning unit stops here i.e., tool.

**Fig.3.1.3. Electronic Temperature Controller**

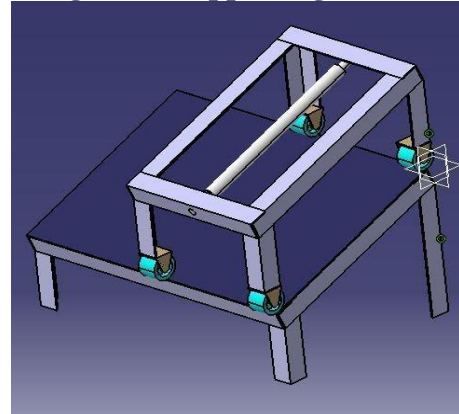


## DESIGN

### DESIGN CALCULATION

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy and efficiency. Hence a careful design approach has to be adopted. The total design work has been split up into two parts.

**Fig.4.4.1. Supporting Frame.**



## SYSTEM DESIGN

System design mainly concerns with various physical constraints, deciding basic working principle, space requirements, arrangements of various components etc.

Following parameters are looked upon in system design. Selection of system based on physical constraints. The mechanical design has direct norms with the system design hence system is designed such that distinctions and dimensions thus obtained in mechanical design can be well fitted in to it. Arrangement of various components made simple to utilize every possible space. Ease of maintenance and servicing achieved by means of simplified layout that enables quick decision assembly of components Scope of future improvement.

## MECHANICAL DESIGN

In mechanical design the components are listed down and stored on the basis of their procurement in two categories, Design parts & Parts to be purchased.

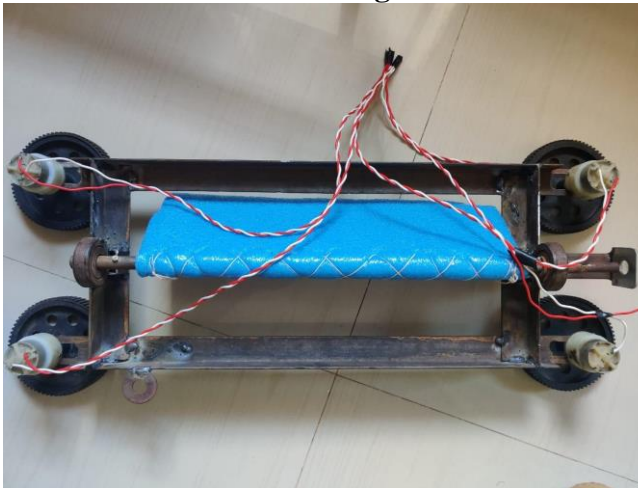
For designed parts detailed design is done and dimensions there obtained are compared to next dimensions which are already available in market. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified. The process charts are prepared and passed to manufacturing stage. The parts to be purchased directly are selected from Cleaning & cooling system of solar panel. The parts to be purchased are directly selected from various catalogues and are specified so as to have case



of procurement. In mechanical designed at the first stage selection of appropriate material for the part to be designed for specific application is done. This selection is based on standard catalogues or data books;

E.g.: - (PSG DESIGN DATA BOOKS) (SKF BEARING CATALOGUE) etc.

**Fig.4.1.2. System Design, Supporting Frame, Motors & Cleaning Foam.**



*Motor selection*

T = Torque transmitted by the motor N.m.  
 F = force to be applied on solar panel = 5 kg = 49.05 N. (Assume)  
 R = Shaft Dia. = 10mm.  
 $T = F \times R$   
 $= 49.05 \times 0.01$   
 $T = 0.4905 \text{ N.m.}$   
 P = Power of motor  
 N = Speed of the motor = 60 rpm. (Assume)  
 $P = 2 \pi N T$   
 $60$   
 $= 2 \pi \times 60 \times 0.4905$   
 $60$   
 $P = 3.082 \text{ Watt.}$   
 Thus, selecting a motor of the following specifications  
 1. Single phase DC motor  
 2. Power =50 watt  
 3. Speed= 60 rpm  
 Motor Torque  
 $P = 2 \pi N T$   
 $60$   
 $T = 60 \times 50$   
 $2 \pi \times 60$   
 $T = 7.96 \text{ N-m}$

*Shaft design:*

For shaft material C40 yield stress  $\sigma_y = 330 \text{ N/mm}^2$   
 Ultimate shear stresses =  $0.5 \sigma_y = 165 \text{ N/mm}^2$   
 Tensional shear stress  $T = P/16 \times \tau \times d^3$   
 $P \tau =$   
 $7.96 \times 10^3 =$   
 $d^3 = 6.2626 \text{ mm}$   
 Select Shaft dia.  $d = 10 \text{ mm.}$

*Shaft Design*

For shaft material C40 yield stress  $\sigma_y = 330 \text{ N/mm}^2$   
 Ultimate shear stresses =  $0.5 \sigma_y = 165 \text{ N/mm}^2$   
 Tensional shear stress  $T = P/16 \times \tau \times d^3$   
 $P \tau =$   
 $7.96 \times 10^3 =$   
 $d^3 = 6.2626 \text{ mm}$   
 Select Shaft dia.  $d = 10 \text{ mm.}$

*Bearing selection:*

As shaft dia. – is 10mm so we have selection a bearing having shaft outer dia. –10mm. In selection of ball bearing the main governing factor is the system design of the drive i.e.; the size of the ball bearing is of major importance; hence we shall first select an appropriate ball bearing. Taking into consideration convenience of mounting of ball bearing.

Total load on bearings are = Assume =5kg = 50 N  
 Radial load on each bearing for front transmission side,  
 $F_r = 50/2 = 25 \text{ N.}$   
 Equivalent dynamic load  
 $P_e = V. F_r. K_a$   
 $= 1 \times 25 \times 1.5$   
 $P_e = 37.5 \text{ N}$   
 bearing life is,  
 $L_{10} =$   
 $L_{h10}$  from graph 4.6 PSG Design data book for bearing 6200 maximum life of ball bearing is 200000 Hours.

$L_{10} =$   
 $L_{10} = 60 \text{ millions of revolutions.}$   
 $L_{10} =$   
 $C = X P_e$   
 $C = X 37$

C = 126.37 N. PSG Design data book P.No. 4.13. [18]

- 1) Portable. Autonomous self-cleaning & cooling mechanism that can be attached to solar panels and operated without human operation.
- 2) It is easy to construct, low cost and low maintenance. The surface of PV panel remains clean regularly to gives better efficiency of PV system comparing with old systems.
- 3) Cost of system modification is low & No need to purchase heavy machine components.
- 4) Working principle is quiet easy & Manual assistance is not required.
- 5) By using adjustable timer, user can clean & cool the panel as per convenience changes.

### TESTING AND RESULTS

Sr . No.	T1 (°C)	T2 (°C)	N (rpm)	P (watt)	t (sec)
1.	34	34.5	60	50	20.78
2.	34	35	60	50	22.68
3.	34	35.5	60	50	24.86
4.	34	36	60	50	27.65
5.	34	36.5	60	50	30.57
6.	34	37	60	50	33.57
7.	34	37.5	60	50	35.31
8.	34	40	60	50	38.36

**T1= Starting Temperature**      **N= Speed**  
**T2= Final Temperature**      **P= Power**  
**t = Time taken for cooling**

We have conducted the above experiment to find out the time required to cool certain temperatures, i.e., the time take for pump to

start the flow of water, time taken by water to cool and for the pump to stop. The temperature T1 is the starting temperature. It is the temperature set by the user which when exceeded the pump starts flowing water to cool the panel. Temperature T2 is the temperature at which the user stops heating the thermostat to get the reading of the time required to cool the certain amount of temperature.

N is the speed of the motor in rpm. P is the power of motor which was derived and used for selection of motor.

### CONCLUSION

The effects of dust were studied using falling leaves, dust, bird dropping. Dust has major impact on the efficiency and percentage reduction in power generation. The peaks in reduction in power generation are 10-30%.

Water having higher heat capacity has the ability to draw more heat out of the solar panel as compared to air when it is operating at high temperatures. The use of water flow over the front surface of solar panel also reduces the irradiation losses due to reflection. It was noted that increasing the water flowrate reduces the surface temperature of solar panel which results in increase in electrical yield

Existing automated cleaners mainly focus on large arrays and in general are unsuitable for installing on smaller arrays namely residential roofs. For those with limited space this means that a smaller array only needs to be installed, hence our idea serves as a huge advantage for those smaller sites. Our system can be installed for roof top solar panels. The solar panel cleaning system was first designed taking into consideration the design parameters. Our model was tested and the following observations were made. The rack and pinion mechanism work as it was designed to do.

This system work as an autonomous self-cleaning & cooling mechanism that can be attached to solar panels and operated without human operation to increases solar panel efficiency

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**Design & Performance Evaluation of Eco-Cooler by Varying Different Parameters****Anil Dube<sup>1</sup>, Ketan Pitrubhakta<sup>2</sup>, Vishwajit Patil<sup>3</sup>, Omkar Kulkarni<sup>4</sup>, Mayank Gajbhiye<sup>5</sup>**<sup>1</sup> Professor, Mechanical Department, SIEM, Nashik, Maharashtra,<sup>2,3,4,5</sup> UG Student, Dept. of Mech. Engg., Sandip Institute of Engineering and Management, Nashik**ABSTRACT**

*In summer we all complain about the heat. But not everybody having air conditioner appliances because of their cost and also not everybody can afford them, especially in a rural area. In rural areas, there is a problem with electricity even in urban areas 24x7 electricity is not provided, especially in summer. Eco cooler is an attempt to provide low-cost air conditioning built by waste material. It built from empty plastic bottles cut at some length and mounted into a grid through bottleneck sized holes. The grid is situated over a window with the narrow top end of the bottle facing inwards. When the wind blows through the bottles, the air gets compressed in the bottle and expands, making it cool. This technique may decrease the temperature by approximate up to 50C Stage. Nearly 300 million people in India live without access to power. This Eco-cooler can be a solution for these peoples. Zero Electricity Air Conditioning is an attempt to give minimal effort ventilating impact and is worked from a common waste thing: purge plastic pop bottles. To make this cooling system, plastic bottles are sliced down the middle and then mounted into a lattice through Bottleneck sized Holes. The setup can be arranged over a window with the smaller best end of the jug confronting inwards. Eco-Cooler can decrease temperatures up to 50C.*

**Keywords:** Eco Cooler, Zero Electricity Air Conditioning, Eco-Friendly Cooling Solution.

**Introduction**

In India temperature in the summer season range starting from 40<sup>0</sup>C to up to 50<sup>0</sup>C. This temperature is not suitable for human comfort. Hence, people use fans, coolers, air conditioners etc. in summer. But not all people can buy air conditioning appliances for their comfort due to their cost. Also, there is an issue of 24 x 7 electricity in our country some of the villages even don't have electricity. Also, air conditioning appliances consume electricity which is generated from fossil fuels which lead to creating pollution. Also, the refrigerant gases use in air conditioning are also harmful they cause greenhouse emission and causing global warming. The water air cooling systems have the problem with that they increase the humidity over the time of uses. Also, this appliance requires periodic maintenance. Some people also may have health issues due to using air conditioning appliances. For all that problem Eco-Cooler can be a solution. The objective of the eco-cooler is to provide the cooling of the air by using an economical and environmentally friendly solution. We are going to use empty plastic bottles which is a plastic waste we humans create after drinking the water and other beverages. This waste is dangerous to the environment as it adversely

affecting the wildlife, wildlife habitat, oceans life, ocean habitat and also humans. By using the waste material, we aim to provide the cooling of the air at a low as a possible cost with using low as possible resources. We are going to test different types of bottles with different diameter and cutting the bottles at different length with a varying velocity at different environmental conditions and aim to provide the best result from the eco-cooler.

**Literature Review**

Akshansh Mishra, Anish Das Gupta, Amit Kumar Mandal and Anand Singh did the work on Zero electricity air conditioning using phase-changing material in 2016. It is an eco-friendly method to cool down natural air. The further advantage of this method is to reuse the waste items like an empty plastic bottle of soda. To create this nifty cooling system plastic bottles are cut in half and then mounted into a grid through bottleneck-sized holes. The grid can be situated over a window with a narrower top end of the bottle facing inwards. The set-up of zero electricity air conditioning consists of the thermocol sheets, bottle cans, small strands, phase changing material like paraffin and salt hydrates. They gather as many as used soft-drink and water bottles. The bigger the size difference between the body and the rim of the

bottle the better it would be. They cut a hole in the one side thermocol sheet of the box and fix the bottle in the hole. Phase changing material like paraffin or fatty acids is placed in the strand which dismounted at the inlet of the bottle. The thermocouple is placed on the top of the rectangular box. The initial temperature of the box was recorded to be  $37.5^{\circ}\text{C}$  after a period of 10minute the temperature decreases to  $34.8^{\circ}\text{C}$ . They saw a temperature fall of  $2.7^{\circ}\text{C}$ . The cooling of air is observed without any applications of an external source. They do not use bottles of the same size in some quantity to measure the combined effect of it. The effect of combination may give a better result.<sup>[1]</sup>

Bhanuprakash Ch, Vinod Mummina and Mahesh Chakravarthi V did the work on Performance Evaluation of a Cooler analysed by varying the Physical and flow Parameters in 2018. Before using the Eco-cooler on the window they test the prototype in the laboratory. They use a cardboard box having a hole on one side of it. Then they cut the holes in the cardboard sheet of various diameters according to the bottle's outlet diameter size. They use three types of bottles having inlet diameter 3 inches, 2.75 inches and 4 inches respectively and outlet diameters 1inch. They use an external source of airflow by using a fan. Then they regulate the speed of an in three Steps from 10.5kmph, 13kmph and 16kmph respectively. They get the average temperature difference of  $0.967^{\circ}\text{C}$ ,  $0.67^{\circ}\text{C}$ ,  $1.3^{\circ}\text{C}$  respectively from three specimens. From this result, we clearly say that the type 3 bottle of 4-inch inlet and 1inch outlet diameter Gives the best temperature difference. But they cannot procure the required an of bottles of specimen 3 hence they make a prototype of 1<sup>st</sup> specimen which is a second better result. Three specimens having inlet dia. of 3, 2.75, 4 inches respectively and outlet dia. 1 get an increase in temp difference as the velocity of air increases. The specimen 3 rd. get maximum temp difference at avg. of  $1.87^{\circ}\text{C}$  when placed at window of the classroom. The result they get from 1<sup>st</sup> type of bottle is not best. If they use 3<sup>rd</sup> type of bottle the result can be best.<sup>[2]</sup>

Benya kasantikul did the work on Eco-cooler Analysis for Room Temperature Reduction in 2020. The Computational Fluid Dynamics

(CFD) program was used to test the effect of heat transfer and to predict the fluid flowing behaviour so that the temperature resulting from the Eco-cooler could be analysed. The objectives of this research are to design an Eco-cooler suitable to reduce. The room temperature to compare the temperature results from the Computational Fluid Dynamics (CFD) analysis and the real experiment to find the discrepancy and to study its economic feasibility and worthiness. The CFD program used to analyze the temperature and fluid dynamics result in attest the room of using the circular and rectangular eco-coolers to find the temperature in the experimental rooms and the airflow behaviour. The configuration steps in the program are as follows: to set the scope of the Eco cooler grids, to set the nozzle entrance conditions including the inlet air velocity and the temperature, to specify the conditions of the experimental room such as the friction of the air that hits on the room wall in an adiabatic style and to specify other conditions such as air density, the gravity of the earth, smoothness and duration They examine the reduction of temperature in the  $4.2 \times 3.1 \times 3.3$  experiment room and actual room  $1 \times 1 \times 2 \text{ m}^3$  made of cardboard sheet. The experimental setup runs on Computational Fluid Dynamics (CFD). Velocity range set between 1-3 m/s. They use rectangular bottles in three setups consist 6 liters of 9, 500ml of 64, 1.5 liters of 30 respectively in a  $48 \times 48 \text{ cm}^2$  cardboard sheet on the experimental setup. Actual room of  $1 \times 1 \times 2 \text{ m}^3$  with a rectangular and circular bottle of 6 and 25 respectively. From the CFD analysis, it is observed that rectangular bottle lowers the temperature better than circular bottles. The circular bottles show  $0.941^{\circ}\text{C}$  and the rectangular shows  $1.562^{\circ}\text{C}$ . The experimental setup shows a maximum of  $3.66^{\circ}\text{C}$ . The rectangular bottles used in the actual setup have only 3 quantities instead. We can use small bottles in big quantity to increase the area of reducing quantity.<sup>[3]</sup>

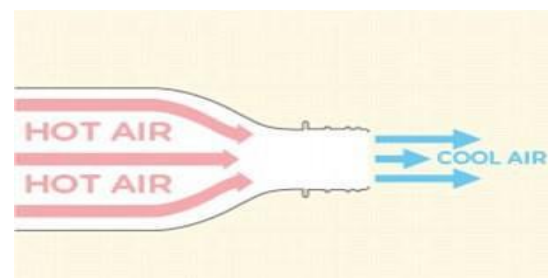
Abib Hossain Khan, Zayed Ahmed, Md. Shafiqul Islam, Angkush Kumar Ghosh did the work on Evaluation of cooling of an eco-cooler: experimental and numerical analysis in 2018 in this work, the capability of reducing room air temperature using four conical shaped eco-coolers has been investigated

experimentally. The eco-coolers have inlet and outlet diameters of 24.67 mm and 92.67 mm respectively and they have a taper angle of  $7.62^\circ$ . The experiments were conducted for five consecutive days from 29<sup>th</sup> May to 2<sup>nd</sup> June 2018 (local evening time) in a confined room where the recorded room air temperatures were 28-30 °C. A low power consuming external fan (5 W) was employed to force airflow through the inlets of the eco-coolers. From the experimental results, it has been observed that it is only possible to reduce the outlet air temperature up to 0.2 °C when the inlet air velocity is in the range of 0.12-0.14 m/s with a negligible air working pressure difference of 10 Pa. The performance of an eco-cooler for similar experimental inlet air velocities (0.1-0.4 m/s) and practically observed air working pressure differences created by a regular fan (25-800 Pa) has also been studied with the help of numerical simulation. Results from numerical simulation indicate that the maximum achievable temperature drop is around 0.34 °C to feel human-skin comfortable, keeping the outlet air velocity within 13 m/s. They get temp diff of **0.25<sup>0</sup>C** by this experiment which is more than the theory and simulation which is **0.01<sup>0</sup>C**. The size of the conical is small and its length is also long hence the temp diff is less.<sup>[4]</sup>

P.Naveenkumar, Raguraman.K, Rajesh Kumar.S, Krishnaraj.M did the work on Design and Analysis of Eco Cooler in 2018. Zero electricity air conditioning Eco accommodating strategy to chill off characteristics air They created a 2d outline structure on an eco-cooler in PTC Creo and then this diagram is examined in Ansys. In Ansys the temperature stream, weight stream and speed. In Ansys, they analyse the pressure, velocity and temperature. They made a mesh analysis of the diagram created using the PTC Creo. The eco-cooler room also to be analyzed by using the Ansys software. This is used to clarify that the room and our pressure is to be considered. While taking the report that the corner of the wall is to be in the form of (3.570pa). At the same time at the end of the wall or a room which is having the value of pressure is (-3.997pa). The velocity of the specimen is used for analysis with the help of Ansys software. This velocity analysis is also one of the parameters in their

fluid analysis. It also plays a major role in analysis by having this they can make a different form of flow. By having this velocity analysis, they can give a comparison of room velocity and also for their specimen. At the inlet of the specimen, they are having a velocity at the range of (1.894m/s). At the same time, they are having the range in mid up to (9.471m/s). Temperature is to be measured and broke down by having the Ansys. Some type of variety will be occurring because of some diversion in our example. By having the variety in the worry temperature, the outcome might be happening. A channel that controls the temperature is might be as (3.007k) toward the finish of the room there is some different form (2.981k). The temperature contrast was 2.70C. In this way, the cooling of air is observed without any application of an outside source. This set-up additionally expounds on how to repurpose plastic containers into ease, simple to-influence, power to free air conditioner that can enable the nation's poorest better to endure the sweltering summer Warm. The experiment is analysed by using a 2D diagram created by using PTC Creo and analysed by using ANSYS software. The experiments values that come out are from software the practical values may be varying. The outcomes show **2.7<sup>0</sup>C** in the temperature difference The setup is not actual experimented.<sup>[5]</sup>

#### Working Principle: -



**Fig.1 Working Principle**

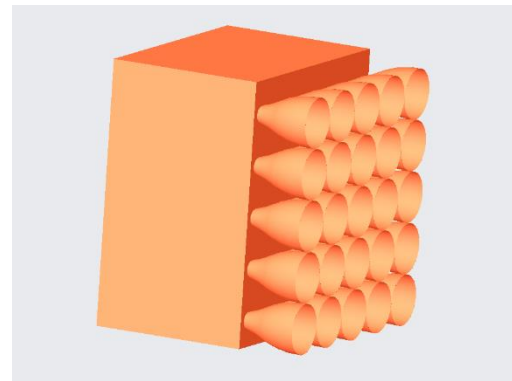
The Eco-Cooler is placed on the window in the direction of maximum airflow. The wider open ends are placed outside the window allowing the air in without letting additional solar radiation come in. When the air enters the wider end of the bottle facing towards the wind direction outside of the window the air passes

through the bottleneck and gets compressed in there. This compression will increase the velocity of the air at the expense of its pressure. This compressed-air undergoes rapid expansion soon after it exits the brim of the water bottle. This rapid expansion lowers the temperature of the air stream and creates some sort of low pressure there which in turn draws the surrounding air into the stream.

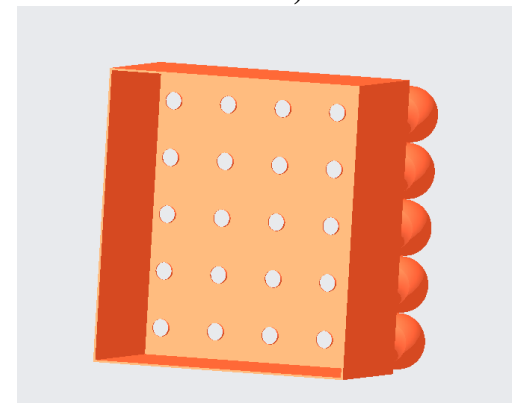
### Design of the Eco-cooler

**Software used: - PTC Creo**

PTC CREO, formally known as master/build, is a 3D computer-aided design/CAM/CAE highlight based affiliated strongly demonstrating programming. Creo is a family or suite of outline programming supporting item plan for discrete fabricates and is created by PTC. The suite comprises of applications; every conveyance is a distinct set of capacities for a client part inside item advancement. Creo keeps running on Microsoft windows and gives applications to 3D computer-aided design parametric highlights strong displaying, 3D coordinate demonstrating, 2D orthographic views, finite component investigation and recreation, schematic design, technical delineations, and survey and perception. Creo components/genius and Creo parametric contend straightforwardly with CATIA, Siemens NX solid edge, and solid works. The Creo suite of application supplants and supersedes PTC's items formally known as star/design, to create an item see. Creo has a wide range of programming bundle arrangements and highlights. PTC discharged Creo 1.0 in June 2011. In our undertaking, we utilized Creo for outlining the process, on that we fortify the investigation of the technique on the correct premise. However, the spout changes over stream enthalpy into motor vitality. The warmth limit of air is sufficiently substantial that any critical change in stream speed just delivers fantastically little change in stream temperature. However, the focal points may originate from an expansion in the convective warmth exchange coefficient and the clear cooling rate. What happens first hot air from the air, it approaches the surrounding temperature. The cooling sensation originates from the little pipe.



**Fig.2 Experimental Setup Design (Front View)**



**Fig.3 Experimental Setup Design (Back View)**

### Equipment Used



**Fig.4 Digital Temperature Sensor R-Tek RT115**

A Digital temperature sensor is a device, typically, a thermocouple or resistance temperature detector, that provides temperature measurement in a readable form through an electrical signal. A thermometer is the most basic form of a temperature meter that is used to measure the degree of hotness and coolness. Temperature meters are used in the geotechnical field to monitor concrete, structures, soil, water, bridges etc. for structural changes in them due to seasonal

variations. A thermocouple (T/C) is made from two dissimilar metals that generate an electrical voltage in direct proportion with the temperature change.

Model Number	RT115
Temperature Range	-50 <sup>0</sup> C to + 110 <sup>0</sup> C
Temperature display resolution	1(≤-20 <sup>0</sup> C) 0.1(>-20 <sup>0</sup> C)
Temperature measurement accuracy	+/-1 <sup>0</sup> C (-30 <sup>0</sup> C+/-40 <sup>0</sup> C)
Item weight	80g
Product dimension	10 x 10 x 5 cm; 80 grams
Temperature Range Using environment	Temperature 5 <sup>0</sup> C to +50 <sup>0</sup> C Humidity 5% to 80%
Power: two button batteries	LR44, 1.5V

**Table.1 Technical Specification of Temperature Sensor R-Tek RT115**



**Fig.5 Digital Anemometer Lutron AM-4201**

Anemometer uses air pressure to determine the wind pressure, or speed anemometer measures the air pressure inside a glass tube that is closed at one end. Other anemometers work by measuring the speed of sound waves or by shining laser beams on tiny particles in the wind and measuring their effect portable anemometer provides fast accurate readings with digital readability and the convenience of a remote sensor separately. Multi-functions for air flow measurement: m/s, km/h, ft/min, knots. Low-friction ball-bearing design resulting in accuracy at both high and low

velocities. Conventional twisted vane arms, always a source of unreliability have been eliminated. DATA HOLD. Compact housing cabinet. Wide applications: use this anemometer to check air conditioning.

General Specification: -	
Display	18 mm (0.7") LCD (Liquid Crystal Display), 3 1/2 digits.
	m/s (meters per second).
	Km/h (Kilometer per hour),
Measurement	Ft/min (feet/ per minute),
	Knots (nautical miles per hour),
	Data hold
Operating Humidity	Less than 80 % RH.
Air Velocity Sensor Structure	Conventional twisted vane arms and low-friction ball-bearing design.
Power Supply	006P DC 9V battery (heavy duty type).
Power Consumption	Approx. DC 9 mA.
Weight	325 g/0.72 lb. (including battery).
	168 x 80 x 35
Dimension	Instrument mm (6.6 x 3.2 x 1.2 inch)
	Sensor Head Round, 72 mm Dia.
	Instruction Manual 1 PC.
Standard Accessories	Sensor probe 1 PC. Carrying case 1 PC.

**Table.2 General Specification of Digital Anemometer Lutron AM-4201**



**Electrical Specification**

Measurement	Range	Resolution	Accuracy
m/s	0.4-30.0 m/s	0.1 m/s	+ - (2% + 0.2 m/s)
Km/h	1.4-108.0 km/h	0.1 km/h	+ - (2% + 0.8 km/h)
Knots	0.8-58.3 knots	0.1 knots	+ - (2% + 0.4 knots)
Ft/min	80 - 5910 ft/min	10 ft/min	+ - (2% + 40 ft/min)

m/s – meters per second km/h- kilometers per hour

ft/min – feet/per minute knots-nautical miles per hour (international knot)

mph – miles per hour

**Table.3 General Specification of Digital Anemometer Lutron AM-4201**

**Experimental Setup**

**Principal of operation**

The Eco-Cooler is placed on the window in the direction of maximum airflow. The wider open ends are placed outside the window allowing the air in without letting additional solar radiation come in. When the air enters the wider end of the bottle facing towards the wind direction outside of the Window the air passes through the bottleneck and gets compressed in there. This compression will Increase the velocity of the air at the expense of its pressure. This compressed-air undergoes rapid Expansion soon after it exits the brim of the water bottle. This rapid expansion lowers the temperature of the air stream and creates some sort of low pressure there which in turn draws the surrounding air into the stream.

In this Setup, we used bottles of various size to get different results and analysis.

**The following Experiments are as below:**

Forced Convection by using an external fan.



**Fig.6 200ML Capacity Bottles in 9 quantities**



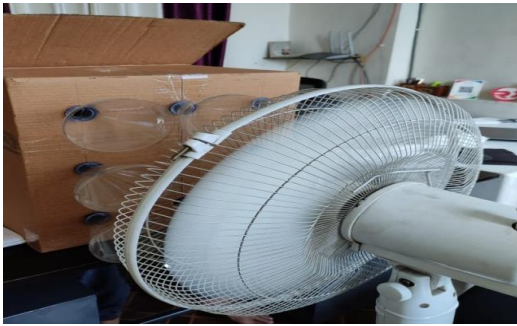
**Fig.7 1L Capacity Bottles Setup (Spherical Shape) in 7 quantities**



**Fig.8 1L Capacity Bottles Setup in 9 quantities (Conical Shape)**



**Fig.9 1.25L Capacity Bottles Setup in 9 quantities (Conical Shape)**



**Fig.10 2.25L Capacity Bottles Setup in 9 quantities (Conical Shape)**



**Fig.11 2.25L Capacity Bottles Setup in 4 quantities (Spherical Shape)**

Natural Convection



**Fig.12 200ML Capacity Bottles in 9 quantities**



**Fig.13 1L Capacity Bottles Setup in 9 quantities**



**Fig.14 1.25L Capacity Bottles Setup in 9 quantities**



**Fig.15 2.25L Capacity Bottles Setup in 9 quantities**

Testing of setup on Window



**Fig.16 Testing of Setup on Window Using 2.25 L Water\_Bottle in 9 quantities (Side View) on 17<sup>th</sup> June 2021**



**Fig.17 Testing of Setup on Window Using 2.25 L Water in 9 quantities (Back View) on 17<sup>th</sup> June 2021**

**Observation Table**

Vi = Inlet Velocity in meter per second (m/s)  
 V<sub>0</sub> = Outlet Velocity in meter per second (m/s)  
 Ti = Inlet or ambient Temperature in degree Celsius (°C)  
 T<sub>0</sub> = Outlet Temperature in degree Celsius (°C)  
 ΔT = Temperature Difference in degree Celsius (°C)

**Forced Convection by using external fan.**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	3.0	3.1	34.0	33.0	1.0
2	3.6	3.8	34.0	32.8	1.2
3	4.2	4.3	34.0	32.7	1.3

**Table.4 200ML Capacity Bottles in 9 quantities**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	3.0	3.3	34.0	32.8	1.2
2	3.6	4.1	34.0	32.6	1.4

3	4.2	4.4	34.0	32.5	1.5
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**Table.5 1L Capacity Bottles Setup (Spherical\_Shape) in 7 quantities**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	3.0	3.2	34.0	32.9	1.1
2	3.6	4.0	34.0	32.7	1.3
3	4.2	4.4	34.0	32.5	1.5

**Table.6 1L Capacity Bottles Setup in 9 quantities\_(Conical Shape)**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	3.0	3.3	34.0	32.8	1.2
2	3.6	4.1	34.0	32.6	1.4
3	4.2	4.4	34.0	32.5	1.5

**Table.7 1.25L Capacity Bottles Setup in 9 quantities\_(Conical Shape)**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	3.0	3.5	34.0	32.3	1.7
2	3.6	4.4	34.0	32.1	1.9
3	4.2	4.6	34.0	32.0	2.0

**Table.8 2.25L Capacity Bottles Setup in 9 quantities\_(Conical Shape)**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	3.0	3.5	34.0	32.6	1.4
2	3.6	4.3	34.0	32.2	1.8
3	4.2	4.6	34.0	32.0	2.0

**Table.9 2.25L Capacity Bottles Setup in 9 quantities (Spherical Shape)**

**Natural Convection**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	0.7	0.9	36.7	36.5	0.2
2	0.9	1	36.8	36.7	0.1
3	1.0	1.3	36.2	36.2	0
4	1.9	2	36.7	36.4	0.3
5	2.0	2.1	36.5	36.4	0.1
6	1.8	1.9	36.9	36.7	0.2

**Table.12 1.25L Capacity Bottles Setup in 9 quantities**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	1.7	1.9	36.4	35.5	0.9
2	1.9	2.3	36.9	35.9	1
3	1.8	2.1	36.0	35.2	0.8
4	2.1	2.4	36.2	35.4	0.8
5	1.6	1.9	36.7	35.1	1.6
6	2.2	2.4	36.5	35.0	1.5

**Table.10 200ML Capacity Bottles in 9 quantities**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	2.0	2.3	36.7	36.1	0.6
2	1.8	2	36.8	36	0.8
3	2.2	2.5	36.5	36	0.5
4	1.6	1.9	26.9	36.2	0.7
5	1.9	2.2	36.8	36.3	0.5
6	1.6	2	36.5	35.9	0.6

**Table.13 2.25L Capacity Bottles Setup in 9 quantities**

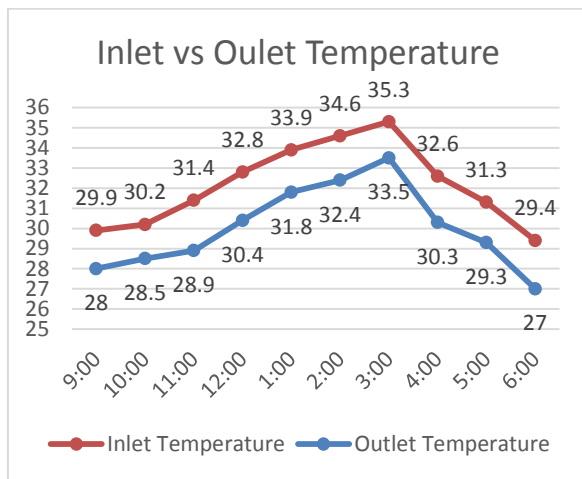
**Testing of setup on Window**

Time	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
9:00 AM	2.3	2.5	29.9	28	1.9
10:00 AM	2.1	2.4	30.2	28.6	1.7
11:00 AM	1.9	2.2	31.4	28.9	2.5
12:00 PM	2.0	2.1	32.8	30.4	2.4
01:00 PM	1.8	2.0	33.9	31.8	2.1
02:00 PM	1.6	1.9	34.6	32.4	2.2
03:00 PM	1.7	1.8	35.3	33.5	1.8
04:00 PM	2.1	2.3	32.6	30.3	2.3
05:00 PM	2.2	2.4	31.3	29.3	2.0
06:00 PM	2.4	2.5	29.4	27.0	2.4

**Table.11 1L Capacity Bottles Setup in 9 quantities**

Sr. No	Vi (m/s)	V <sub>0</sub> (m/s)	Ti (°C)	T <sub>0</sub> (°C)	ΔT (°C)
1	1.9	2.1	36.5	35.6	0.9
2	2.2	2.4	36.3	35.8	0.5
3	1.8	2	36.6	35	0.6
4	0.9	1.2	35.8	35.1	0.7
5	1.7	1.9	36.7	36.1	0.6
6	2.1	2.3	36.9	35.9	1

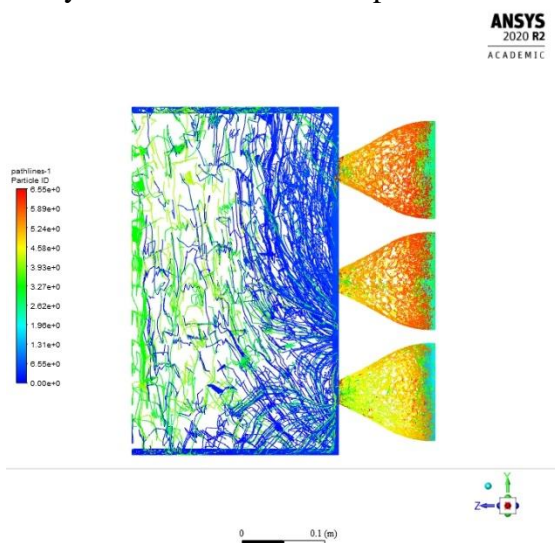
**Table.14 Testing of setup on the window on 17<sup>th</sup> June 2021**



**Fig.18 Graph Inlet vs Outlet Temperature tested on the window on 17<sup>th</sup> June 2021**

### Ansys

To examination the cooling waves from our project we analysed our 3D model in Ansys 2020 R2. It requires no power to grinding and is made utilizing waste items. Where 70% of inhabitants live in a tin house without control In Ansys we examined the temperature stream.



**Fig.19 Ansys of 3D model**

From our Ansys, we saw that the air gets cools as it passes through the convergent area of plastic bottles. The air is mostly cooled at the end of a convergent area of the bottle.

### Conclusion

Temperatures are getting increasing in summer days, also day by day the temperatures are increasing due to industrialization, global warming, pollution etc. As always, whatever may be the case, the poor are get most affected. This solution, Eco-Cooler, will work well within the tiny houses of the poor. According to our experiment, we will try to decrease as much as the temperature of 5-6<sup>0</sup>C we are using water bottles with different dimensions and compare it, which is best among them to decrease the temperature of the room we will use in our Eco-cooler solution.

This zero electricity, zero pollution, low cost, easy to make, and easy to install cooling device will help the poor in the summer heat by reducing the indoor temperature. By our experiment, we can cool down air up to 3<sup>0</sup>C at optimal conditions when installed in the house. The temperature difference will be more when used the big size bottles.

This solution will be helpful to improve human comfort in summer for lots of the disadvantage of the project is that it required air velocity the more one the better result.

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## A review study of Nano refrigerant based vapour compression refrigeration system (R134a+Al<sub>2</sub>O<sub>3</sub>)

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### ABSTRACT

*In today's world refrigeration systems play a significant role to meet the human desires and never-ending analysis is being done out by several researchers so as to boost the performance of those systems. Here, an endeavor has been created to boost the performance of the system. Our, gift study on experimental investigations into the performance of nano refrigerant (R134a + Al<sub>2</sub>O<sub>3</sub>) based mostly cooling. it absolutely was ascertained that there's additional temperature drop across the condenser for the nano refrigerant (12.37% — 10.88%) compared to refrigerant R134a. Similarly, a gain of five.52% and 9.24% was obtained for evaporator temperature. Associate in Nursing improvement in COP was additionally ascertained throughout the investigations (1.17% — 9.14%). This was achieved underneath 25–26 oC evaporator temperature load. The results indicate that constant of performance will increase with the usage of nano Al<sub>2</sub>O<sub>3</sub>. so mistreatment Al<sub>2</sub>O<sub>3</sub> nano refrigerant in cooling is found to be possible.*

**Keywords:** Aluminium Oxide Nano particles, Silicon Oxide Nanoparticles, Nano refrigerant, Thermal Conductivity, a cop, Energy Consumption

### Introduction

In cooling and heating applications, thermo-physical properties of matter play a great role. It has been observed that the performance of any system mainly depends on the thermal conductivity, viscosity, specific heat and density of gases and liquids which are used in system. Conventional fluids have poor heat transfer capacity and low thermal conductivity which limits its performance. Due to this, there is always a need to develop effective & efficient fluids capable to deal with high heat transfer rate. Small solid additives usually in micrometer are good option to enhance the thermal properties of fluids, but it has been found that these small solid additives pose number of problems like particle sedimentation, particle clogging, large pressure drop in the system, corrosion of components, etc. (Maxwell et al., 1873). Investigations shows that use of nanoparticles in typical fluids may be a sensible choice because it additionally reduces the amount of different issues as a result of, at nano-meter the fabric behaves like colloidal suspension. fashionable technology offers us many routes to prepare nanometer sized particles. It's doable to interrupt down the bounds of typical solid particle suspensions by conceiving the concept of nanoparticle-fluid suspensions. area unit

termed nano-fluids, obtained by admixture nano-meter sized particles in an exceedingly a base fluid like, water, oil etc. Nanoparticles like bronze oxides (Al<sub>2</sub>O<sub>3</sub>, CuO, SiO<sub>2</sub>), chemical compound ceramics (AlN, SiN), semiconductors (TiO<sub>2</sub>, SiC), inorganic compound ceramic (SiC, TiC), metals (Cu, Ag), single, double or multi walled carbon nanotubes area unit used. Even at terribly low concentrations the nano fluids show an honest improvement within the thermal physical phenomenon and performance (Choi et al., 2001; industrialist et al., 2001). With increase in concentration and temperature they show massive improvement (Wang et al., 1999). Choi S.U.S et al. (1995) urged the thought of nanofluids by suspending bronze or nonmetallic particles. Recently some studies are according on nanoparticles in refrigeration systems as a result of its capability to enhance heat transfer characteristics, thus potency improvement. Kumar R.R et al. (2013) investigated the result of aluminum oxide primarily based nano-lubricant on the COP of the system and phase transition capability of the system. The experimental came upon was built as per Indian standards. Refrigerants like R12, R22, R600, R600a and R134a were used as a refrigerant. The performance of the system depends upon the thermos physical properties of the refrigerant. The addition of nanoparticles

to the refrigerant leads to improvement within thermo-physical properties thereby up the performance of the cooling system. The experimental studies indicate that the cooling system with nano refrigerant works unremarkably. There was increase within the COP of the system by 19.6 %. oil with corundum nanoparticles oil mixture was investigated and it absolutely was found that there's an increase in freezing capacity and reduction in power consumption by 11.5 % as compared to polyester. Aluminum oxide-based nano-lubricant in refrigeration system was found working satisfactorily. Mahbulul I.M et al. (2012) studied the volumetric and temperature effects over viscosity of R123-TiO<sub>2</sub> nano refrigerant for 5°C to 20°C temperatures and up to 2 % volume concentration of nanoparticles. The effect of pressure drop with the increase in viscosity has also been investigated. Based on the analysis it was found that viscosity of nano refrigerant increases accordingly with the increase of nanoparticles volume concentrations and decreases with the rise in temperature. Furthermore, pressure drop increases significantly with the intensification of volume concentrations. Therefore, low volume concentrations of nano refrigerant are suggested for better performance of a refrigeration system. Bi et al. (2007) have experimented on a domestic refrigerator with R134a as refrigerant and a mixture of mineral oil and TiO<sub>2</sub> was used as the lubricant. It was found that the refrigeration system with the above combination works normally and efficiently and the energy consumption reduces by 21.2% as compared with R134a/POE oil system. Jwo C.S et al. (2009) had mixed mineral lubricant with Al<sub>2</sub>O<sub>3</sub> nanoparticles to improve the lubrication and heat-transfer performance. This study showed that R134a + 0.1 wt % Al<sub>2</sub>O<sub>3</sub> nanoparticles were optimal for best performance. Under these conditions, the power consumption was reduced by about 2.4%, and the coefficient of performance was increased by 4.4%. Kang Y.T et al. (2012) measured the thermal conductivity of the Al<sub>2</sub>O<sub>3</sub> nanofluids using the transient hot-wires method (THWM). The experimental uncertainties in repeatability were obtained as 1.95% for DI water and 1.34% for pure

methanol, respectively. The results show that the dispersed nanoparticles can always enhance the thermal conductivity of the base fluid and the highest enhancement observed was 6.3% in the concentration of 0.1% (vol.) of Al<sub>2</sub>O<sub>3</sub> nanoparticles, 40% (vol.) of CH<sub>3</sub>OH and 10% (wt.) of NaCl at 293.15 K. In addition, the zeta potential, visualization and Tyndall effect were also investigated to discuss the stability of nanofluids. Subramani N et al. (2011) studies indicated that the refrigeration system with nano refrigerant works normally. It was found that the freezing capacity is higher and the power consumption reduces by 25% when POE oil is replaced by a mixture of mineral oil and alumina nanoparticles. Calculations showed that the enhancement factor in the evaporator is 1.53 when nano refrigerant were used instead of pure refrigerant. Kumar S.D et al. (2012) did experimental work on nano refrigerant. Nanoparticle Al<sub>2</sub>O<sub>3</sub>-PAGoil in R134a vapor compression refrigeration system. An experimental setup was designed and fabricated. The system performance was investigated victimization energy consumption take a look at and freeze capability take a look at. The results indicated that Al<sub>2</sub>O<sub>3</sub> nanorefrigerant works commonly and safely within the cooling. The performance of cooling was higher than pure lubricating substance with R134a operating fluid, a 10.32% less energy was consumed once zero.2% volume of the concentration employed in the system. The results indicated that heat transfer constant will increase with the usage of nanoparticles Al<sub>2</sub>O<sub>3</sub>. Thus, victimization Al<sub>2</sub>O<sub>3</sub> nanorefrigerant in cooling is found to be possible and works commonly.

Gupta H.K et al. (2012) in step with them advancements in technology have originated the new rising heat transfer fluids known as nano fluids. Nanofluids ar ready by dispersing and stably suspending millimicron sized solid particles in standard heat transfer fluids. Past researches have shown that a awfully bit of suspending nanoparticles have the potential to reinforce the thermo physical and transport properties of the bottom fluid. thanks to improved properties, an improved heat transfer performance is obtained in several energy overwhelming and warmth transfer devices as compared to ancient fluids that open the door



for a brand-new field of research project and innovative applications. Wang K.J et al. (2006) applied AN experiment and studied boiling heat transfer characteristics of refrigerant R22 with Al<sub>2</sub>O<sub>3</sub> nanoparticles. The study showed improvement in heat transfer properties and reduced bubble size close to heat transfer space. Peng H et al. (2011) investigated through an experiment influence of refrigerant-based nano fluids composition and heating condition on the migration of nanoparticles throughout pool boiling. The nanoparticles embrace copper (average diameters of twenty, fifty and eighty nm), Al and Al<sub>2</sub>O<sub>3</sub> (average diameters of twenty nm), and CuO (average diameter of forty nm). The refrigerants embrace R113, R141b and n-pentane. The mass fraction of grease RB68EP is from zero to ten skyscraper, the warmth flux is from (10 to one00) kW/m<sup>2</sup> and therefore the initial liquid level height was from 1.3 to 3.4 cm. The experimental results showed that a migration magnitude relation of nanoparticles throughout the pool boiling of refrigerant based nano fluids will increase with the decrease of nanoparticles density, nanoparticles size, coefficient of refrigerant, mass fraction of grease or heat flux; whereas will increase with the rise of liquid-phase density of refrigerant or initial liquid level height.

Hafez E.A et al. (2011) used CuO-R134a within the vapor compression system and evaporating heat transfer constant was through an experiment investigated. Measurements were taken for warmth flux ranged from ten to forty kW/m<sup>2</sup>, victimization CuO nanoparticles with totally different concentrations (0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.55, 0.6, 0.8 and 1%) and nanoparticles size was from fifteen to seventy nm. there's increase in heat transfer constant up to 0.55% within the investigated concentration vary so decreases for all values of warmth flux. With nanoparticles examine to twenty-five nm heat transfer constant will increase than decrease with the rise in size of nanoparticles.

Pruzaesky F. C et al. (2010) studied numerically the employment of nanofluids as secondary coolants in vapor compression refrigeration systems. A simulation model for a liquid-to-water setup, with reciprocatory

mechanical device and double-tube condenser and evaporator was studied. The multi-zone methodology was used within the modeling of the warmth exchangers. The water based mostly nanofluids was alleged to flow through the inner circular section of the evaporator, whereas the refrigerant was left to the rounded passage. A procedure program was developed to resolve the ensuing non-linear system of algebraic equations. Totally different nanoparticles (Cu, Al<sub>2</sub>O<sub>3</sub>, CuO and TiO<sub>2</sub>) were studied for various volume fraction and particle diameters. Simulation results have shown that, for a given refrigerant capability, evaporator space and refrigerant-side with the rise in volume fraction of nanoparticles pressures drop as reduced. Also, nanofluids-side pressure drop and, consequently, pumping power, increase with nanoparticles volume fraction and reduce with nanoparticles size. Results show a decrease in evaporator space once we use nanofluids as compared to the standard fluid (H<sub>2</sub>O).

Ding G (2007) simulation has been wide used for performance prediction and optimum style of refrigeration systems. A quick review on history of simulation for vapor-compression refrigeration systems is finished. The models for evaporator, condenser, compressor, capillary and wrap structure as summarized. Some developing simulation techniques, as well as implicit regression and specific calculation methodology for refrigerant physical science properties, model-based intelligent simulation methodology and graph-theory based mostly simulation method, as given. Prospective ways for future simulation of refrigeration systems, like noise-field simulation, simulation with information engineering methodology and calculation ways for nanofluids properties as introduced concisely. pantzali M.N et al. (2009) development of plate device (PHE) with modulated surfaces has been primarily driven by the requirement for compact, high performance, but little or no and light-weight instrumentality. the type of flow at intervals PHE channels augments heat transfer, because of flow separation and re-attachment, whereas the quality induced by the modulation significantly can increase the friction losses.

Since the flow passages in such PHE's unit of activity advanced in scientific discipline and of little dimensions, it's terribly powerful to conduct correct measurements of the operation parameters (e.g. temperature, pressure and rate fields). Thus, CFD simulation, that's taken into thought an honest and reliable tool, is utilized to estimate momentum and the heat transfer rates throughout these types of technique instrumentality. Throughout the last decade so on boost the thermal physical phenomenon of the operational fluids in heat transfer instrumentality, nano meter sized solid-particle suspensions in common fluids (e.g. water, olefin glycol), mentioned as nano fluids, unit used. These suspensions exhibit an important increase at intervals the thermal physical phenomenon compared to the bottom fluid whereas problems with deposit is encountered. Experimental add the convective heat transfer of nano fluids continues to be quite scarce, so more investigations unit of activity needed.

Louisa J.C.V et al. (2010) studied the use of nano fluids as secondary coolants in vapor compression refrigeration systems numerically with a simulation model for a liquid-to-water setup, exploitation mutual machine and double-tube condenser and evaporator. The simulation program was run slightly capability system operative with four whole completely fully completely different water-based nano fluids, Cu, Al<sub>2</sub>O<sub>3</sub>, CuO and TiO<sub>2</sub> and volume fraction ranged from 0.1 to 5 and particle size from 10 to fifty nm. it had been determined that greatest reductions in evaporator house were obtained with Cu+H<sub>2</sub>O nano fluids, flowing with huge volume fractions and lower particle diameters followed by TiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> results increase in COP of the system. The experimental results unit of activity compared with theoretical simulations supported the assumptions regarding the heat and mass transfer. Bozorgan N et al. (2012) studied numerically the applying of CuO-water nano fluids with twenty nm size particle and volume concentrations up to twenty in a very radiator of Chevrolet residential district diesel motor below flow conditions. They lived the native and overall heat transfer constant within the radiator and conjointly measure the pressure drop and pumping power. Within the

gift study, the results of the automotive speed and Reynolds variety of the nano fluid within the totally different volume concentrations on the radiator performance also are investigated. The results show that for CuO-water nano fluids at a pair of volume concentration current through the flat tubes with Reynolds No 6000 whereas the automotive speed is seventy km/hr, the heat transfer constant and pumping power square measure close to 100 percent and twenty-three.8% quite that of base fluid for given conditions, severally.

Clancy E.V et al. (2012) projected a replacement style, wherever the warmth transfer of a vapor compression system was Increased by increasing the thermal heat transfer properties of the refrigerant exploitation nanoparticles. Nanoparticles were mixed with refrigerant at water of the condenser and removed at outlet of condenser, therefore by this implies heat transfer rate was accelerated in condenser. This analysis suggested a but 100 percent (wt.) of nano particles within the fluid. Moreover, the condenser potency may be increased to enhance the performance of the system.

Eiyad A.N et al. (2008) given the numerical investigation of nano fluids heat transfer with backward facing step. Differing types of nano particles in several volume fractions were utilized in base fluid. To resolve the momentum and energy equation finite volume technique was used. Nusselt range at the highest and also the bottom walls of the BFS was obtained. For Cu nanoparticles, there was increment in Nusselt range. Nanoparticles that have high thermal physical phenomenon show additional enhancements in Nusselt range outside the recirculation zones like silver, Cu. however in recirculation zone, low thermal physical phenomenon nano particles show a more robust heat transfer. There's increase in Nusselt range for will increase in volume fractions for whole vary of Reynolds range.

### Literature review

Air conditioners and refrigerator-freezers are major energy users in a household environment and hence efficiency improvement of these appliances can be considered as an important

step to reduce their energy consumption along with the environmental pollution prevention. As per the Montreal Protocol, CFC12 is being phased out following a stipulated time frame. The developed countries have already phased out these substances and the developing countries are to totally phase out the CFCs by 2030 as per the Montreal Protocol. Most of the developing countries are drastically reducing their CFC production and consumption. This demand for a suitable substitute for CFC12 for possible retrofitting of existing systems as well as for new systems.

**S. Joseph Sekhar et al. (2004)** presented two potential substitutes, namely, HFC134a and HC blends are available as drop in substitutes for CFC12. HC (hydrocarbon) refrigerants do have inherent problems in respect flammability. HFC134a is neither flammable nor toxic. But HFCs (hydro fluorocarbons) are not 15 compatible with mineral oil and the oil change is a major issue while retrofitting. They carried out an experimental analysis in a 165 liters CFC12 household refrigerator retrofitted with eco-friendly refrigerant mixture HFC134a/HC290/HC600a without changing the mineral oil. Its performance, as well as energy consumption, is compared with the conventional one. As the system has been running successfully for more than 12 months consumption by 4 to 11% and improve the actual COP by 3 to 8% from that of CFC12. The new mixture also showed 3 to 12% improvement in theoretical COP. The overall performance has proved that the new mixture could be an eco-friendly substitute to phase out CFC12.

**Satnam Singh et al.** represented a review on behavior of Nano- refrigerant in vapour compression cycle with different concentration of Nano-particles. The experimental studies revealed that the performance of such systems gets improved by using Nano refrigerants. It is observed that using a Nano-refrigerant with higher concentration is not always true.

**T. Coumaressin et al.** studied performance of a refrigeration system using nano fluid and concluded CuO nanoparticle with R134a refrigerant can be used as an excellent refrigerant to improve the heat transfer characteristics of a refrigerant. Heat transfer coefficients were evaluated using FLUENT for

heat flux ranged from 10 to 40 kW/m<sup>2</sup>, using nano CuO concentrations ranged from 0.05 to 1% and particle size from 10 to 70 nm. The results indicate that evaporator heat transfer coefficient increases with the usage of nano CuO.

**Kuljeet Singh et al.** carried out an investigation into the performance of a Nano refrigerant (R134a+Al<sub>2</sub>O<sub>3</sub>) based refrigeration system. It has been found out that the improvement in coefficient of performance (COP) is maximum (7.2 to 8.5%) with 0.5% Al<sub>2</sub>O<sub>3</sub> (% wt.) nanoparticles. When the mass fraction of nanoparticles increased to 1% in refrigerant COP is found to be lower than even from pure R134a. Further, increased mass fraction of Al<sub>2</sub>O<sub>3</sub> (1%), lowers down the pressure and temperature after expansion of the Nano refrigerant in the expansion valve. In addition to this the specific heat of refrigerant gets decreased. So these both factor will results in decrease in the refrigeration effect, hence COP. Improvement is found to be maximum by using Nano-refrigerant R134a+0.5% Al<sub>2</sub>O<sub>3</sub> keeping refrigerant flow rate as 6.5 LPH.

**N. Subramani et al.** done experimental studies on a vapour compression system using nano-refrigerants. It was found that, the R134a refrigerant and mineral oil mixture with nanoparticles worked normally (ii) Freezing capacity of the refrigeration system is higher with SUNISO 3GS + alumina nanoparticles oil mixture compared the system with POE oil (iii) The power consumption of the compressor reduces by 25% when the nano-lubricant is used instead of conventional POE oil (iv) The coefficient of performance of the refrigeration system also increases by 33% when the conventional POE oil is replaced with nano-refrigerant (v) the energy enhancement factor in the evaporator is 1.53.

**D. Sendil Kumar et al.** Nano Al<sub>2</sub>O<sub>3</sub>-PAG oil was used as nano refrigerant in R134a vapour compression refrigeration system and it was found that addition of nano Al<sub>2</sub>O<sub>3</sub> in to the refrigerant shows improvement in the COP of the refrigeration system. Usage for Nano refrigerant reduces the length of capillary tube and cost effective. The system performance was investigated using energy consumption test and freeze capacity test. The refrigeration system performance was better than pure

lubricant with R134a working fluid with 10.32% less energy used with 0.2% V of the concentration used.

**Omer A. Alawi et al.** presented a comprehensive review of fundamentals, preparation and applications of nano refrigerants. Physical properties of nanorefrigerants such as density and viscosity, surface tension and specific heat have a significant effect on nucleate pool boiling, convective flow boiling and condensation. He concluded that adding nanoparticles to the refrigerant enhanced the heat transfer and that the heat transfer coefficient increased with increased nanoparticle mass fraction. From the literatures, it has been found that the thermal conductivities of Nano refrigerants are higher than pure refrigerants. The power consumption was reduced by about 2.4%, and the coefficient of performance was increased by 4.4%. The refrigerator's performance was found 26.1% better with 0.1% mass fraction of TiO<sub>2</sub> nanoparticles compared to a refrigerator's performance with the HFC134a and POE oil system.

**R. S. Mishra et al.** studied thermo physical properties by addition of different nanoparticle mixed with ecofriendly refrigerant are analyzed and their effects on the coefficient of performance (C.O.P.). The experimental results are indicating the thermal conductivity, dynamic viscosity and density of Nano-refrigerant (different nanoparticle i.e. Cu, Al<sub>2</sub>O<sub>3</sub>, CuO and TiO<sub>2</sub> with ecofriendly refrigerant R134a, R407c and R404A) increased about 15 to 94 %, 20% and 12 to 34 % respectively compared to base refrigerant on the other hand specific heat of Nano refrigerant is slightly lower than the base refrigerant. Moreover, Al<sub>2</sub>O<sub>3</sub>/R134a Nano refrigerant shows highest C.O.P. of 35%. R404A and R407 with different nanoparticle show enhancement in C.O.P. about 3 to 14 % and 3 to 12 % respectively.

**A. Senthilkumar et al.** studied the method that uses natural gas to enhance the energy efficiency of refrigeration retorting method employing CuO - R600a as alternate refrigerants. A new nano refrigerant is employed in the domestic refrigerator. The performances of the nano refrigerant, such as the cooling capacity, energy efficiency ratio

were determined. The results indicate that the mixture of R600a with nano particles (CuO) works normally in the domestic refrigerator. The cooling capacity of the domestic refrigerator is increased by 10 - 20% by using nano - refrigerant. The results indicated that CuO - R600a can work normally and efficiently in refrigerator. Combined with refrigerator using pure R600a as working fluids. 0.1 & 0.5g/L concentrations of CuO - R600a can save 11.83% and 17.88% energy consumption respectively and the freezing velocity of CuO - R600a was more quickly than the pure R600a system. Several investigations have been carried out to tackle the problem of Global Warming and Ozone layer depletion with the usage of alternative refrigerants in the refrigeration system. Hence it is felt that a detailed investigation on the possibility of exploring new alternative refrigerant and addition of nano additives to the refrigerant. Accordingly, the specific objectives of the present research work are as follows:

1. Nano additives Al<sub>2</sub>O<sub>3</sub> were blended with R134a refrigerant and their corresponding performance on the same system was investigated. Nano additives of Al<sub>2</sub>O<sub>3</sub> with particle size of 40- 50 nm. The compressor discharge temperature, discharge pressure and evaporator temperature, Coefficient of performance (COP), vapour pressure, volumetric cooling capacity (VCC) were measured. An experimental test rig is designed and fabricated indigenously in the lab to carry out the investigations. Nanoparticles with refrigerant mixture were used in HFC R134a refrigeration system. The system performance with nanoparticles was then investigated.

The scope of this work is limited based on the following:

1. Al<sub>2</sub>O<sub>3</sub> nanoparticles were selected for study.
2. The concentration of nano additives were chosen as 0.5% and 1% by mass in this investigation.

### Experimental methodology

The temperature of the refrigerant at inlet/outlet of each component of the refrigerator is measured with thermometers. Temperature measurement is necessary across each component of the system in order to investigate the performance. Similarly,

pressure measurements are also taken across different components of the refrigeration system. The Pressure gauges are fitted at the inlet and outlet of the compressor and expansion valve. The pressure gauges are fitted with the T-joint and then brazed with the tube to measure the pressure at desired position. A power meter is connected with compressor and heater to measure the power and energy consumption. Firstly, performance of the system is investigated with pure refrigerant R134a. Then nanoparticles are injected in the refrigerator through charging line for the refrigerant. Then performance is investigated with the Al<sub>2</sub>O<sub>3</sub> nanoparticles. Volumetric concentration of nanoparticles, mass flow rate of refrigerant are the key parameters which varied during experimentation.

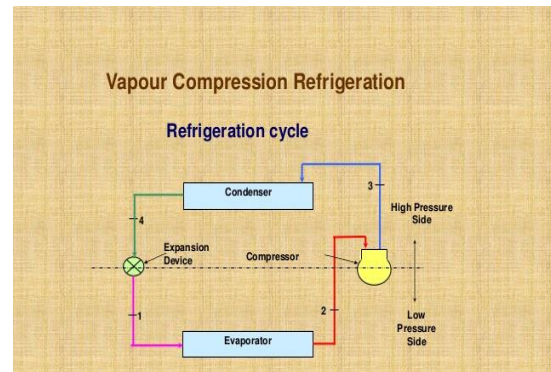
### Experimental Setup

This section provides a detailed description on the facilities developed for conducting the experimental work on a domestic refrigerator. The technique is used for charging nano particles and the evacuation of the system is also discussed here. A detailed report on this facility development is as follows.

Figure .1 shows the actual setup for vapor compression domestic refrigerator in which R134a refrigerant is used as working fluid along with the nanoparticles.



**Figure.1 actual setup of vapour compression system.**



**Figure.2 layout of vapour compression system.**

### Result & discussion

COP is outlined because the quantitative relation of refrigeration impact and work input to the system. During this case COP is that the quantitative relation of power input to heater submerged in evaporator water to the facility consumed by the mechanical device Refrigeration impact

Refrigeration impact COP = Work Done COP is extremely influenced by operative conditions, particularly close temperature and relative temperatures between sink and system. Here during this experimental study actual COP of cooling has been investigated. First study is performed at eleven LPH volume flow of the refrigerant and at constant evaporator heat load at 25-26 oC, once close temperature is around 33oC ±1oC.

As shown in the fig.3, a cop with a pure refrigerant R134a is found to be 0.68 and with nano refrigerant R134a + 0.25% Al<sub>2</sub>O<sub>3</sub> and a refrigerant R134a + 0.50% Al<sub>2</sub>O<sub>3</sub>, the cop is 0.68 and 0.76 respectively. So with a refrigerant R134a + 0.25% Al<sub>2</sub>O<sub>3</sub> and the refrigerant R134a + 0.50% Al<sub>2</sub>O<sub>3</sub> improvement in performance is up to 11.76% as compared to the refrigerant R134a.

Same study has been performed at 11 LPH volume flow rate and 35-36 oC evaporator temperature and at 31.5oC ±2oC ambient temperature. As shown in Fig.4, COP for pure refrigerant R134a is 0.86 and with nano refrigerant R134a + 0.25% Al<sub>2</sub>O<sub>3</sub> and R134a + 0.50% Al<sub>2</sub>O<sub>3</sub>, COP is 0.87 and 0.94 respectively. So it has been concluded that with refrigerant R134a + 0.25% Al<sub>2</sub>O<sub>3</sub> and

refrigerant R134a + 0.50% Al<sub>2</sub>O<sub>3</sub> improvement in performance is 1.16% and 9.3%. Hence, there is increase in the COP of the system with addition of nanoparticles in the refrigerant and also with increases in mass fraction of nanoparticles. Cooling load temperature - time analysis for refrigerant R134a and Al<sub>2</sub>O<sub>3</sub> based nano refrigerants at 11 LPH volume flow rate. (0.25gm) at 11 LPH volume flow rate. the cooling load temperature — time analysis for refrigerant R134a +0.25 % Al<sub>2</sub>O<sub>3</sub> at 11 LPH volume flow rate and at 32oC ±1oC ambient temperature. Refrigerant R134a +0.25 % Al<sub>2</sub>O<sub>3</sub> takes 1 hour 30 minutes for temperature drop from 40oC to 25oC. the cooling load temperature — time analysis for refrigerant R134a +0.50 % Al<sub>2</sub>O<sub>3</sub> at 11 LPH volume flow rate and at 32oC ±1oC ambient temperature. Refrigerant R134a +0.50 % Al<sub>2</sub>O<sub>3</sub> takes 1 hour 22 minutes for temperature drop from 40oC to 25oC.

To know about the cooling capacity of the evaporator studies have been performed with a pure refrigerant R134a, a refrigerant R134a + 0.25% Al<sub>2</sub>O<sub>3</sub> and the refrigerant R134a + 0.50% Al<sub>2</sub>O<sub>3</sub>. the cooling load temperature — time analysis at 11 LPH volume flow rate for pure refrigerant R134a, refrigerant R134a + 0.25% Al<sub>2</sub>O<sub>3</sub> and refrigerant R134a + 0.50% Al<sub>2</sub>O<sub>3</sub> at ambient temperature 32oC ±1oC. In this study it is found that pure refrigerant R134a takes 1 hour 33 minutes for temperature drop from 40oC to 25oC, while nano refrigerant R134a +0.25% Al<sub>2</sub>O<sub>3</sub> takes 1 hour 30 minutes. While nano refrigerant R134a +0.50% Al<sub>2</sub>O<sub>3</sub> takes 1 hour 25 minutes for temperature drop from 40oC to 25oC. So, a decrease in time by 3.23% for refrigerant R134a +0.25% Al<sub>2</sub>O<sub>3</sub> and by 8.6% for refrigerant R134a +0.50% Al<sub>2</sub>O<sub>3</sub> for a temperature. Drop from 40oC to 25oC are determined. This means heat transfer will increase as concentration will increase and takes less time to realize a desired temperature.

In order to analyze the facility consumption for cooling load temperature — time analysis following studies are performed with pure refrigerant R134a, refrigerant R134a + zero.25% Al<sub>2</sub>O<sub>3</sub> and refrigerant R134a + zero.50% Al<sub>2</sub>O<sub>3</sub>. Fig.7 shows power

consumption for 40oC to 25oC temperature drop at eleven LPH volume rate of flow. Close temperature is found to be around thirty-one.5oC ±2oC. During this study it's found that pure R134a consumes zero.23 kWh for chilling from 40oC to 25oC, whereas nano refrigerant R134a + zero.25% Al<sub>2</sub>O<sub>3</sub> and R134a + zero.50% Al<sub>2</sub>O<sub>3</sub> consume zero.22 kWh and zero.196 kWh severally. Figure conjointly shows Reduction in power consumption for nano refrigerant R134a + zero.25% Al<sub>2</sub>O<sub>3</sub> and nano refrigerant R134a + zero.50% Al<sub>2</sub>O<sub>3</sub> is found to be four.35% and 14.7% severally as compared to refrigerant R134a. It's been determined that as concentration of Al<sub>2</sub>O<sub>3</sub> nanoparticles will increase the power input to the cooling decreases.

### Conclusion

The present research work entitled “An Experimental investigation into the Performance of Nano refrigerant (R134a+Al<sub>2</sub>O<sub>3</sub>) Based Refrigeration System” was aimed at, to use nanoparticles in conjunction with R134a refrigerant. It has been decided to use nanoparticles Al<sub>2</sub>O<sub>3</sub> of size 60-70 nm each. Two concentrations of nanoparticles were taken to compare performance with pure refrigerant R134a.

(i) The system was charged with nano refrigerant R134a + Al<sub>2</sub>O<sub>3</sub> with 0.25 gm mass and 0.50 gm mass of nanoparticles

(ii) Temperature drop in condenser, temperature gain in evaporator, COP for the system and temperature-time chart was studied for both nanoparticles at both concentrations

(iii) It was found that addition of aluminum oxide nanoparticles to the refrigerant results in improvement in the thermo physical properties and heat transfer characteristics of the cooling.

(iv) It was discovered that there's additional temperature drop across the condenser for the nano refrigerant (12.37% — 10.88%) compared to refrigerant R134a. Similarly, a gain of five.52% and 9.24% was obtained for evaporator temperature. Associate in Nursing improvement in COP was conjointly discovered throughout the investigations (1.17% — 9.14%). This was achieved

underneath 25–26 °C evaporator temperature load.

(v) A reduction within the power consumption (4.35% & 14.7%) at the side of quicker cooling (from 40 °C — 25 °C) is additionally achieved once nano refrigerant are used.

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## Improvement In COP Using Different Energy Source

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### ABSTRACT

*In the world circumstance the most disturbing issue is constantly get together with energy. We are defying a broad lack of energy and for that it will continually valuable to limit the energy use. So for that this work contain a preliminary procedure by which we can see how much energy we can save by applying three particular energy focal point for developing a ventilating system. While in three fuel source one is normal fuel source and another two is nontraditional fuel source.*

*The conventional fuel source is associated with essential fume pressure cycle and non-standard fuel source is associated with concentrate energy from peltier effect and earth heat exchanger. This work in like manner contains a significant piece of warmth pipe which is used to move energy from on demonstrate other.*

*This work moreover contains the pressing factor of energy usage with three special conditions which are:*

1. *When just fume pressure cycle is used.*
2. *When fume pressure cycle is used with earth heat exchanger.*
3. *When fume pressure cycle is used with earth heat exchanger and likewise peltier module.*

**Keywords:** Vapor Compression Cycle, Peltier module, Air- conditioner, Earth heat exchanger, Thermal Analysis, Heat pipe.

### Introduction

In the current age with depleting wellsprings of essentialness there is reliably a goal to get the best imperativeness extents so that there will be least electric force use in activity of the cooling units. Various systems and considerations from evaporative cooling, thermoelectric cooling, etc have been endeavored to keep the force use to a base in circulating air through and cooling applications. Solely these considerations don't stand extraordinary be that as it may by mix of somewhere around two thoughts locally situated way stands a credibility to develop an imperativeness capable system for circulating air through and cooling. Hence, there is a suggestion to use the standard fume pressure cycle related to thermoelectric cooling and earth warm exchanger methodology to diminish the force usage of the air circulation and cooling framework and thusly increase the COP of structure [2].

A people group situated methodology is used as a piece of progress of a novel air circulation and cooling framework where in the conventional fume pressure cycle ventilating equipment is used as a piece of combination to two distinct systems to be explicit the

thermoelectric cooler and ground cooling heat pipe structure. A ground-coupled warmth exchanger is an underground warmth exchanger that can get warm from just as disperse warmth to the ground. They use the Earth's nearby consistent underground temperature to warm or cool air or various fluids for private, green or mechanical occupations. Earth tubes are often a useful and reasonable alternative or supplement to routine central warming or circulating air through and cooling outline works since there are no blowers, synthetics or burners and just blowers are needed to move the air. These are used for either partial or full cooling or conceivably warming of office ventilation air. Thermoelectric cooling uses the Peltier effect on make a warmth motion between the crossing points of two one of a kind kinds of materials. A Peltier cooler, radiator, or thermoelectric warmth siphon is a solid state dynamic warmth siphon which trades warm from one side of the device to the contrary side against the temperature incline (from frosty to hot), with usage of electrical imperativeness [12].



Broaden work will oversee warm burden affirmation, blower control confirmation for conventional Vapor constrain cycle to take 100 % of evaluated load. Assurance of thermoelectric modules and Selection of warmth pipe system for earth warm exchanger module to take 20 % of warmth load .Design and improvement of authority space with the evaporator twist of routine AC with composed with thermoelectric modules [7]. Test and Trial on made air circulation and cooling framework choose, temperature incline, cooling limit (weight) and COP of system, under given conditions. Structure will be attempted both freely moreover in various mixes viz, VCC with Ground coupled warmth exchanger or VCC with Thermoelectric module, etc and comparable survey will be displayed in proposition to evaluate the reasonability of individual systems or blends over one another [7].

### Literature Review

Ehsan Firouzfard, and Maryam Attaran et al. State that As a very powerful heat exchange component, warm pipes have step by step perceived, and are playing a more critical part in every mechanical field. A heat pipe is a vanishing buildup gadget for moving heat in which the dormant heat of vaporization is misused to transport warm over long separations with a comparing little temperature contrast. The heat transport is acknowledged by method for vanishing a fluid in the heat bay locale (called the evaporator) and in this manner consolidating the vapor in a heat dismissal district (called the condenser). Shut course of the working liquid is kept up by fine activity and/or mass powers. The heat pipe was initially designed by Gaugler of the General Motors Corporation in 1944, yet did not genuinely gather any huge consideration inside the heat exchange group until the space program restored the idea in the mid 1960's. Leeway of a heat pipe over other customary strategies to exchange heat such a finned warm sink, is that a heat pipe can have a greatly high warm conductance in consistent state operation. Thus, a heat pipe can exchange a high measure of heat over a generally long length with a similarly little temperature differential. Warm pipe with fluid metal

working liquids can have a warm conductance of a thousand or even a huge number of times more prominent than the best strong metallic transmitters, silver or copper. There are by and large no less than five physical marvels that will restrain, and now and again calamitously confine, a heat pipe capacity to exchange warm. Manoj Kumar Rawat et al. Explained that In late years, with the expansion mindfulness towards natural debasement because of utilization of CFCs and HCFCs refrigerants in traditional refrigeration frameworks has turned into a subject of extraordinary concern. In addition, these sorts of refrigeration frameworks having constraint of utilization of lattice power and same can't be used for remote applications. Specialists are persistently giving endeavors for advancement of eco-accommodating refrigeration innovations like thermoelectric, adsorption, attractive and thermoacoustic refrigeration. Dai et al. built up a thermoelectric refrigeration framework controlled by sun powered cells and completed test examination and investigation. Scientists built up a model which comprises of a thermoelectric module, exhibit of sunlight based cell, controller, stockpiling battery and rectifier. The examined cooler can keep up the temperature in refrigerated space at 5–10°C, and has a COP around 0.3 under given conditions. Wahab et al. have outlined and built up a moderate sun oriented thermoelectric icebox for the abandon individuals living in Oman where power is not accessible. In this review, they utilized 10 nos. of thermoelectric module in plan of fridge. The trial comes about demonstrated that the temperature of the refrigeration was decreased from 27°C to 5°C in around 44 min. The coefficient of execution of the cooler was figured and observed to be around 0.16.

J.W. Wan et al. Explored the effect of warmth pipe air- dealing with circle on imperativeness use in a central cooling structure with bring air back. By taking an office working for example, the survey shows that differentiated and conventional central circulating air through and cooling system with return air, the warmth pipe ventilating structure can save cooling and warming imperativeness. In the average extent of 22–26.8°C indoor layout temperature and half relative clamminess, the RES (pace of

essentialness saving) in this place of business investigated is 23.5–25.7% for cooling load and 38.1–40.9% for total imperativeness use. The RES of the warmth pipe circulating air through and cooling system increases with the extension of indoor arrangement temperature and the decreasing of indoor relative sogginess. The effect of indoor relative soddenness on RES is considerably more noticeable than the effect of the indoor layout temperature. The audit exhibits that a central circulating air through and cooling system can basically reduce its essentialness use and upgrade both the indoor warm comfort and air quality when a warmth pipe air-dealing with circle is used observable all around trim interaction.

Girja Sharan et al. Analyzed likely that, a single pass earth- tube warm exchanger (ETHE) was acquainted with study its execution in cooling and warming mode. ETHE is made of 50 m long ms line of 10 cm apparent width and 3 mm divider thickness. ETHE is covered 3 m far underneath surface. Encompassing air is siphoned through it by a 400 w blower. Velocity in the line is 11 m/s. Air temperature is estimated at the channel of the line, in the middle (25 m), and at the power source (50 m), by thermisters set inside the line. Cooling tests were finished three consecutive days in consistently. On consistently system was labored for 7 hours in the midst of the day and close down for the evening. ETHE could lessen the temperature of hot encompassing air by as much as 14°C. Considering the results it tends to be communicated that ETHE holds critical assurance same as to cooler warmth encompassing air for a variety of employments, for instance, the trained creatures building sand nurseries.

Yat H. Yau et al. Probably investigated that, how the reasonable warmth extent (SHR) of HPHX was influenced by every one of three key boundaries of the bay air state, to be explicit, dry-globule temperature, and relative tenacity and velocity. On the reason of this survey, it is recommended that tropical HVAC structures should be presented with heat pipe warm exchangers for dehumidification improvement and saving the essentialness. The exploratory results displayed that for all cases broke down, the overall SHR of the HVAC

structure was diminished from the most limit of 0.688 to the foundation of 0.188 by the HPHX as delta DBT to the HPHX evaporator extended. These results proposed that the sogginess removal limit with regards to the HVAC system with HPHX was growing as cove DBT for HPHX evaporator extended. On the reason of this survey, it is recommended that tropical HVAC structures should be presented with heat pipe warm ex-transformers for dehumidification

Test & Trial-I on conventional VC-model with earth heat exchanger

Procedure:

Start compressor Peltier module off Earth heat exchanger

Take temperature readings after every 3min

Calculation:

$$KWH = (\text{time}/60) \times (\text{compression power})/1000$$

$$COP = (KWH)/((mcp\Delta t) \times 3600)$$

$$\text{Tonnage} = COP/3.516$$

**RESULT TABLE:**

Sr No	Δt	Net Compressor Power	Mcp Δt	Cop	Tonnage
01	2	91	20.8832	1.274921	0.3285878
02	7	89	73.0912	2.281248	0.5879506
03	9	83	93.9744	2.096707	0.5403884
04	11	82	114.8576	1.94542	0.5013969
05	15	80	156.624	2.175333	0.5606529

**Result Table for trial-I**

Above mention trial is the first trial with taking consideration of peltier module and the vapour compression cycle. In this there is no role of earth heat exchanger. Trail-I contain the energy source from two different energy provider i.e. from vapour compression cycle which is high grade energy source while there is also another energy source from peltier module which supply low grade energy. Since the low grade energy used fist to lower or higher the temperature of outside airso the required energy from high grade energy source become less due to which it can observed in result table of trail -I that the load capacity (Mcp Δt) of system is increases. Since the load capacity is directly proportional to COP & Tonnage of system it is also increases

Test & Trial-II on conventional VC-model with Peltier module

Procedure:

- Start compressor Peltier module on
- No earth heat exchanger
- Take temperature readings after every 3min

Calculation:

- 1.)  $KWH = (time/60) \times (compression\ power)/1000$
- 2.)  $COP = (KWH)/((mcp\Delta t) \times 3600)$
- 3.)  $Tonnage = COP/3.516$

Sr No	Δt	Net Compressor Power	Mcp Δt	Cop	Tonnage
01	2	103	20.8832	1.126386	0.2903057
02	7	97	73.0912	2.093104	0.5394599
03	12	89	125.2992	2.607141	0.6719436
04	15	83	156.624	2.620884	0.6754854
05	20	81	208.832	2.864636	0.7383084

**RESULT TABLE:**

Sr No	Δt	Net Compressor Power	m cp Δt	Cop	Tonnage
01	2	112	20.8832	1.035873	0.2669776
02	7	106	73.0912	1.915388	0.4936567
03	10	98	104.416	1.973091	0.5085287
04	13	92	135.7408	2.049227	0.5281513
05	18	88	187.9488	2.373091	0.6116214

Above mention trial is the second trial with taking consideration of Earth heat exchanger and the vapour compression cycle. In this there is no role of peltier module. Trail-II contain the energy source from two different energy provider i.e. from vapour compression cycle which is high grade energy source while there is also another energy source from Earth heat exchanger which supply low grade energy. Since the low grade energy used fist to lower or higher the temperature of outside air so the required energy from high grade energy source become less due to which it can observed in result table of trail -I that the load capacity (Mcp Δt) of system is increases. Since the load capacity is directly proportional to COP & Tonnage of system it is also increases

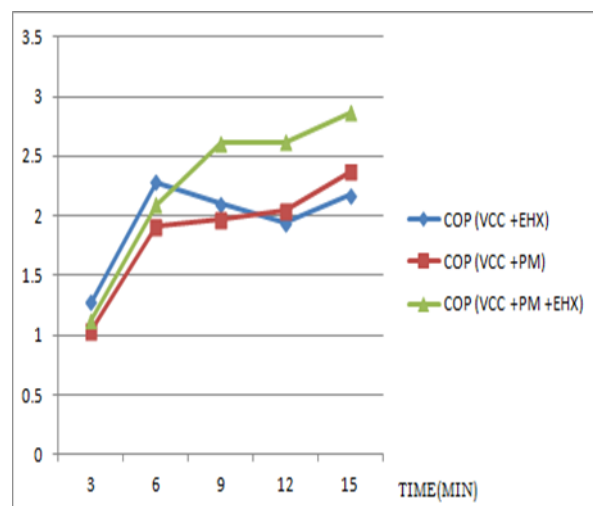
Test & Trial-III on Conventional VC-Model with Peltier Module and EarthHeat Exchanger Calculation:

- 1.)  $KWH = (time/60) \times (compression\ power)/1000$
- 2.)  $COP = (KWH)/((mcp\Delta t) \times 3600)$
- 3.)  $Tonnage = COP/3.516$

**Result Table for trial-III**

Above mention trial is the third trial with taking consideration of Earth heat exchanger and the vapour compression cycle as well as peltier module. Trail-III contain the energy source from three different energy provider i.e. from vapour compression cycle which is high grade energy source while there is another two energy source from Earth heat exchanger and peltier module which supply low gradeenergy. Since the low grade energy used fist to lower or higher the temperature of outside air so the required energy from high grade energy source become less due to which it can observed in result table of trail-III that the load capacity (Mcp Δt) of system is increases. Since the load capacity is directly proportiona COP & Tonnage of system it is also increases

**GRAPH RESULT-I:**



Comparison of COP Result:

COP of (VCC+PM+HEX) is maximum and thus most effective of the three combinations hence it is recommended that all three modifications of the hybrid system be used for best results.

Comparison of the COP of (VCC+ PM) & (VCC +EHX) shows that (VCC +PM) shows better COP as compared to the (VCC +EHX) over delayed duty cycle i.e., from 12 to 15min, hence will be recommended if the temperature cycling is to be done over a range above 12 minutes time.

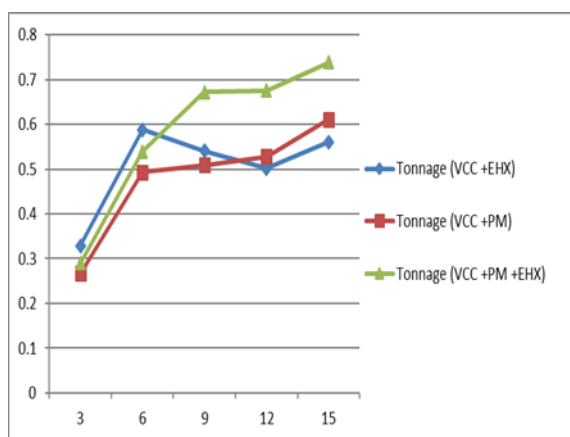
Comparison of the COP of (VCC+ PM) & (VCC +EHX) shows that (VCC +EHX) shows better COP as compared to the (VCC +PM) over short duty

cycle i.e., from 0 to 12min, hence will be recommended if the temperature cycling is to be done over a range below 12 minutes time.

Discussion on Result- I

Graph Result-I give us comparison of COP for three distinct case and these cases are "Result from trail -I, Result from trail- II and Result from Trail -III". As we have three distinct table so this graphical result help us to study the optimized condition. This result shows that trail - III have higher COP and it will be most appropriate condition which is because that in trail test III we take three different energy source instead of two sources. Graph result-I also shows that up to certain time i.e. 6 minute the performance of (VCC +EHX) has better. Reason behind it for that is upto 6 min peltier module doesn't have effective cooling capacity in comparison of earth heat exchanger.

**GRAPH RESULT-II**



Comparison of Tonnage Result:

Tonnage of (VCC+PM+HEX) is maximum and thus most effective of the three combinations hence it is recommended that all three

modifications of the hybrid system be used for best results.

Comparison of the Tonnage of (VCC+ PM) & (VCC +EHX) shows that (VCC +PM) shows better Tonnage as compared to the (VCC +EHX) over delayed duty cycle i.e., from 12 to 15min

, hence will be recommended if the temperature cycling is to be done over a range above 12 minutes time.

Comparison of the Tonnage of (VCC+ PM) & (VCC +EHX) shows that (VCC +EHX) shows better Tonnage as compared to the (VCC +PM) over short duty cycle i.e., from 0 to 12min, hence will be recommended if the temperature cycling is to be done over a range below 12 minutes time.

Discussion on Result- II

Graph Result-II give us comparison of tonnage for three distinct case and these cases are "Result from trail -I, Result from trail- II and Result from Trail -III". As we have three distinct table so this graphical result help us to study the optimized condition. This result shows that trail - III have higher tonnage and it will be most appropriate condition which is because that in trail test III we take three different energy source instead of two sources. Graph result-II also shows that up to certain time i.e. 6 minute the tonnage of (VCC +EHX) has better. Reason behind it for that is upto 6 min peltier module doesn't have effective cooling capacity in comparison of earth heat exchanger.

### Conclusion

1. Cop of the hybrid system increases with application of the Peltier module and Earth heat exchanger arrangement to up to 10 %
2. Tonnage of the hybrid system increases with application of the Peltier module and Earth heat exchanger arrangement to up to 11 %
3. Thermodynamically work done on entire system is decreased due to increased in Cop.
4. Due to use of low grade energy the saving of high grade energy increases.

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## Improvement In COP With Combination Of Vapour Compression Cycle & Vapour Absorption Cycle

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### ABSTRACT

The most concern thing on the planet in current decade is the solid wellspring of Energy. As the question of time it is presently an ideal opportunity to move toward non-customary wellspring of energy. The significant energy among non-customary energy is created by sunlight-based energy. In this survey paper we examined on the part where we create energy exhaustive nearby planetary group and after that we use that energy to beat the part load on Hybrid cooling. This is done to run the framework on part of the way on sun oriented and lay on power. In this entire interaction the test is to keep up with the refrigerating impact with at the same time minimization of power utilization. The part of coefficient of execution of framework is extremely basic in light of the fact that as the time elapsed Coefficient of execution is first decline and afterward increment so the test is to keep up with it. This audit paper additionally elaborates the work done in this field of Refrigeration and Air molding.

**Keywords:** Refrigeration and Air molding, close planetary system, Hybrid cooling, Nonconventional

### Introduction

Test and Trial on made air circulation and cooling framework choose, temperature slant, cooling limit (weight) and COP of structure, under given conditions. Structure will be attempted both autonomously besides in various mixes viz, VCC with Ground coupled warmth exchanger or VCC with Thermoelectric module, etc and comparable audit will be displayed in hypothesis to survey the feasibility of individual systems or blends over one another.

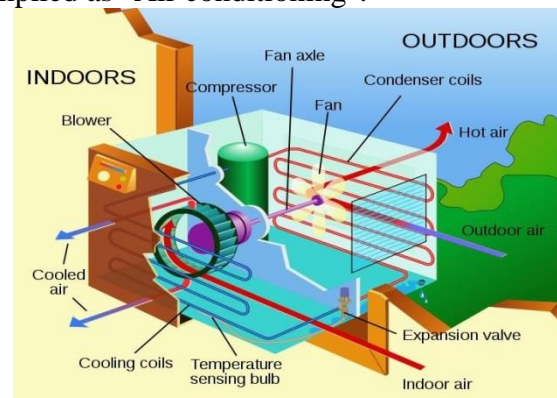
Private or business air circulation and cooling framework is basically delegated Window AC or Split Ac structure depending on the method for mounting and position. The customary AC structures use the Vapor Compression cycle for activity.

Air circulation and cooling framework gear power is every now and again portrayed with respect to "gigantic measures of refrigeration." A "colossal measure of refrigeration" is described as the cooling power of one short ton (2000 pounds or 907 kilograms) of ice condensing in a 24-hour time period. This is comparable to 3517 watts. Private central air structures are generally from 1 to 5 tons (3 to 20 kilowatts (kW)) in limit. The use of electric/compressive circulating air through and cooling puts an essential solicitation on the electrical force grid in blistering environment,

when most units are working under overpowering weight.

### Hybrid Airconditioner

An Air molding framework (as often as possible insinuated as AC) is a home machine, system, or part planned to dehumidify and remove warm from an area. The cooling is finished using an essential refrigeration cycle. Being developed, a whole course of action of warming, ventilation, and Air molding is implied as "Air conditioning".



**Fig. of an Air Conditioning Unit**

Fig. shows a cooling unit where just fume pressure cycle is utilized and one can without much of a stretch comprehend the working of split cooling. Following is the point which melding:

The twists and lines in a cooling unit contain refrigerant gas. The refrigerant gas enters the

blower as warm, low-weight gas and leaves it as hot, high-weight gas.

In the condenser twists, hot, compacted refrigerant gas loses warmth to the outdoors and will be unmistakably liquid while it is still warm.

The warm, liquid refrigerant goes through the unobtrusive opening of the advancement valve, expands, and to some degree swings to gas at a low temperature.

In the cooling twists, the refrigerant takes up heat from the indoor air and leaves the circles as warm, low-weight gas.

The indoor air gives up warmth to the refrigerant in the cooling circles besides loses moistness as it is chilled. The suddenness solidifies on the twists and streams down to outside exhaust openings. Cooled air is blown again into the room.

### Literature Review

J.C.V. Chinampa et al [1] presents a crossover cooling framework comprising of an ordinary R-22 fume pressure refrigeration framework fell with a sun based worked, smelling salts water, fume assimilation framework. The condenser of the R-22 framework is cooled by the evaporator of the smelling salts framework. This works with activity of the R-22 framework at a low consolidating temperature and pressing factor. This is found to yield impressive investment funds in electrical energy utilization by the pressure framework.

A.O. Diengand et al [2] presents the essential goal of this audit is to give major understandings of the sun powered adsorption frameworks and to give helpful rules in regards to plans boundaries of adsorbent bed reactors, and the pertinence of sun based adsorption both in cooling and refrigeration with the improvement of the coefficient of execution. Sun powered adsorption heat siphon and refrigeration gadgets are of importance to address the issues for cooling necessities, for example, cooling and ice-production and clinical or food protection in far off regions. They are additionally quiet, non-destructive and harmless to the ecosystem. Hence the examination exercises in this area are as yet expanding to tackle the urgent focuses that make these frameworks not yet prepared to contend with the notable fume pressure

framework. There is an expanding interest in the turn of events and utilization of adsorption chillers because of their different monetary and great natural advantages, empowering sun based energy or waste warmth to be utilized for applications, for example, region organizations and cogeneration plants. Contrasted with adsorption frameworks that require heat sources with temperatures above 100°C (zeolite–water frameworks, actuated carbon–methanol frameworks) or regular blower chillers, a silica gel/water adsorption cooler uses squander heat with temperature underneath 100°C. This makes additional opportunities for using low temperature energy.

R. Z.wang et al [3] Solar driven cooling frameworks can adapt to sun-oriented gatherers working in a wide scope of temperatures. Sorption frameworks, including retention and adsorption refrigeration frameworks, are among the most ideal decisions for sun powered cooling. Five frameworks including measured silica gel–water adsorption chiller, single/twofold impact LiBr–water retention chiller, 1.n impact LiBr–water assimilation chiller, CaCl<sub>2</sub>/AC (actuated carbon) smelling salts adsorption fridge, and the water–alkali ingestion ice producer with better interior warmth recuperation were introduced. The over five sorption chillers/fridges work under different driven temperatures and satisfy diverse refrigeration requests. The thermodynamic plan and framework improvement of the frameworks were shown. This load of frameworks has enhancements in correlation with existing frameworks and may offer great choices for high effective sun powered cooling sooner rather than later.

K.K. Fong et al [4] presents Stratum ventilation (SV), another indoor air conveyance technique, has been advanced for applications in various structure premises lately. Contrasted with the regular blending ventilation (MV), the noticeable benefit of SV is that indoor warm solace can be happy with a generally high stock air temperature, consequently less energy utilization in refrigeration. In sunlight-based cooling, the energy execution can likewise be worked with by high-temperature cooling. Accordingly, the capability of SV to be associated with sun-based cooling was

assessed. In this examination, the sunlight-based cooling frameworks included sun-based retention cooling framework (SACS), sun powered adsorption cooling framework (SACS), sun based desiccant cooling framework (SDCS), half breed sun-based assimilation desiccant cooling framework (HSADCS) and mixture sun-based adsorption-desiccant cooling framework (HSADCS). Their exhibitions utilizing SV and MV were resolved through all year dynamic reproduction. Contrasted with the partner utilizing MV, SACS, SACS, SDCS, HSADCS and HSADCS related with SV could have 35%, 54%, 59%, 29% and 44% saving in the yearly essential energy utilization for working in subtropical environment individually. Benchmarked with the customary cooling framework, they could have essential energy setting aside to 30%. Thus, sun-oriented cooling and SV can have synergetic legitimacy in building application in sweltering and muggy city.

Z.F. Li et al [5] presents the reproduction of a sun based fueled assimilation cooling framework with the ingestion pair of lithium bromide and water. An endeavor is made to build the COP of the framework by parceling a solitary stockpiling tank into two sections. Toward the beginning of the day when daylight is low, the upper part is initiated, and in the early evening, the entire (upper and lower) tank is associated with the authority. The examination shows that it is desirable over use a divided water tank as opposed to the ordinary delineated water tank in light of the fact that the cooling impact can be acknowledged a whole lot sooner contrasted with the typical defined water stockpiling tank. Additionally, the general cooling effectiveness (cooling burden to add up to sunlight-based energy proportion) was discovered to be higher for the divided stockpiling cooling framework.

### DESIGN

Following data has been assumed,  
Capacity of system = 0.1TR (0.3517KW)  
Concentration of NH<sub>3</sub> in refrigerant, X<sub>r</sub> = 0.98  
Concentration of NH<sub>3</sub> in Solution, X<sub>s</sub> = 0.42  
Concentration of NH<sub>3</sub> in absorbent, X<sub>w</sub> = 0.38  
Temperature of the evaporator, T<sub>E</sub> = 7°C  
Generator or condenser pressure = 7 bar

Evaporator pressure = 4.7 bar  
Temperature of the Condenser, T<sub>C</sub> = 54°C  
Temperature of the Absorber, T<sub>A</sub> = 54°C  
Temperature of the Generator, T<sub>G</sub> = 80°C

### Calculation for mass flow rate:

At outlet of condenser it is saturated liquid,  
We have assume, pressure at that point, P<sub>2</sub> = 7 bar

And Concentration of NH<sub>3</sub> in refrigerant X<sub>r</sub> = 0.98

Using the enthalpy concentration diagram for Ammonia / Water We get: Condenser temp T<sub>2</sub> = 54°C h<sub>2</sub> = 200 KJ/Kg

At expansion valve,

Expansion of refrigerant through expansion valve from high pressure to low pressure at constant enthalpy

h<sub>2</sub> = h<sub>3</sub> = 200 KJ/Kg

T<sub>3</sub> = 7°C

P<sub>3</sub> = 4.7 bar

At evaporator,

Extraction of heat by low pressure ammonia vapour in the evaporator

Saturation Pressure in evaporator; P<sub>4</sub> = 4.7 bar

Evaporator temp; T<sub>4</sub> = 7°C

Using Enthalpy concentration diagram;

Considering the ammonia vapour as saturated.

h<sub>4</sub> = 1220 KJ/Kg

Heat Extracted by evaporator;

Q<sub>E</sub> = M<sub>r</sub> × (h<sub>4</sub> - h<sub>3</sub>)

M<sub>r</sub> = Mass flow rate of refrigerant

Q<sub>E</sub> = 0.875 KW

0.3517 = M<sub>r</sub> × (1220 - 200) M<sub>r</sub> = 0.3448 gm/sec

Here,

Mass Of solution (M<sub>s</sub>) = Mass of refrigerant (M<sub>r</sub>) + Mass of absorbent (M<sub>w</sub>) But here,

M<sub>s</sub> X<sub>s</sub> = M<sub>r</sub> X<sub>r</sub> + M<sub>w</sub> X<sub>w</sub>

(M<sub>w</sub> + M<sub>r</sub>) X<sub>s</sub> = M<sub>r</sub> X<sub>r</sub> + M<sub>w</sub> X<sub>w</sub>

(M<sub>w</sub> + 0.3448) × 0.42 = 0.3448 × 0.98 + M<sub>w</sub>

(0.38) M<sub>w</sub> = 4.8075 gm/s so, M<sub>s</sub> = M<sub>r</sub> + M<sub>w</sub> M<sub>s</sub> = 0.3448 + 4.8075

M<sub>s</sub> = 5.1515 gm/s

### Design of Condenser

Ammonia Vapour Entering the condenser shell as a Saturated Vapour

P<sub>1</sub> = 7 bar

X<sub>r</sub> = 0.98

Using h-x Diagram for Ammonia/Water,

T<sub>1</sub> = 54°C h<sub>1</sub> = 1135 KJ/Kg Heat rejected by condenser



$Q_c = M_r \times (h_1 - h_2)$   
 $Q_c = 0.3448 \times (1135 - 200)$   
 $Q_c = 0.321 \text{ KW}$   
 Here we use air cooled condenser  
 So we assume,  
 Inlet temperature of air =  $27^\circ\text{C}$   
 Outlet temperature of air =  $45^\circ\text{C}$   
 For LMTD ,  
 Condenser temperature =  $54^\circ\text{C}$   $\theta_1 = 54 - 27 = 27$   
 $\theta_2 = 54 - 45 = 9^\circ\text{C}$   
 $\text{LMTD} = \theta_1 - \theta_2 / \ln (\theta_1 / \theta_2)$   
 $\text{LMTD} = 27 - 9 / \ln (27/9) = 16.38^\circ\text{C}$   
 $Q_c = UA \times \text{LMTD}$   
 $0.3217 = 0.401 \times A \times 16.38$   
 $A = 0.0489 \text{ m}^2$   
 Considering the number of Condenser tubes (n)  
 $= 18$  The effective area of Condenser (A) =  $n \times 3.14 \times D \times L$   
 $0.0489 = 18 \times 3.14 \times 0.008 \times L$   
 So length of each tube,  $L = 15 \text{ cm}$

**Design of Evaporator**

Let air inlet temperature to evaporator  $Th_1 = 35^\circ\text{C}$  Air outlet temp,  $Th_2 = 17^\circ\text{C}$ . And

evaporator temperature =  $7^\circ\text{C}$   $\theta_1 = 35 - 7 = 28^\circ\text{C}$   
 $\theta_2 = 17 - 7 = 10^\circ\text{C}$   
 $\text{LMTD} = \theta_1 - \theta_2 / \ln (\theta_1 / \theta_2)$   
 $\text{LMTD} = (28 - 10) / \ln (28/10)$   
 $\text{LMTD} = 17.45^\circ\text{C}$   
 $Q_e = UA \times \text{LMTD}$   
 $0.3517 = A \times 17.45 \times 0.401$   
 $A = 0.05024 \text{ m}^2$   
 Considering the number of evaporator tubes (n)  
 $= 8$   
 Here from market we get diameter of pipe =  $8 \text{ mm}$   
 The effective area of evaporator, (A) =  $n \times 3.14 \times D \times L$   
 So,  
 $0.05024 = 8 \times 3.14 \times 0.008 \times L$   
 So, length of each tube  $L = 25 \text{ cm}$

**TESTING**

First switch on the pump to circulate the solution. At the start of generator Assumed  $T=0$ , then we have taken a reading of output air after some time of interval.

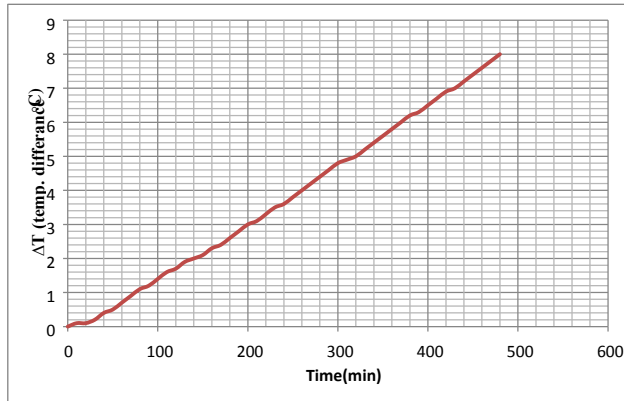
Time (Min)	Temp. (I/P Air) °C	Temp. (O/P Air) °C	ΔT (Temp. Difference) °C	Heat Supplied(Qg) KW	Heat Absorbed(Qe) KW	COP
0	0	0	0	0	0	0
10	30	29.9	0.1	0.250	0.001741	0.0069
20	30	29.9	0.1	0.250	0.001741	0.0069
30	30	29.8	0.2	0.250	0.00348	0.0139
40	30	29.6	0.4	0.250	0.006964	0.0278
50	30	29.5	0.5	0.250	0.00870	0.0348
60	30	29.3	0.7	0.250	0.012188	0.0487
70	30	29.1	0.9	0.250	0.01567	0.0626
80	30	28.9	1.1	0.250	0.01915	0.0766
90	30	28.8	1.2	0.250	0.02089	0.0835
100	30	28.4	1.4	0.250	0.02437	0.0974
110	30	28.4	1.6	0.250	0.02785	0.1114
120	30	28.3	1.7	0.250	0.02959	0.1183
130	30	28.1	1.9	0.250	0.03308	0.1323
140	30	28	2	0.250	0.03482	0.1392
150	30	27.9	2.1	0.250	0.03656	0.1462
160	30	27.7	2.3	0.250	0.04004	0.1601
170	30	27.6	2.4	0.250	0.04178	0.1671
180	30	27.4	2.6	0.250	0.04527	0.1810
190	30	27.2	2.8	0.250	0.04875	0.1950
200	30	27	3	0.250	0.05223	0.2089

210	30	26.9	3.1	0.250	0.05397	0.2158
220	30	26.7	3.3	0.250	0.05745	0.2299
230	30	26.5	3.5	0.250	0.06094	0.2437
240	30	26.4	3.6	0.250	0.06268	0.2507
250	30	26.2	3.8	0.250	0.06616	0.2646
260	30	26	4	0.250	0.06964	0.2745
270	30	25.8	4.2	0.250	0.07312	0.2924
280	30	25.6	4.4	0.250	0.07661	0.3064
290	30	25.4	4.6	0.250	0.08009	0.3203
300	30	25.2	4.8	0.250	0.08357	0.3342
310	30	25.1	4.9	0.250	0.08576	0.3368
320	30	25	5	0.250	0.08705	0.3482
330	30	24.8	5.2	0.250	0.09054	0.3621
340	30	24.6	5.4	0.250	0.09402	0.3760
350	30	24.4	5.6	0.250	0.09576	0.3830
360	30	24.2	5.8	0.250	0.10098	0.4039
370	30	24	6	0.250	0.10446	0.4178
380	30	23.8	6.2	0.250	0.10795	0.4318
390	30	23.7	6.3	0.250	0.10969	0.4387
400	30	23.5	6.5	0.250	0.11317	0.4527
410	30	23.3	6.7	0.250	0.11665	0.4666
420	30	23.1	6.9	0.250	0.12014	0.4805
430	30	23	7	0.250	0.12188	0.4875
440	30	22.8	7.2	0.250	0.12536	0.5014
450	30	22.6	7.4	0.250	0.12884	0.5153
460	30	22.4	7.6	0.250	0.13232	0.5292
470	30	22.2	7.8	0.250	0.13581	0.5432
480	30	22	8	0.250	0.13929	0.5571

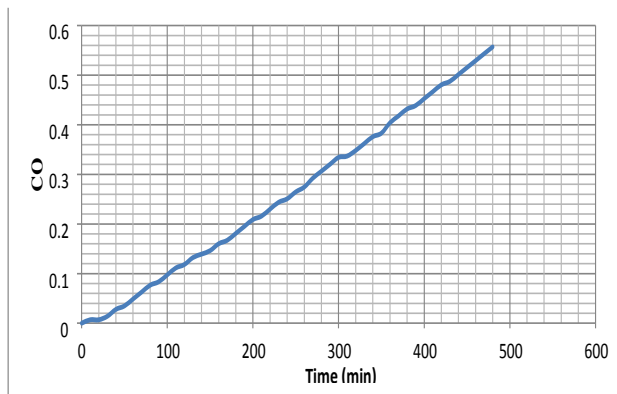
**Actual COP,** $Qg$  = Heat supplied by Heater (KW) $Qe$  = Heat absorbed (KW) $Qe = M_a \times C_{p,air} \times \Delta T$   $M_a = \rho \times A \times V$   $\rho$  = Density of air $A$  = Area of duct =  $0.125 \times 0.165 = 0.020625 \text{ m}^2$  $V$  = Velocity of air $M_a = 1.2 \times 0.020625 \times 0.7$  $M_a = 0.017325 \text{ Kg/s}$ 

For reading 1,

Output temperature =  $30 \text{ }^\circ\text{C}$ Input temperature =  $29.9 \text{ }^\circ\text{C}$  $\Delta T = 0.1 \text{ }^\circ\text{C}$  $Qe = 0.017325 \times 1.005 \times 0.1$  $Qe = 0.001741$  $Qg = 0.250 \text{ KW}$  $COP = Qe/Qg = 0.001741/0.250 = 0.006964$ **Theoretical COP,** $Qe$  $Qg$  $Qe$  = Capacity of system (0.1 TR) $Qg$  = Heat supplied (Neglect pump) $Qe = 0.1 \times 3.517$  $\frac{Qe}{Qg} = \frac{0.3517}{0.250} = 1.4068$  $Qg = 0.250$  $COP = 1.4068$

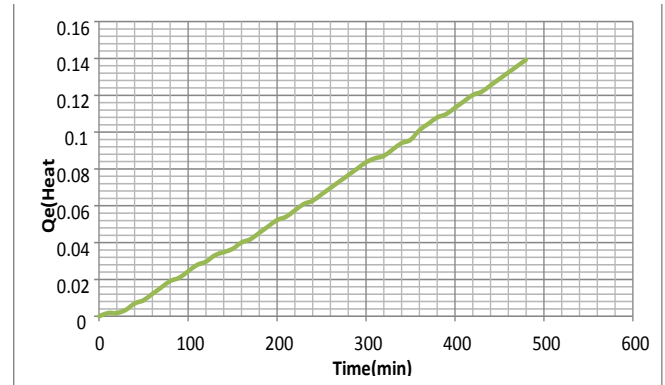
**RESULT:****Time vs  $\Delta T$** **Graph 1: (Time vs Temp. Difference)**

From above graph, we can conclude that as the time increases the temperature difference also increases so we can say that the time is directly proportional to temperature difference. So, for achieving large temperature difference we need more time.

**Time vs COP****Graph 2: (Time vs COP of system)**

From above graph, we can conclude that as the time increases the COP also increases so we

can say that the time is directly proportional to COP. So, for achieving more COP we need more time.

**Time vs  $Q_e$** **Graph 3: (Time vs Heat absorption capacity)**

From above graph, we can conclude that as the time increases the heat absorption capacity ( $Q_e$ ) also increases so we can say that the time is directly proportional to heat absorption capacity. So, for achieving more heat absorption capacity we need more time.

**CONCLUSION:**

- The COP of the system is time based. We can achieve the COP 0.5571 after 8 hours of time. So to obtain large COP time required is more.
- Energy consumption of this system is very lesser than vapour compression system.
- The system is based on solar energy so no convectional energy is required.
- To achieve more absorption capacity time required is more.

The system is not suitable for large capacity plants because system gets bulky and high maintenance required.

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## Pneumatic Sealing Machine for Plastic Housing

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### ABSTRACT

A buzzer is a device used in semi-automatic washing machine as an indicator for starting as well as stopping of the washing cycle. In this object a improper riveting issue was noticed in many samples examined by our team. So we have proposed to implement the new ideas to overcome the problem.

This paper aims on improving the overall efficiency of the plant by observing problems at different stages of production line and provide optimum solutions to them. Paper also aims on implementing new technology and machine learning to smartly detect problems and errors in different parts with high precision and speed and thus avoid human errors in quality control.

**Keywords:** buzzer, improper riveting, new technology, avoid human errors.

### Introduction

In one of the industry located in India, as per customer requirement related to washing machine component, a buzzer is manufactured and supplied. During the transportation of the material it is found that in many buzzers, the integrated locks provided for locking in the back panel are damaged/broken, due to impact during transportation and during assembly. The study undertaken provides solution for the same.

As per customer's perspective, improper riveting issue was found in some samples. This was because the product could not withstand insertion force at the terminal connectors. This led to a breakage of plastic rivet.

Also, during transportation, the locks which are made of plastic brakes and that's why the buzzer doesn't work properly. Most of the time, finished goods products are supplied to Supplier Company via railways. And train stops at any particular station for just 3-4 min, in 3-4 min there are so many materials to load in trains. So the workers load material so harshly in train and due to which plastic case brakes, plastic casing removes from assembly, locks gets damaged as per shown in fig. - 1.



Fig 1- WORKPIECE

### Literature Review

Renis D Thumaret al[1] analyzed heat sealing is the process of sealing one thermoplastic to another similar thermoplastic using heat and pressure. It can join two similar materials or can join dissimilar materials, one of which has thermoplastic layer. Plastic bags are mostly used for packaging of foods, powders, chemicals, doughy products, etc. In heat sealing, a sealing bar is used to apply heat to seal the two thermoplastic layers together. Heat sealing is used in many fields like, bio-engineering, food industries, etc. It is also used in manufacturing of film for filling the blood. Sealing quality depends on the accurate parameters like Time, Temperature and Pressure. By applying accurate pressure on the sealing bar, with accurate time and temperature as per the thickness of the plastic bag, we can seal it perfectly. Sealing quality can be tested by a simple pull to determine the bond between the two layer. The effect of sealing parameter(Pressure) on heat sealing is the

process of sealing one thermoplastic to another similar thermoplastic using heat and pressure. It can join two similar materials or can join dissimilar materials, one of which has thermoplastic layer. Plastic bags are mostly used for packaging of foods, powders, chemicals, doughy products, etc. In heat sealing, a sealing bar is used to apply heat to seal the two thermoplastic layers together. Heat sealing is used in many fields like, bio-engineering, food industries, etc. It is also used in manufacturing of film for filling the blood. Sealing quality depends on the accurate parameters like Time, Temperature and Pressure. By applying accurate pressure on the sealing bar, with accurate time and temperature as per the thickness of the plastic bag, we can seal it perfectly. Sealing quality can be tested by a simple pull to determine the bond between the two layer.

Akash A. Pawar [2] et al reviewed packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale and use. Carton is the name of certain types of containers typically made from paperboard which is also sometimes known as cardboard. Many types of cartons are used in packaging. Sometimes a carton is also called a box.

Prajakta Hambir et al[3] studied the Automatic Weighing and packaging machines are fully automatic multi-head weighing and packaging machine. It fills the product in the bags and den seal the product centrally. It is based on draw bar mechanism or belt draw down mechanism. The entire weighing and packaging process is done with the help of electro pneumatics and motors. The increase in manufacturing is led by the automation as well as low wages, customization, mass production, flexibility and information.

We conclude that by using applications heating can used for sealing purpose.

1. In **STEP 1** we discussed this innovative idea with our guide & visited organisation. Company provide all basic information regarding their products, and other general information.
2. In **STEP 2** company executive explains us production line of buzzer

manufacturing and the problem faced by them during manufacturing.

3. In **STEP 3** we discussed some solution with company executive such as :
  1. Locking by using plastic locks.
  2. Use of adhesive material for sealing purpose.
  3. Use of screw and nut arrangement.

But company executive refuses our idea by giving proper reason such as,

1. By using plastic locks sometimes, they can brake by worker during manufacturing and also during transportation.
2. By use of adhesive there will be a chance of reaction takes place with copper coils and other with other material
3. Adhesive material may be or may not be waterproof, if water enters in buzzer assembly then malfunction occurs and buzzer not works properly.
4. By using nut and screw arrangement cost of manufacturing buzzer increased by Rs. 2 to Rs.2.5 per piece.

**STEP 4:** We had discussion under guidance of company executive & guide regarding types of heaters. Then we conclude that the Pencil heater should be implemented because of its desired properties & suitable for sealing material. Because of its properties like temperature range, voltage, heating material (S.S), light in weight, rating which is suitable (200w-250w), cost is less compared to other and free-standing installation (movable)

Pencil heater is available in any size. we need accurate in size of heater as per the length of fixture, so we customized pencil heater as per our convenience.

#### **Key points of sealing material PBT**

Polybutylene terephthalate

Melting point: **223 °C**

Formula:  $(C_{12}H_{12}O_4)_n$

#### **Advantages of PBT**

1. Polybutylene terephthalate (PBT) is the second most important commercial polyester. It is a semi-aromatic thermoplastic that can be easily molded and thermoformed.

2. Cost is low.
3. Light in weight.
4. Easily available.
5. High strength etc.

**STEP 5:** Experiment of heater (electric heaters)

**Table 1: LIST OF HEATERS**

Types of Heater	Rating
Cartridge heater	350w-400w
Causted heater	500w
Pencil heater	200w-250w

Detailed specifications of pencil heaters (Fig. 2)-

- Length – 65mm
- Día – 5mm
- Quantity- 2
- Rating of heater – 200W
- Rate of manufacturing – 40rs /inch (1 inch = 25.4 cm)
- Temp range – 200 to 250 °C
- Heater manufactured company – power heaters PVT. (Customised)



**Fig.2: -PENCIL HEATER[8]**

**STEP 6:** experiment and error

#### Experiment 1

- As we choose pencil heater because of its temperature range (200°C to 250 °C) and other advantages. So first we set heater temperature as 250 °C but it is concluded that, material is completely melt and evaporate.
- In second trial we drop temperature and set around 240 °C but again evaporation occurred.
- Then again, we drop temperature and set 230 °C and after some moment it resulting into liquefaction of PBT takes place.
- So, we concluded that melting point of PBT is 220°C to 230 °C.

#### Experiment 2: Punch design

The punch used for punching the hole was as shown in Fig. 3, which is modified as shown in Fig. 4.

- Punch design is flat.



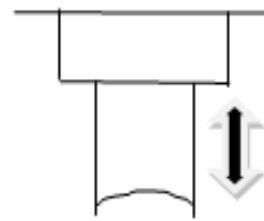
**Fig. 3: FLAT PUNCH**

**Observation-** while pressing by the pneumatic machine case locks breakdowns

#### Experiment 3

- Punch design change for flaring case locks

**Observation** – partially sealing is done.



**Fig. 4: CIRCULAR PUNCH**

**STEP 7 & STEP 8:** experiment & error

(Temperature & time set as per requirement for sealing of buzzer & process completed successfully.)

1. Pencil heaters are mounted on pneumatic punch by making a hole of 5.5 mm dia and screw arrangement.
2. There are 2 types of sensors is used – Temperature maintaining sensor 2. Timer
3. Temperature is maintained in between 220 °C to 230 °C.
4. And time required to complete sealing process is 6 to 8 sec.
5. This cycle time is also set in timer sensor, after completion of 1 cycle, punch moves in upward direction and work piece (sealed buzzer) is removed from the cavity by manually. And another work piece is placed.
6. Heating insulating material (asbestos material) is placed in between punch and machine assembly to avoid heating issues.

**Experiment 4**

- Even punch design changes, no satisfactory result found so we discussed with their R&D team to place timer for holding top fixture. (heater provided for specific time up to heating of case lock i.e. PBT material)

**EXPERIMENT 5**

- Even timer fitting, there is access to operation to change the operational setting.
- To avoid this, we are suggested that no access give to operator by change setting so timer is removed from panel and inserted into panel box. As shown in Fig. 5.



Before

After

**Fig. 5: Before & After****CONCLUSION**

- a) By providing solution to company their problem regarding manufacturing is solved.
- b) Operator efforts are reduced.
- c) Productivity improved.
- d) Production rate increased.
- e) By doing work in a group which increase our problem solving approached, which will be very helpful for future goals.

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## Sprinkler Irrigation System

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### ABSTRACT

*Sprinkler irrigation system distributes water by spraying it over the fields. Simulating that of natural rainfall. The spray is produced by the flow of water under pressure through small perforations and nozzles in pipelines. The pressure is usually provided by pumping water from wells, tube wells, river, canals and reservoir. With careful selection of nozzle sizes, operating pressure and sprinkler spacing, the amount of irrigation water required for refill the crop root zone can be applied uniformly at a rate to suit the infiltration rate of soil, thereby obtaining efficient water application. Sprinkler irrigation is the best method to use on soils that have steep slopes, undulating of irregular topography and on soils that are too shallow to level It is difficult, however to sprinkler irrigate if water intake rate of the soils is less than 4mm/hour. Close growing crops can be sprinkler irrigated (except rice, tobacco, and jute).It may be difficult in moving portable lateral lines in tall crops such as corn and that soft fruits should be protected from the spray when they are ripening.*

*Wind disturbs the spray patterns and usually reduces efficiency of the system. A careful selection on the right equipment and proper operation of the system are necessary where strong wind occurs in the area to be sprinkler irrigated.*

**Keywords:** sprinkler system, sprinkler irrigation

### Introduction

The development and maximum utilization of both land and water resources are problems of major concern in almost all the developing countries. In humid as well as arid countries water is a serious limiting factor in the development of a available land resources. A judicious use of this vital source which is becoming scarce and costlier day by day should be as a major focus to facilitate bringing more area under irrigation.

In India 60-70% of water is wasted in spreading irrigation water over the soil, that is only 30-40% of water is delivered from the reservoirs is utilized for irrigation and only 50 % of it is actually used by the plants. A need for a shift from conventional or traditional surface irrigation methods to the modern methods of water application using less water per unit area i.e sprinkler irrigation method . With the limited water resources an alternative method has to be taken into a serious consideration.

This paper attempts to bring together the necessary information on sprinkler irrigation, its adoptability, system planning, design procedure, evaluation of the system design for optimum water utilization.

#### 1.1 Advantages of Sprinkler Irrigation System

Advantages of Sprinkler Irrigation are listed n as below

1. Considerably improved water utilization over conventional methods so that larger areas are irrigated.
2. Land is saved as there is no loss for channels and bunds. It eliminates the need for farm ditches, and more area is available for crop production.
3. The overall irrigation efficiency is from 65 to 80% while that of the surface irrigation ranges only 25 to 60 percent.
4. It is suitable where depth of the soil is limited by a gard pan or other restricting layers.
5. It is suitable on porous soil, such as sands, where water penetrates so rapidly that

irrigation by other methods gives excessive losses by deeper percolation.

6. Run off and subsequent erosion of soils can be eliminated.

7. Reduced labor requirement, labour can be used for other productive work on the farm. Mechanization and automation is possible to reduce labor cost.

8. Fixed system can eliminate field labor during irrigation season.

9. Better weed control less weeds due to elimination of channels and bunds that harbor weeds.

10. Fertilizer can be distributed through the system for rapid, effective response.

11. Saves fertilizers- surface irrigation washes fertilizer below root zone

### 1.2 Limitations of Sprinkler Irrigation

a) Capital cost: Unless a loan is available few farmers cannot make an outright investment from their own resources, however bank loans are readily available. There are also sponsored Central and State Government incentives for sprinkler irrigation available to all farmers at 50 % of the actual cost.

b) A pump is required: If farmer uses lift irrigation, a pump is obviously essential in any case. Sometimes for sprinklers a booster or more powerful pump may be required. Where new or up rated electricity connection are not permitted this may present a problem, however lower pressure sprinklers have now been developed that operated from standard lift pump sets.

c) Running costs and financial feasibility: In comparison with lift irrigation the running cost per hectare for sprinklers is comparable. Although more horse power may be used the area irrigated will be larger. As a general rule, the installed horse power per hectare irrigated will be similar for surface and sprinkler irrigation

d) Operational difficulties in systems. Farmers who use pumps and tractors have no difficulty with sprinkler .Simple and replacements hardly average 1% of the system value per year.

e) Windy conditions: Strong wind does blow the sprayed water out of the regular pattern. However by judicious selection of sprinklers usually smaller models nozzle size and

pressure, the effect of wind can be minimized. When there is wind for certain seasonal periods, it may be quite feasible to operate at night when the air is usually still.

### 1.3 Disadvantages of Sprinkler Irrigation

Some of the actual disadvantages are

1) Sprinkler irrigation is not well adapted to soils having very low Intake rates less than 4mm/hour.

2) Larger evaporation losses occur because sprinklers wet the entire soil-surface as well as the leaves of the plants

3) High and continuous energy requirement for operation.

4) Sprinkler water containing an appreciable amount of salt may result in burn or death of the plant leaves.

5) Under certain climatic conditions spread of diseases may be encouraged

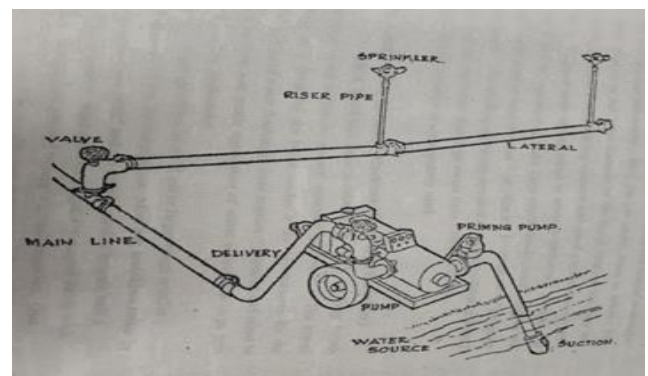
### Components of the Sprinkler System

The sprinkler system consists of the pumping plant, the main pipelines and laterals, sprinkler heads, risers, fittings, filters and fertilizer applicators. Fig. 1 shows the components of a sprinkler system. A typical component of swing arm rain gun is shown in Fig. 2, while Fig. 3 shows components of rotary sprinkler. In the figure 4, rotary sprinkler and a pressure regulator shown.

#### 2.1 The main component parts of Sprinkler System

The main component parts of sprinkler system are

1. The pumping plant 2. Main lines 3. Lateral lines 4. Sprinkler heads



**Fig. 1: Sprinkler Irrigation System**

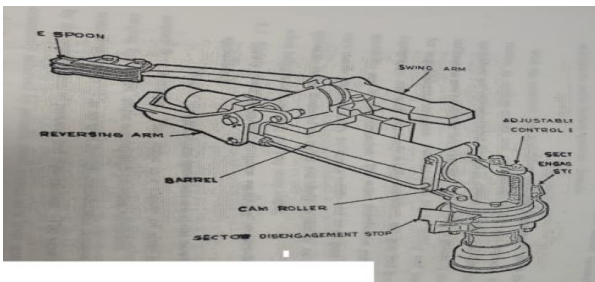


Fig. 2: Swing Arm Rain Gun.

2. 2 Some of the other Parts of Sprinkler System

Some of the other parts of sprinkler system are

- Nozzle lines (Fig. 6)
- Risers
- Fittings: Some of the fitting accessories are shown in Fig. 7.

2.3 Types of rotating sprinklers:

- Rapidly-whirling Sprinkler (Reaction rotation)
- Giant or Gun Sprinkler Machines (Boom type Sprinkler)
- Slowly rotating sprinkler-(Slow revolving impact drive sprinklers)
- Low Sprinklers (0.25 to 2 kg/cm<sup>2</sup>)
- Intermediate pressure sprinklers (2-4 kg/cm<sup>2</sup>)
- High pressure (4kg/cm<sup>2</sup>)
- Large volume sprinkler (above 5.5 kg/cm<sup>2</sup>)
- Fixed head sprinklers
- Perforated lateral pipelines

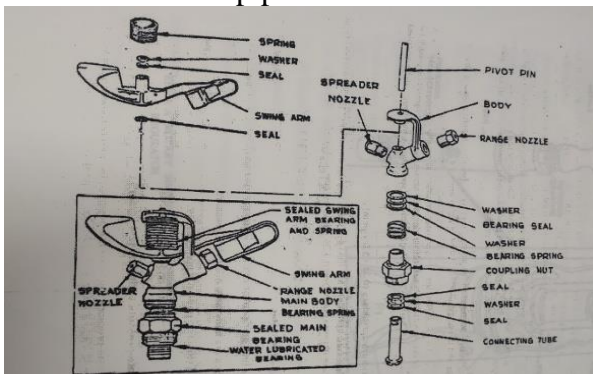


Fig. 3: Components of Rotary Sprinkler

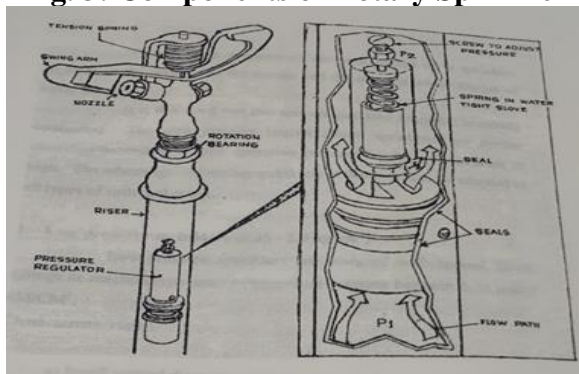


Fig. 4: Rotary Sprinkler and a Pressure Regulator

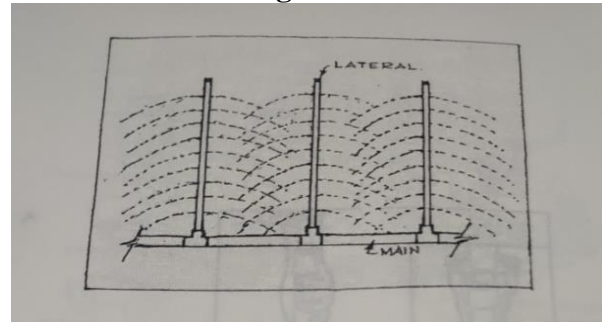


Fig. 5: Perforated Portable Line

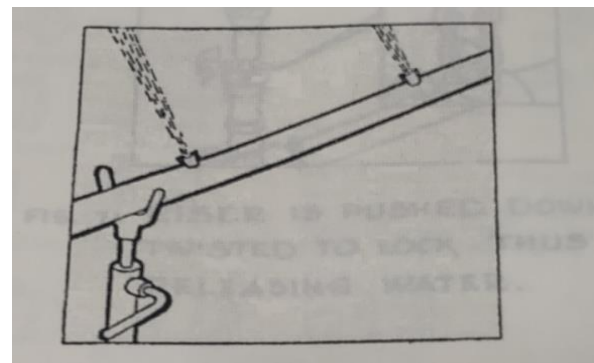


Fig. 6: Nozzle Line

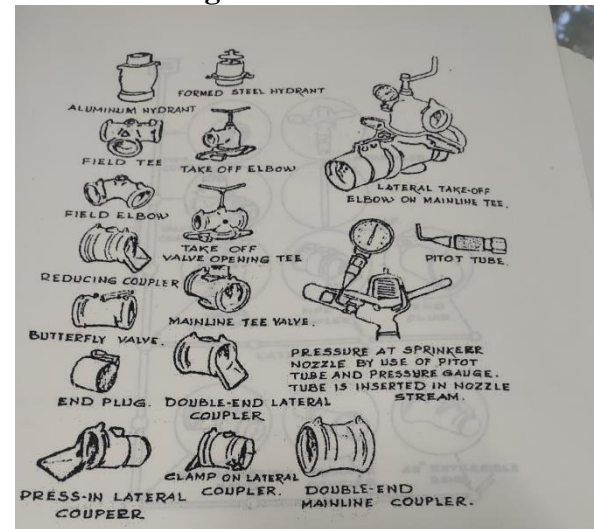


Figure 7: Typical Irrigation Fittings for Sprinkler

Types of Sprinkler System

It is classified according to the way the system is installed and operated whether the sprinkler heads are operated individually or operated as a group installed along a lateral and according to how they are moved to irrigate the entire field.

1) *Solid and permanent system:* The solid-set systems are generally designed to use low flow, medium press, sprinklers, although,

depending upon the uses for which the system is designed and the of design used, many sizes of sprinklers are adapted. (Figure 8)

2) *Semi permanent system*: A semi- Permanent or semi portable sprinkler system is the most widely use at all pressures. It has the advantages of both portable and solid-set `equipment's.

Some few common of semi-permanent systems are:

- a). Sprinkler-hop system (Fig. 9)
- b) Pipe-grid system (Fig. 10 a and b )
- c) Hose-pull system

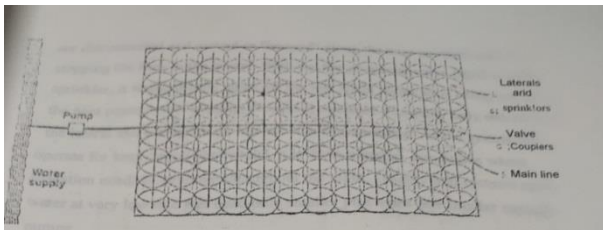


Fig. 8: Solid set or Permanent System

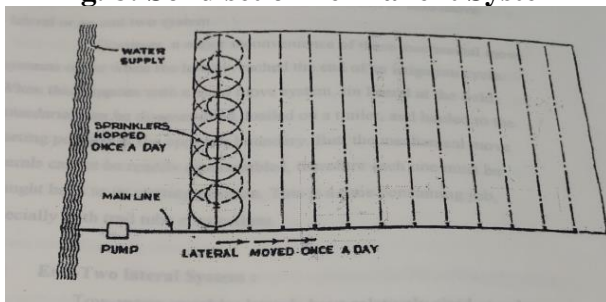


Fig. 9: Sprinkler – Hop System

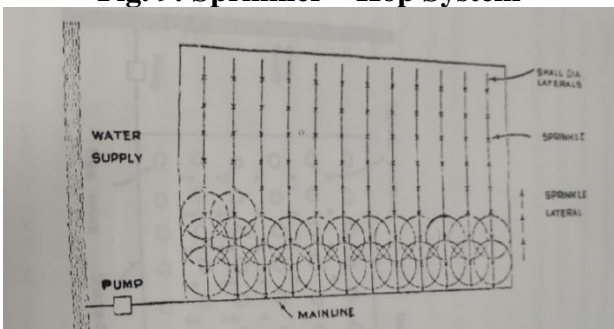


Fig. 10 a: Semi permanent system, Pipe Grid System

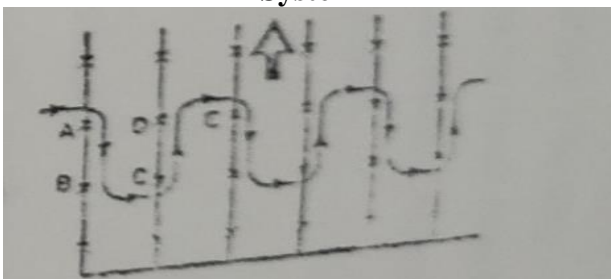


Fig. 10b: Semi permanent system, Pipe Grid System

3) *Portable System or Periodic-Lateral Move Systems*

- a) Hand-move lateral system
- b) Side-roll System
- c) Side-move laterals or carriages with trailer line:
- d) End move lateral system
- e) Gun and boom sprinklers

### Design of Sprinkler System

The details steps in the design of sprinkler irrigation system are illustrated by taking an example. Design chart for sprinklers is used as given in figure 11. The layout shown in figure 12 is helpful in designing the system. Figure 13 necessary for effect of topographical conditions of field.

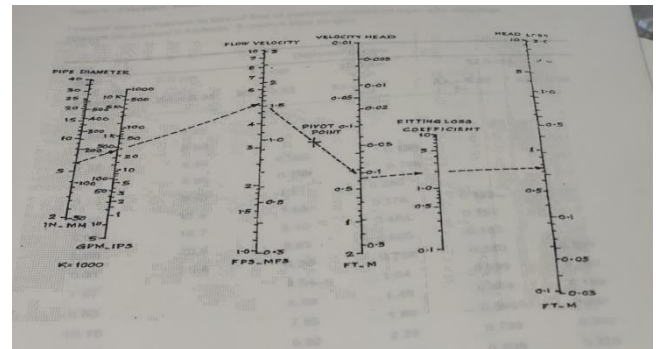


Fig. 11: Design Chart for Sprinkler

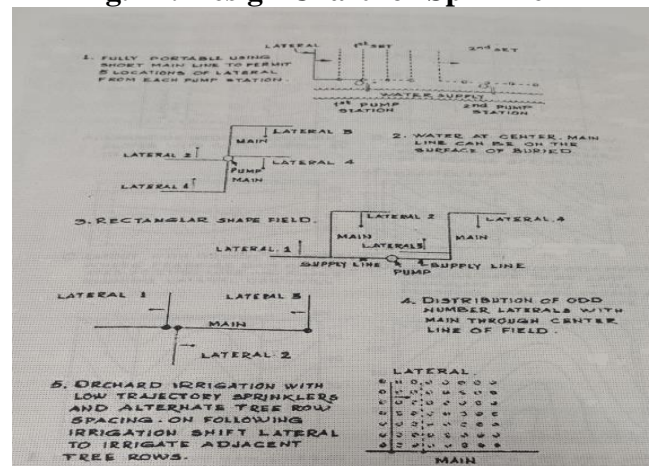
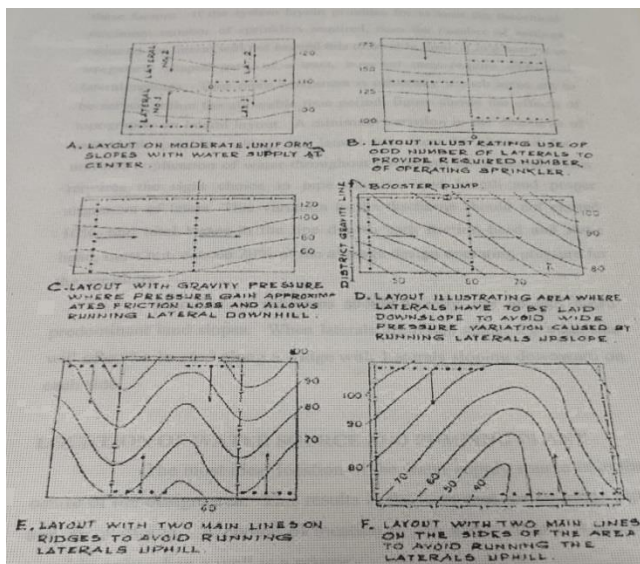


Figure 12: Typical Sprinkler Layout



**Fig. 13: Typical Sprinkler Layouts of Sprinkler System showing Effect of Topography**

**An EXAMPLE TO ILLUSTRATE THE METHODOLOGY OF AFRAM UNIT SPRINKLER DESIGN**

This example problem only presents basic principles of design of a sprinkler system with the available data from a specified location.

Step 1: Inventory of resources

Location - Semi arid type region

Area: 6ha (300m\*200m)

Soil: Medium textured

Soil basic infiltration rate: 15mm/hr

Allowable soil moisture depletion (MAD):50%

Topography, average land slope: 2-3%

Crop: Cotton

Effective root depth: 120cm

Crop evapotranspiration (ETc): 7 mm/day

Climate: No effective rainfall during the peak growing period.

Water source: canal as water source.

Delivery head: 1.5m

Suction head: 3m

Elevation head: 6m

Availability of electricity: 16hrs/ day

Step 2: Determine the net depth per irrigation

Net depth (dn in mm) = (FC- WP) \*dr\*MAD

Where (FC- WP) - the available moisture holding capacity of soil

i.e. FC- wilting point.

MAD- 50 % ( Allowable soil moisture depletion.)

dn = (1.6 mm/cm)\* 120\*0.5=96mm

Step3: Determine the shortest irrigation interval (Ii) -- time allowable between successive irrigation -- called as rotation cycle during the consumption use of crops.

$I_i = dn/ET_c = 96mm/(7mm/day) = 13.7 \text{ days} = \text{say } 14 \text{ days.}$

Step 4: Determine the preliminary pumping capacity of the system Q

$$Q = A * D * 278 / (I_i * H * E)$$

Where Q= preliminary pumping capacity (lps)

A=Area in ha

D= Depth of application (cm)

Ii=Irrigation interval, days

E= Field application efficiency

278= Conversion factor.

$$Q = 6ha * 9.6cm * 278 / (14days * 14hrs * 0.8)$$

$$Q = 102 \text{ lps}$$

Step5: Determine optimum water application rate. This will be determined by the soil type, crop cover, slope and application rate.

The maximum application rate is 12.7mm/hr.

Sprinkler selection and spacing must be so as to not exceed the rate.

Required application rate (I)

$$I = dg / \text{number of hrs per setting}$$

where  $dg = dn / (Cu * Re)$

Cu=anticipated uniformity of application coefficient at wind condition

Re= effective portion of the application rate, the Re value for coarse spray at wind speed of 6km/hr

$$dg = 96mm / 14hrs \text{ setting}$$

$$I(\text{opt}) = 123/14 = 8.78 \text{ mm/hr} = \text{say } 9mm/hr$$

Step 6: Decide what type of sprinkler to choose

.Most sprinkler systems are designed for 'round the clock' or continuous operation which will permit the minimum size of pump, main and laterals. Let us try the intermediate pressure sprinkler which satisfies most of the given conditions.

Step 7: Determine spacing nozzle discharge and operating pressure for the optimum application rate.

$$q = I * Si * Sm / 1000$$

I= Determined rate optimum rate of application mm/hr

Si=spacing between sprinklers along the lateral (m)

Sm=spacing between position of lateral along the main.

a) With spacing of 12\*18m

$$q = 9 \text{ mm/hr} * (12 * 18) / 3600 = 0.54 \text{ lps}$$

b) With spacing of 9m\*18m

$$q=9*8*18/3600=0.405\text{ lps}$$

c) With Si\*Sm=12m\*15m

$$q=9*12*15/3600=0.45\text{ lps}$$

With the above 3 possible move-spacing selection, the corresponding rates are computed by

$$\text{cm/hr} = \text{lps of Sprinkler} * 360 / (\text{Si} * \text{Sm})$$

$$(a) I1 = 0.54 * 46 / (12 * 18) = 0.9 \text{ cm/hr or } 9 \text{ mm/hr}$$

$$(b) I2 = 0.40 * 360 / (9 * 18) = 0.88 \text{ cm/hr or } 8.8 \text{ mm/hr}$$

$$(c) I3 = 0.45 * 360 / (12 * 15) = 0.9 \text{ cm/hr or } 9 \text{ mm/hr}$$

Let us choose 12m\*15 m for the lateral spacing and an intermediate size of sprinkler i.e. 3.5 kg/cm<sup>2</sup>. Now check the distance between two sprinklers, whether it has 60% overlap of the wetted diameter.

$$29 * 0.6 = 17.4 \text{ m}$$

Hence that Si = 12 m is ok.

Step 9 = Determine the length of lateral, the required number of settings per day and number of laterals

$$(a) \text{Length of lateral} = 200 / 2 - 5 \text{ m} = 95 \text{ m}$$

Where 5m is the distance from boundary of the field to the end of the lateral.

$$\text{Length of lateral} = 95 \text{ m}$$

$$(b) \text{Number of sprinklers on one lateral} = 95 / 12 = 7.92 \text{ say } 8$$

(c) Number of lateral settings

$$\text{Time of setting} = 123 \text{ mm} / (9 \text{ mm/hr}) = 13.66 \text{ hrs}$$

$$\text{Number of setting/day} = 16 / 13.66 = 1.17 \text{ say } 1$$

Only one setting is possible as remaining 2hrs will be required for setting the lateral.

$$\text{Number of total setting along with sides of the main} = 300 / 15 + 1 = 21$$

$$(\text{Total number of settings on both sides}) = 21 * 2 = 42$$

Number of laterals to be operated simultaneously (Check, with the designed irrigation interval)

$$1. I_i = 42 / 2 = 21 \text{ days}$$

$$2. I_i = 42 / (2 * 2) = 10.05 \text{ say } 10 \text{ days}$$

Therefore two laterals are required to be able to complete sprinkling within the design irrigation interval.

Step 10: Design of lateral

Discharge q at the beginning of lateral

$$q = 0.45 * 8 = 3.6 \text{ lps}$$

Frictional loss by Hazen William's formula

$$H_f (\text{lateral}) = 1.22 * 1012 (q/c) 1.852 / D^{4.875}$$

D = size of lateral, 50mm

q = pipe discharge, 3.60 lps

c = corrected value of C

$$c = C - \{0.1 * (1 - D/100)\} * C$$

From table C = 120

$$c = 120 - \{0.1 * (50/100)\} * 120$$

$$c = 108.6$$

$$H_f = 1.22 * 1012 (3.6/108.6) 1.852 / 50^{4.875}$$

$$H_f = 11.80 \text{ m} / 110 \text{ m}$$

For length of 95m, H<sub>f</sub> = 11.21m. Then computing for actual frictional loss (H) in lateral using table.

$$H_1 = 11.21 * 0.41 = 4.56 \text{ m}$$

Now check for pressure variations in the first and last sprinkler

$$P_1 = \{P_a + 3/4 H_1\} = 35 + 3/4 * 4.56 = 38.42 \text{ m}$$

$$P_2 = \{P_a - 1/4 H_1\} = 35 - 1/4 * 4.56 = 33.86 \text{ m}$$

Check if  $100(P_1 - P_2) / P_1$  Less than 20%

$$100(38.42 - 33.86) / 38.42 = 21.86 \text{ less than } 20\%$$

Thus 50mm sprinkler lateral is ok.

Step 11: Design of main

The critical position of lateral along the main will be at the middle of the main i.e.

$$300 / 2 = 150 \text{ m from the pump}$$

$$\text{Discharge of main} = 3.60 * 2 = 7.20 \text{ lps.}$$

Frictional loss in the main

Let us choose 100mm diameter of main

$$\text{Corrected } C = 120 - \{0.1 * (1 - 100/1000)\} * 120 = 109.2$$

$$H_f \text{ main} =$$

$$1.22 * 1012 (7.60/208.2) 1.852 / 100^{4.875} = 1.75 \text{ m} / 10 \text{ m}$$

$$\text{For } 150 \text{ m length, } H (\text{main}) = 2.62 \text{ m}$$

Step 12: Calculate the total pumping head (TPH)

$$\text{TPH} = H_s + H_d + H_p + H_e + H_f$$

H<sub>s</sub> = Suction head (m)

H<sub>d</sub> = delivery head (m)

H<sub>e</sub> = elevation in difference (m)

H<sub>p</sub> = Riser height

H<sub>f</sub> = Total friction losses along pipe system.

$$H_1 \text{ total} = H_{fs} + H_{fd} + H_{fm} + H_{f1} + H_{fc}$$

$$\text{Where } H_{fc} = 0.1(1 + 4.56 + 2.62)$$

Assuming (H<sub>fs</sub> + H<sub>fd</sub>) friction loss due to suction and friction loss due to delivery = 1

$$H_{fc} = 0.818$$

Therefore

$$H_f \text{ Total} = 1 + 4.56 + 2.68 + 0.82 = 8.96 \text{ m}$$

Computing for TPH

$$\text{TPH} = 3 + 1.5 + 6 + 26 + 0.5 + 9.06 = 46 \text{ m}$$

Step 13: Calculate the pumping capacity Q, required to operate all the laterals in the shift.

$Q$ =Average sprinkler discharge (q) \*maximum number of Sprinklers operating simultaneously.

Step 14: Determine the power requirement

Using the pump selection chart,

$$\text{BHP} = \frac{Q \cdot \text{TPH}}{75 \cdot E_p}$$

Where  $Q$  - pumping capacity required to operate the system, lps

TPH=Total pumi head, m

$E_p$ = pump efficiency (usually ranging from 70%to 80%)

$$\text{BHP} = \frac{72 \cdot 46}{75 \cdot 0.70} = 6.31 \text{ BHP}$$

Input HP= BHP/ Motor efficiency

Assuming a motor efficiency of 85%

$$\text{Input HP} = \frac{6.31}{0.85} = 7.45 \text{ HP say } 7.5 \text{ HP}$$

Step 15: Evaluate the system for economic considerations.

There should be a reasonable balance between annual cost of capital investment and the annual operating cost- considering the power

cost ,seasonal hours of operation .and overall cost of production.

Try other alternative layouts of the main and laterals length and diameter of lateral and compare the results for economy.

## CONCLUSIONS

The sprinkler system can be effectively used as an alternative for surface irrigation methods by considering the saving of water. Irrigation may be designed for a smaller flow of water and therefore is desirable over some other methods. It is an economical method of irrigation where annual requirement is low. It is adopted to light application of water for shallow rooted crops, germination of seeds and during the seedling period . It is generally offers the only method of obtaining adequate distribution of water on certain rolling or hilly lands where leveling for surface irrigation is not feasible

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**Improvement of Thermal Efficiency of Household Gas Stove-Review and Discussion****Dr. N L Bhirud<sup>1</sup>, Aftab Shaikh<sup>2</sup>, Imran Shaikh<sup>3</sup>, Aun Peerzada<sup>4</sup>, Ibrahim Shaikh<sup>5</sup>**<sup>1,2,3,4,5</sup> Department of Mechanical Engineering, Sandip Institute of Engineering, and Management, Nashik, Maharashtra, India.Email: <sup>1</sup>gajanan.shelke@siem.org.in, <sup>2</sup>abhibhesar@gmail.com, <sup>3</sup>nirajbendale@gmail.com, <sup>4</sup>chetanbachhav0610@gmail.com, <sup>5</sup>pankajbargaje995@gmail.com**ABSTRACT**

Gas stoves nowadays are very common in all houses counting urban and remote areas. The main power source for gas stoves are LPG. Liquefied petroleum gas LPG is usually used as a cooking fuel because it has higher energy content and produces lower emissions compared to other traditional fuels. Due to immense demand for LPG, aside from its limited reserve, performance improvement of the LPG cook-stoves is important. LPG plays a significant role in the transition towards a more safe, sustainable, and competitive energy model. The major source of the LPG is fossil fuels, so its huge consumption will definitely lead to its shortage in the future. Considering the limited fuel resources, energy conservation, environmental issues, increase within the demand of LPG in near future, it's necessary to explore the ways to further improve the thermal efficiency and therefore the emission characteristics of the domestic LPG cooking stoves. In the present work, performance parameters of the LPG stove such as parameters affecting thermal efficiency and CO emissions are studied. Various parameters affecting thermal efficiency of a burner such as distance between burner and pot, material of the burner, size of injector, swirl effect, pan support modification are determined. The paper is aimed to spotlight the latest add in this field and also, the areas needed to be addressed are discussed.

**Keywords:** domestic cook stove, emission, liquefied petroleum gas, thermal efficiency.

**INTRODUCTION**

The burners are widely used for heating and cooking purposes in domestic and industrial applications owing to their simplicity, low cost, and simple usability. This common utilization causes a huge portion of total energy consumption via cookstoves in present. The performance of a stove or burner is usually represented by its thermal efficiency, which is defined because the ratio of the rate of heat transferred from the burned gas to the product of the rate of supplied fuel and its calorific value. The combustion efficiency of the LPG stove remains very high, and any longer improvement within the same is usually difficult to realize. However, the thermal efficiency of a standard domestic LPG cookstove is 68%, as quite 31% of the entire energy released from the fuel gets lost within the flue gas.

The loss can be minimized by improving the rate of heat transfer from the impinging flame to the load. Thus, the performance of an LPG cookstove can be significantly affected by the heat transfer efficiency of the impinging flame. The heat from the flame is mainly transferred to the impinging surface of the cooking vessel

by forced convection, though the radiative part of heat transfer plays only a small role due to the low emissivity of the flames established on the burner [1].

Therefore, any work toward improvement in the overall efficiency must aim toward enhancing the convective heat transfer rate from the flame to the load. An improvement in the efficiency of the stove contributes toward both sustainability and cleaner production. More efficient stoves help to reduce the fuel consumption and higher efficiency contributes to reduced emission of carbon dioxide and other toxic gases to the environment and lessens the degradation in air quality. However cleaner and efficient combustion of LPG in the stove, improves the ambient condition in the kitchen and reduces the associated health hazard. In countries like India, where the LPG supply primarily depends on import, improvement in cookstove efficiency helps to conserve foreign exchange.

The overall efficiency of a cook top burner depends on the design of the burner, stove and the pot. In recent years, several studies have been conducted with the household gas stoves to achieve the desired objectives. Junus considered the effects of the burner cap design



on flame stability in natural gas fired cookstoves. They observed that lift off occurs at high thermal inputs above certain levels of primary aeration, while flash back occurs at lower thermal inputs. They aimed for a design that offered a stable flame over a turndown ratio of at least 5, along with 60% primary aeration to curtail the pollutant emission from the burner. The burner cap design was optimized to achieve the desired turndown ratio and primary aeration [2].

In a further work, Junus reported that a circular ring insert at a suitable place of the burner could aid in improving the thermal efficiency and reducing the NO<sub>2</sub> emission significantly at all loads. Since NO<sub>2</sub> imposes more serious indoor air pollution than the other oxides, its reduction received special attention in the design of domestic burners [3].

There is effects of variations in gas composition on the performance of domestic gas stoves. Larger heating value of gas led to a lower thermal efficiency and higher CO emission. Although the above studies were extensive, they overlooked the fact that burner efficiency and emission could be significantly improved by decreasing the gas pressure, increasing the primary aeration, selecting proper thermal input, and adjusting the optimized heating height [4].

## **PERFORMANCE PARAMETER OF LPG COOKSTOVE**

### **THERMAL EFFICIENCY**

Thermal efficiency of LPG stove is defined as the ratio of the amount of heat transfer from the impinging flame to pot to the amount of heat supplied through fuel. There are several parameters that affect the thermal efficiency of cookstove some of which are discussed below:

### **LOADING HEIGHT**

Loading height is the distance between the top surface of the burner to the bottom surface of the vessel or pot. In many studies it is found that the loading height affect the thermal efficiency of the LPG cookstove, it is obvious that the amount of heat transfer will vary if we change the distance between source of heat and

the surface of vessel, at lower loading height there is less entrainment of cold air and hence heat transfer is more whereas at higher loading height the entrainment of the cold air is more and hence the heat transfer reduces at this height. Rohit Singh Lather [5] conducted an experiment on "Performance Analysis of an LPG Cooking Stove for Improvements" in which he observed the effect of loading height on thermal efficiency, gas consumption and flue gas emission. For changing the loading height of the utensil on the LPG cookstove, the loading height mechanism was fabricated and installed on the cookstove. The change in the loading height was measured by a measuring scale attached. He observed the variation in thermal efficiency by varying the loading height. With an increase in the loading height, increased thermal efficiency was observed. After reaching a maximum, a drop in the thermal efficiency was seen. The trend is attributed to the fact that loading height changes the shape of the flame, resulting in cooler core and wider higher temperature zone, leading to higher heat transfer and thermal efficiency. The highest thermal efficiency was measured for 5 mm loading height and lowest was measured for 7.5 mm loading height. He observed the lowest gas consumption for 5 mm loading height and the highest was observed for 7.5 mm height. It is noteworthy that, higher thermal efficiency is observed for higher loading higher in comparison to the original loading height provided by the gas stove manufacturer [5].

Agung Sugeng Widodo[6] conducted an experiment on "Efficiency of Household Gas Stove by Optimizing Gap of Pan and Stove Cover" in which the Efficiency of the household gas stove has been investigated by changing the gap between pan and stove cover. The efficiency was analyzed by measuring combustion energy produced by LPG, cover surface, and water temperature used in cooking process. The ceramic cover was used since this cover showed the best efficiency compared to other materials. The gap between pan and stove cover was varied in 1 mm to 7 mm with increment of 1 mm.

When compared to a conventional stove the results were that efficiencies tend to low at the

initial condition because the energy produced from the combustion process is absorbed by any materials in the stove including stove cover and pan [6].

### SIZE OF INJECTOR

Basu et al. [7] investigated the performance improvement of LPG cook stove through the different design of burner cap and fuel injection nozzle. The nozzle of diameters 0.7-0.83 mm was considered for the study. Four different sizes of injectors were considered along. The thermal performance study of LPG cook stove was done in two ways, with modification in fuel injector size or nozzle size and also modification in burner cap material.

It is found that the increase in the diameter of fuel injector which means admitting the fuel-primary air mixture is more and more, to enhance the performance of cook stove. The smaller holes of fuel injector improve the performance of cook stove and reduced emissions at the expense of decreasing burner loading. While using larger holes, the fuel flow rate is maximum and also increases convection heat transfer between hot combustion product and pot which is less than the heating losses to surroundings. Due to this phenomenon the thermal efficiency of the cook stove gets reduced. The optimum size of fuel injector is obtained at 0.77 mm for both the burners. This can be attributed to the optimum gas flow and enhancement of effective heat transfer and impinging resident time of hot flue gas onto the pot. With the increase in fuel injector size, the thermal efficiency of cook stove first increases then decreases. The optimum nozzle size gives higher thermal efficiency at minimum power input. The variation of thermal efficiency is due to the different primary aeration. For a smaller nozzle, the primary aeration is more than the fuel flow rate, this lowers the thermal efficiency. For a bigger size of nozzle, the fuel flow rate is higher than the primary aeration, so heat losses are more as compared to the smaller nozzle.

Performance of LPG cook stove, improves by the fuel injector nozzle size. Injector size is neither too small nor too large, the optimum

size gives the maximum thermal efficiency and low heat losses to surroundings. When injector size is small, more resistance to fuel flow rate and complete combustion of fuel which gives better performance as vice versa. It has been observed that the maximum thermal efficiency of domestic cook stove is 68% for Brass burner and 64% for Cast Iron burner at the same fuel injector size of 0.77 mm [8].

### POROUS RADIANT BURNER

Porous medium combustion has attracted more attention due to its clean and high combustion efficiency. To have these advantages they constructed the burner was with two layer porous media. The combustion zone was made from silicon carbide, and alumina balls were used to form the preheating zone. For a given burner diameter, the performances of the burner, in terms of thermal efficiency and emission characteristics, were analyzed for various equivalence ratios and thermal loads. The water boiling test as prescribed within the BIS: 4246:2002 was used to calculate the thermal efficiency of both the traditional LPG cooking stoves and therefore the porous radiant burner. The maximum thermal efficiency of the LPG cooking stoves with a porous radiant burner was found to be 68% which is 3% higher than that of the maximum thermal efficiency of the conventional domestic LPG cooking stoves. The axial temperature distribution within the burner showed that the reaction zone was on the brink of the interface of the two zones and at a better thermal load, it shifted towards the downstream. The surface temperature of the porous radiant burner uniform [9].

The combustion zone of the two-layer porous radiant burner was made of silicon carbide porous matrix. Alumina balls of 5 mm diameter form the preheating zone. The porosity of the porous radiant burner was 90% and its thickness varies from 1.5 cm to 2.0 cm. The burner casing was made by using alumina powder and sodium silicate binder. To sustain high thermal stresses, the casing was sintered at high temperatures. The PRB consists of a combustion zone, a preheating zone, a wire mesh to support the preheating zone, a burner

casing, and a mixing tube made up of Teflon. The experiments were performed with various diameters and thicknesses of the combustion zone. Five different types of burners were used in the study. The experimental set-up used for testing the performance of the porous radiant burner. The fuel flow and airflow rates were measured using the rotameters with control valves. The compressed air and the LPG were taken through their respective rotameters to the mixing pipe. The water boiling test as per the guidelines of the IS: 4246 was employed for evaluation of the thermal efficiency of the LPG cooking stoves. The distance between the burner surface and the bottom of the pan was kept at 5 cm.

In every case, the maximum thermal efficiency has been observed at different equivalence ratios, and this is for the reason that for different burners, for flameless conditions, the air requirement was different. For a given burner at a given wattage, the thermal efficiency is higher at a lower equivalence ratio and found to decrease with an increase in equivalence ratio. Such as for the B6 type burner efficiency decreases when the equivalence ratio increases at 1.3kW. For the two-layered porous radiant burner, the investigation was made for five different combinations in terms of thicknesses and diameters of the combustion zone made of SiC. The axial and radial temperature distributions of the burner were measured for different loads and equivalence ratios. For all the burners thermal efficiencies and CO and NO<sub>2</sub> emissions were calculated. The axial temperature measurement revealed that at higher wattages, the reaction zone shifted downstream of the burner. For higher wattages radial temperature was found to be more uniform, which can be a desirable feature of any burner. The maximum thermal efficiency of the B8 type burner was about 68%, which is 3% higher than the maximum thermal efficiency of the traditional LPG cooking stoves. The thermal efficiency of the porous radiant burner was found to increase. The maximum thermal efficiencies of B8 and B9 type burners were found to be almost the same. However, the maximum thermal efficiency of the B10 type burner was found to decrease due

to the higher radiation heat loss. The CO and NO<sub>x</sub> emissions of the porous radiant burners were much low compared to the traditional stove [10].

## MATERIAL OF BURNER

Burners of different material were used to study the effects on LPG stove performance. It was experimentally found out that thermal efficiency of stove using flat and flower face brass burners were higher as compared to regular cast iron burner. The burner head was removed and replaced by different design. Different burner head designs used in this work. Thermal efficiency was found out as per the BIS. It is observed that thermal efficiency of LPG stove improves by using flat and flower faced burners. When flower face burner was used, thermal efficiency of LPG stove was found to improve. The thermal efficiency of flat face brass burner was found to be maximum of 58%.

The thermal efficiency of LPG stove for regular cast iron burner was found to be 48%. When flat and flower face burners were used, thermal efficiency of LPG stove improved. When flat face brass burner was used maximum thermal efficiency of 58% was achieved. While thermal efficiency of 50% was observed when face brass flower burner was used. Further, it was experimentally found out that thermal efficiency of LPG stove using regular brass burner was 4% higher as compared to regular cast iron burner. The technique of replaced of burner head is simple and safe. It can be easily implemented in domestic LPG stove for fuel conservation [11]. With various researches carried out regarding improvement of efficiency it was found out that a brass burner can give an efficiency of up to 68% and with conventional burner its efficiency is as low as 51%. So, for better performance of cook stove the material of Brass burner cap would be preferred. The thermal efficiency using the brass burner cap is approximately 4% higher than the cast iron

burner for each nozzle size. The cost estimation on monthly basis, we can save the money if we use Brass burner in place of CI burner [8].

### SWIRL EFFECT

A. A. Moustafa conducted tests on three patterns of flow orientation Swirl flow, Star pattern swirl, with the radial flow as a benchmarking burner in the swirling effect on a single ring gas domestic burner. As the changing conditions, the influence of the pan height on the flame front and Reynolds number has been introduced.

LPG was used as the testing gas for the examination of these burners in order to study how to improve future domestic gas burners by increasing thermal efficiency while lowering CO emissions. For the ignition discharges, burners that contained the swirling movement gave lower outflows, the three burners created emanations as follows Radial burner 0.09%, Swirl 0.08% star design was the least with 0.01% emanations and this is expected the bigger violent power created by these whirl flares, the Star design burner likewise permits adequate measure of air to pass and arrive at the blazes openly which diminished obviously the burning outflows generally to different burners plans. From the warm effectiveness imminent the whirl burner gave the most noteworthy warm productivity coming to practically 60.4% followed by the outspread burner 58.8% and the Star design burner 51.97%, and this leads us to the swirling movement improves the proficiency of the burner as a result of empowering the flares from connecting for a more extended timeframe with the lower part of the warmed skillet, truly we may reason that this occurs because of the way that the whirl will in general make a concentrated swirling activity alongside rakish energy to empower the warmth to be moved to the warmed burden, and the most noteworthy thermal efficiencies for all burners were kept up at the least pot height and greatest Reynolds number.

So at long last to have as a trade-off for an upgraded effectiveness and brought down ignition discharges the Swirl burner would be promising to concentrate more, and more cases

should be intended for the star design burner adding a tendency point to improve the contact between the blazes and the warmed burner [12].

### DESIGN OF PAN SUPPORT

Mithun Das[13] suggested that the cook-stove design be tweaked to increase overall efficiency. A metal annular plate (referred to as the insert) is attached to the pan support (on which the cooking vessel is placed) in the modified cook-stove design to guide the flow of air and the burned gas. The insert's width is 40 mm, and its inclination angle with the horizontal is 13 degrees. In addition, we have also modified the spill-tray by closing the gap between the burner periphery and spill-tray (GBS). The design changes are incorporated into the 12-degree sector of the physical domain (placement of insert and GBS closed). The insert height (Hinsert) in the modified design is defined as the vertically measured distance between the vessel's bottom surface and the top edge of the insert. While optimising the modified design, Hinsert is varied from 6 to 12 mm, and the load height (Hload=distance between spill-tray and vessel bottom) is kept constant at 28 mm. The distance between the burner top and the vessel bottom is kept constant at 16 mm in these conditions.

The Spill-Tray and the Gap Between the Burner and the Spill-Tray were demonstrated in this setup. The gap between the burner and the spill-tray in a traditional cook stove allows secondary ambient air to enter from the stove's backside. The secondary air aids in the completion of the fuel combustion process. However, because it is entrained from a colder environment, the flame temperature is reduced slightly. As a result, the rate of heat transfer from the flame to the vessel slows down, lowering the thermal efficiency. If the spill-tray is not connected to the burner, more cold air enters the flame through the GBS, lowering the flame temperature and resulting in a reduction in efficiency. Radiative heat loss through the GBS reduces the efficiency even more. As a result, in addition to installing the insert, our approach to burner design modification includes closing the GBS.

We placed the spill-tray in the modified stove design so that the gap (GBS) around the burner is closed. It keeps the cold secondary air flow from the stove's backside out. Instead, the secondary air is admitted with a slight preheating to reach the flame zone, as previously explained. This allows the gas to maintain a higher temperature while achieving a faster heat transfer rate. Cold secondary air intake from the bottom of the stove is prevented by extending the spill-tray and closing the gap around the burner. When compared to a stove without a spill-tray, this modification improves thermal efficiency by 2.2 points (68.9 percent) [13].

The optimal positioning of the insert has a significant impact on thermal efficiency. A significant amount of energy is lost to the flue gases during the cooking of food. As previously stated, the insert improves the heat transfer rate from the hot gas to the vessel and thus reduces the energy lost through the flue, improving the stove's thermal efficiency. The insert is constructed in such a way that it can be attached to the stove's pan support. The gap between the insert and the spill-tray allows the entire secondary air to enter through the gap between the insert and the spill-tray due to the positioning of the insert and the closure of GBS. The insert's shape also allows for better inward flow of secondary air into the flame's central region, as well as a slight preheating of the secondary air, resulting in a slight increase in gas temperature in the flame zone. Moreover, the insert directs the hot combustion products in a favourable direction around the loading vessel, increasing the heat transfer rate from the gas to the loading vessel. The insert also acts as a radiation heat shield, reducing the hot gas's radiative loss and increasing thermal efficiency. For different insert heights, the heat flux distribution along the vessel bottom wall and side wall varies. The annular metal plate (insert) attached to the stove's pan support directs the flow of secondary air as well as the hot product gas, facilitating the heat transfer process.

The maximum total heat flux is achieved at the optimum insert height, which in this case is 8 mm. At this point, the cook stove's thermal efficiency is 73.6 percent, which is a 4.7-

percentage-point improvement over an identical stove without the insert and extended spill-tray. This also equates to a reduction of 6.4 percent in carbon dioxide emissions per unit of useful energy used in cooking [13].

## EMISSION

Recent studies have shown that the quality of indoor air may be affected by the operation of flueless combustion appliances. Species such as carbon monoxide (CO), nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) are emitted in trace amounts by these appliances and under certain conditions their concentrations may build to undesirable levels. Carbon monoxide emissions arise when the flames are quenched on cool surfaces and when inadequate or vitiated air is supplied to the burner. In natural gas fueled combustion processes, NO is formed as a by-product when atmospheric nitrogen is oxidized within the flame. Nitrogen dioxide is formed by the subsequent oxidation of NO in the cooler regions of the flame. The oxidation of NO to NO<sub>2</sub> is sensitized by the presence of small concentrations of hydrocarbons and carbon monoxide [14].

Reynolds number affect the emission from a LPG cookstove. The cookstove burner's thermal efficiency decreased at a constant rate and the rate of CO emission rose to a peak value and then decreased as the Reynolds number was increased. The value of the equivalence ratio has significant impacts on both the thermal efficiency and the rate of CO emissions from, the burner. As equivalence ratio increased, the burner's thermal efficiency decreased to a minimum value and then increased slightly, whereas the rate of CO emission rose slowly to a maximum value and then fell [15].

## CONCLUSIONS

LPG is most widely used fuel for household cooking in India and it's is still the most rapidly growing source of fuel in terms of usage as people from rural places in India are still switching from coal towards more clean and hassle free source in the form of LPG. So in this paper we aimed to study for higher efficiency by modifying the existing design

which is affordable as well as increases the efficiency.

Following conclusions can be drawn from this study:

- Fuel injector which is neither too small nor too big i.e. the optimum size (0.77mm) increases the efficiency of LPG stove as it gives maximum thermal efficiency and low heat losses to surroundings.
- Brass burner caps give approximately 4% higher thermal efficiency than cast iron burner for each nozzle size. Brass burners with the same fuel injector(0.77mm) gives efficiency of 68% while cast iron burners gives the efficiency of 64% at the same setting.
- Swirl burners which are already used in industries, slightly increases the efficiency with designs in burners but are slightly expensive.
- Closing the gap around burner prevents cold air to enter from the bottom of the stove. This results in increase in thermal efficiency. Further the annular

metal plate insert attached to the pan support guides the flow of secondary air and hot product gas and facilitates the heat transfer process. Insert height of 8mm is determined as optimum height for maximum heat flux to occur. At optimum height, enhancement of 4.7% in thermal efficiency could be seen.

- This setting can also result in 6.4% reduction in the carbon dioxide emission per unit of useful energy used in cooking.
- Use of Porous Radial Burner has also shown an increase in efficiency with maximum efficiency being 68%.
- Variation in Loading height also gave a substantial Improvement in the efficiency.

So it can be concluded with use of different set parameters use in various researches done so far, We can make a setup of combining these parameters and attain a maximum efficiency.

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## Optimization of Process Parameters in Turning Operations and Use of R.S.M. for Design of Experiments

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### ABSTRACT

*Energy conservation and emission reduction is an essential consideration in sustainable Manufacturing. However, the traditional optimization of cutting parameters mostly focuses on machining cost, surface quality, and cutting force, ignoring the influence of cutting parameters on energy consumption in cutting process. This experimentation presents a multi-objective optimization method of cutting parameters based on response surface methodology (RSM), which is applied to turn AISI 304 austenitic stainless steel in order to improve cutting quality, energy efficiency, Power Factor while reducing energy consumption. The objectives is to establish the correlation between rake angle, depth of cut, Cutting speed and feed, the power required to the machining operation and the surface roughness of the work piece. Due to pandemic situation of covid and lockdown restrictions, we were unable to complete the further research. The following data is useful and can be use for completing this research in future.*

**Keywords:** AISI 304, Turning, Energy Consumption, Energy Efficiency, Power Factor, Surface Roughness, MRR, Design Of Experiments, Response Surface Methodology.

### Introduction

Machining is the process which is most widely used in the manufacturing industry. In recent times, machining processes are facing constant pressures of improvement in quality and reductions in cost of productions. It is needed to improve the overall performance of cutting operations to achieve these goals. Turning is one of the cutting operations performed with traditional machining, is one in which the part is rotated as the cutting tool is held against it on a machine called a lathe.

When turning, the workpiece is rotated and a cutting tool is traversed along 1, 2, or 3 axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside to produce tubular components to various geometries. Turning uses simple single-point cutting tools. Each group of workpiece materials has an optimum set of tool angles that have been developed through the years. Experimentation is an important aspect of engineering practices. Most of the engineering system needs to undergo experimentation to gather enough information in order to analyze the performance of that system. If these experiments are designed experiments then, the obtained data can be converted into the empirical models, which can

be used for finding out the performance of the system under different situations.

In all types of manufacturing processes large amount of energy gets consumed. Higher energy consumption increases not only the production cost and but also the emission of harmful gases. Machining is one of the major energy consuming entities in the manufacturing sector and is a main target for energy reduction in recent years. The energy consumed during machining can be reduced and the energy efficiency can be improved without compromising on the quality of the product, if the cutting process parameters are selected properly.

The surface quality of products is generally determined in terms of the measured surface roughness. A good-quality turning surface can lead to improvement in strength properties such as fatigue strength, corrosion resistance and thermal resistance. In addition, the final surface roughness also affects several functional attributes of parts like friction, wearing, light reflection, heat transmission, coating and ability of distributing and holding a lubricant. Right selection of tool geometry and cutting parameters that affect surface roughness are important factors especially in providing tolerance. Power Factor s an



important energy consumption response parameter becomes essential as the electricity boards/suppliers put penalties on the manufacturing units, if the PF is low. The optimization of PF can also reduce the cost of installation of PF correction equipment besides reduction in penalties.

The Design of experiments is usually carried out by using methods like full factorial design, fractional factorial design, Taguchi design and Response surface design. In full factorial design, one factor is varied at a time and experiments are performed at all levels of all the factors. Thus, large numbers of experiments are conducted and all the interactions are captured. Many times, it is not possible to conduct such large number of experiments due to lack of time and resources needed for the experimentation. The replacements could be in the form of fractional factorial designs in which only certain combinations of the levels of the factors are used for experimentation. It is not possible to capture all the interactions in fractional designs. Taguchi method is derived from fractional factorial design. Response surface methodology is the most informative method of analysis of the result of a factorial experiment. RSM is a collection of mathematical and statistical techniques that are useful for modeling and analysis of problems in which a response of interest is influenced by several variables and the objective is to optimize this response. RSM quantifies relationships among one or more measured responses and the vital input factors. RSM can be defined as a statistical method that uses quantitative data from appropriate experiments to determine and simultaneously solve multi-variable equations correlating the dependent parameters. The aim of this work is to Optimization of Process Parameters in Turning Operations and Use of R.S.M. for Design of Experiments

## LITERATURE REVIEW

### Energy Consumption

In all types of manufacturing processes large amount of energy gets consumed. Higher energy consumption increases not only the production cost and but also the emission of

harmful gases. Machining is one of the major energy consuming entities in the manufacturing sector and is a main target for energy reduction in recent years. The energy consumed during machining can be reduced and the energy efficiency can be improved without compromising on the quality of the product, if the cutting process parameters are selected properly.

J. Paulodavim et al. [1] have carried out experiments on turning of Aluminum T6 by varying depth of cut, feed rate and cutting speed. TMCV 16T308F tool were used for the turning operation. The responses like power consumption, tool life and surface roughness were measured and feed rate has the most significant effect on the power, followed by depth of cut, tool nose radius and cutting speed. L. B. Abbang et al. [2] have carried out experimentation for optimization of the cutting parameters for reducing power consumption during turning Of EN 31 alloy steel work piece. The cutting speed, feed rate, depth of cut and nose radius were used as control factors. The tungsten carbide tool is used for the turning. The RSM is used for design of experiments and to optimize the response parameters. Feed rate has the most significant effect on the power, followed by depth of cut, tool nose radius and cutting speed. Rajesh Kumar Bhushan et al. [3] have carried out experimentation for optimization of the cutting parameters for reducing the power consumption and to increase tool life during turning of AI 7075 Alloy. Cutting speed, feed rate, depth of cut and nose radius was used as control factors. Tungsten Carbide Insert is used for the turning. Response surface methodology was used for determining the settings of cutting parameters. The most significant control factor affecting the power consumption was cutting speed is the most significant factor followed by depth of cut, feed and nose radius.

Aman Aggarwal et al. [4] have used cutting speed, feed rate, depth of cut and nose radius as variables during the turning of AISI P20 steel. The TiN coated Tungsten Carbide Inserts tool used for the turning. The response variables were power consumption. It was observed that cryogenic environment is the most significant factor followed by cutting speed and depth of cut. Carmita Camposeco Negrete et al. [5] have

used cutting speed, feed rate and depth of cut as variables during the turning of AISI 1018 steel. The Tin Coated carbide tool is used for the turning. The response variables were energy consumption. It was observed that feed rate (0.2mm/rev), first level of depth of cut (1.14mm) and first level of cutting velocity (350 m/min) lead to minimum energy consumption. V. N. Giatonde et al. [6] have used depth of cut and machining time as variables during the turning of AISI D2 Material. The ceramic inserts used for the turning. The response variables were machining force, power, specific cutting force, surface roughness and tool wear. It was observed that depth machining force and power are highly sensitive to machining time at higher values of depth of cut.

### Energy Efficiency

S. I. Chang et al. [7] have used cutting speed, rake angle, nose radius and edge radius as variables during the turning of AISI 4140 steel. The Carbide Tool used for the turning. The response variables were energy consumption and energy efficiency. It was observed that increasing rake angle or decreasing edge radius is the most effective way to reduce cutting energy. Edge radius and rake angle have significant effect on cutting efficiency, and high efficiency can be achieved by decreasing both.

Paramjit Singh Bilga et al. [8] have used cutting speed, feed rate, depth of cut and tool nose radius as variables during the turning of EN 353 alloy steel. The tungsten carbide used for the turning. The response variables were energy, consumption, energy efficiency, active energy, power factor. It was observed that depth of cut was revealed to be the most critical parameter for PF and EE.

### Surface Roughness

The surface quality of products is generally determined in terms of the measured surface roughness. A good-quality turning surface can lead to improvement in strength properties such as fatigue strength, corrosion resistance and thermal resistance. In addition, the final surface roughness also affects several functional attributes of parts like friction, wearing, light reflection, heat transmission,

coating and ability of distributing and holding a lubricant. Right selection of tool geometry and cutting parameters that affect surface roughness are important factors especially in providing tolerance.

Muhammad Aamir et al. [9] have optimized the cutting parameters for reducing surface roughness during turning of Al 5083steel. Uncoated High-Speed Steel is used for the turning operation. The response surface roughness was measured. Cutting speed and feed rate were used as input factors. Cutting speed and feed rate are influential on the surface roughness. Issam Hanafi et al. [10] have used cutting speed, feed rate and depth of cut as variables during the turning of PEEKCF30. The TiN coated tools tool used for the turning. The response variables were surface roughness and cutting power. It was observed that depth of cut is the most influencing parameter. Yugang Zhao et al. [11] have used cutting speed, feed, axial and radial depth of cut as variables during the turning of AISI 304 Steel. The carbide tool is used for the turning. The response variables were surface roughness. It was observed that cutting speed has great impact of surface roughness and material removal rate. Girish Kant et al. [12] have used cutting speed, feed rate and depth of cut as variables during the turning of AISI 1045 steel. The Uncoated tungsten carbide tool is used for the turning. The response variables were surface roughness and power consumption. It was observed that feed is the main influencing machining parameter for the minimization of power consumption and surface roughness followed by the depth of cut and cutting speed.

Abderrahme Zerti et al. [13] have used cutting speed, feed rate and depth of cut as variables during the turning of AISI 420 steel. The TiN-coated mixed ceramic tool used for the turning. The response variables were surface roughness, cutting force, power and material removal rate. It was observed that surface roughness is strongly influenced by the feed rate and depth of cut seems to be most influence on the cutting force. Salem Abdullah Baganer et al. [14] used uncoated carbide tool for machining of AISI 306 with factors like cutting speed, feed and depth of cut. The parameters under study were power consumption, surface

roughness and tool wear. Minimum value of power consumption of the cutting process was obtained at the lowest cutting speed value and at the greatest values of feed rate and depth of cut the factor with the most significant influence on surface roughness was feed rate. Cutting speed was the most significant factor on tool wear. Yousef Shokoohi et al. [15] have used cutting speed, feed rate and depth of cut as variables during the turning of AISI 1045 steel. The HSS uncoated tool used for the turning. The response variables were surface roughness and machining power. It was observed that the adopted technique (CCM) significantly lowered the surface roughness, power consumption and resulted in smaller chips. Riadh Saidi et al. [16] have used cutting speed, feed rate, depth of cut and nose radius as variables during the turning of cobalt-based alloy. The HSS tool is used for the turning. The response variables were surface roughness and material removal rate. It was observed that feed rate and insert nose radius are high. Depth of cut has the main effect on the evolution of material removal rate and it is followed by cutting speed and feed rate effects.

#### **Power Factor**

Power Factor is an important energy consumption response parameter becomes essential as the electricity boards/suppliers put penalties on the manufacturing units, if the PF is low. The optimization of PF can also reduce the cost of installation of PF correction equipment besides reduction in penalties. Paramjit Singh Bilga et al. [17] have carried out experimentation for optimization of the cutting parameters for increasing the energy efficiency, reduce active energy consumed by the machine and to increase power factor during turning Of EN 353 alloy steel work piece. The cutting speed, feed rate, depth of cut and nose radius were used as control factors. The Taguchi's L27 orthogonal array is used for design of experiments and to optimize the response parameters using. The depth of cut has been revealed to be the most critical input parameter for PF and EE.

#### **DETAILED CASE STUDY**

Due to pandemic situation of covid and lockdown restrictions, we were unable to

complete the further research. So we have decided to do a detail case study on optimizations of process parameters in turning using response surface methodology. We have selected eight research papers of worldwide well known publishers which relates somewhat to our design. Their detailed case study is as stated below:

#### **Multi-Objective Optimization Of Cutting Parameters To Minimize Power Consumption In Dry Turning Of Stainless Steel 316**

Author: Salem Abdullah Bagaber, Ahmed Razlan Yusoff, 2017.

Faculty of Manufacturing Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia.

In these research paper researchers aims to optimize machining parameters, including power consumption and the traditional machining responses of surface roughness and tool wear. The uncoated carbide tool was used for turning of AISI 306 with factors like cutting speed, feed and depth of cut. A multi objective optimization method of Response surface methodology was employed to optimize machining parameters.

The combination of parameters resulted in the minimum power consumption of 14.94% and decreased surface roughness and tool wear by 4.71% and 13.98%, respectively. Minimum value of power consumption of the cutting process was obtained at the lowest cutting speed value and at the greatest values of feed rate and depth of cut the factor with the most significant influence on surface roughness was feed rate. Cutting speed was the most significant factor on tool wear.

Following study results that the RSM can effectively reduce the impact and costs of the machining process.

#### **Multi- Objective Optimization Of Cutting Parameters In Turning AISI 304 Austenitic Stainless Steel**

Author: Yu Su, Guoyong Zhao, Yugang Zhao, Jianbing Meng and Chunxiao Li, 2020.

School of Mechanical Engineering, Shandong University of Technology, Zibo 255000, China.

These research paper shows that the energy consumption of machine tool can be reduced by selecting reasonable cutting parameters, laying the foundation for energy efficiency optimization of machine tool.

In this research paper a multi-objective optimization method of cutting parameters based on grey relational analysis and response surface methodology (RSM), which is applied to turn AISI 304 austenitic stainless steel in order to improve cutting quality and production rate while reducing energy consumption. The cutting parameters was cutting speed, feed, axial and radial depth of cut. The carbide tool is used for the turning operations.

Firstly, Taguchi method was used to design the turning experiments. Secondly, the multi-objective optimization problem was converted into a simple objective optimization problem through grey relational analysis. Finally, the regression model based on RSM for grey relational grade was developed and the optimal combination of turning parameters ( $a_p = 2.2$  mm,  $f = 0.15$  mm/rev, and  $v = 90$  m/s) was determined. Compared with the initial turning parameters, surface roughness (Ra) decreases 66.90%, material removal rate (MRR) increases 8.82%, and specific energy consumption (SEC) simultaneously decreases 81.46. It was observed that cutting speed has great impact of surface roughness and material removal rate.

These paper results that in order to effectively balance the cutting quality, production rate, and energy consumption in turning process, Ra, MRR, and SEC are featured as optimization objectives of turning parameters for sustainable manufacturing.

### **Optimization Of Energy Consumption Response Parameters For Turning Operation Using Taguchi Method**

**Author:** Paramjit Singh Bilga, Sehijpal Singh, Raman Kumar, 2017.

Professor and Head, Department of Mechanical Engineering, GNDEC, Ludhiana, Punjab, India The present research work focuses on the optimization of foremost energy consumption response parameters energy efficiency, active energy consumed by the machine and power factor. An experimental analysis is carried out for the CNC rough turning of EN 353 alloy

steel with multi layer coated tungsten carbide insert. The effect of important input process variables like cutting speed, feed rate, depth of cut and nose radius along with their interactions has been studied on these energy consumption response parameters.

The Taguchi's L27 orthogonal array is used for design of experiments and to optimize the response parameters. The results reveal that optimum turning conditions for the PF and EE are same and occur at 248.69 m/min. cutting speed, 0.3 mm/rev. feed rate, 1.8 mm depth of cut and 0.8 mm nose radius. The optimized control factors setting for AECM are 248.69 m/min. cutting speed, 0.3 mm/rev. feed rate, 1 mm depth of cut and nose radius 1.2 mm. Results of ANOVA, have shown that the depth of cut is the most dominant input process parameter for PF and EE, and feed rate be the dominating vital parameter for reduction of the AECM.

The nose radius does not contribute too much for energy consumption response parameters. The interactions between most of input variables are also not significant for energy consumption response parameters. At optimum turning conditions for each significant energy consumption response parameter EE, AECM and PF achieved in the present study, there is an improvement of 61.776%, 57.025% and 7.49%, respectively compared to turning conditions in common use for rough turning.

In this papers we study about if we added nose radius as an input parameter with speed, feed, and depth of cut then what impact was happen on our output like energy efficiency (EE), active cutting power (ACP), active energy consumed by the machines (AECM), power factor (PF) by using Taguchi method .

### **Multi Objective Optimization Using Different Methods Of Assigning Weights To Energy Consumption Responses, Surface Roughness And Material Removal Rate During Rough Turning Operation.**

**Author:** Paramjit Singh Bilga, Sehijpal Singh, Sehijpal Singh, Raman Kumar.

Professor, Department of Mechanical Engineering, GNDEC, Ludhiana, Punjab.

The present research work focuses on simultaneous optimization of prime energy consumption responses, surface roughness and

material removal rate for sustainable machining operations. The experiments were conducted on rough turning of EN 353 alloy steel with multi-layer coated tungsten carbide insert. The effect of input parameters: nose radius, cutting speed, feed rate and depth of cut along with their interactions were studied on the response parameters viz. power factor (PF), active power consumed by the machine (APCM), active energy consumed by the machine (AECM), energy efficiency (EE), surface roughness (Ra) and material removal rate (MRR).

The Taguchi's L27 orthogonal array had been used for design of experiments by using Minitab 16 software. The weights of importance to the responses were assigned by Equal, Analytical Hierarchy Process (AHP) and Entropy weights method. The multi performance composite index (MPCI) was obtained by Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method and was optimized with Taguchi method. The results showed that the MPCI with these three different weight criteria had different optimum control factor levels. At optimal turning parameters of MPCI using AHP weights, Equal weights and Entropy weights, there was an improvement in MPCI of 319.72%, 45.38% and 9.02% respectively compared to turning parameters in common use. The depth of cut was found to be a vital parameter for MPCI with AHP weights and nose radius for MPCI with Equal and Entropy weights.

In this paper we study about the choice of method of assigning weights of importance to the responses and even the optimization method plays important role in decision making in multi objective optimization.

#### **Modeling And Multi-Objective Optimization For Minimizing Surface Roughness, Cutting Force, And Power, And Maximizing Productivity For Tempered Stainless Steel AISI 420 In Turning Operations**

**Author:** Abderrahmen Zerti, Mohamed Athmane Yaltese, Ikhlas Meddour, Salim Belhadi, Abdelkrim Haddad, Tarek Mabrouki, 2020.

Mechanics and Structures Research Laboratory (LMS), Mechanical Engineering Department, University of Guelma, Guelma, Algeria.

This research paper aims at investigating the influence of the different machining parameters represented by the cutting speed, depth of cut and the feed rate on the output performance parameters expressed through the surface roughness, cutting force and power, and the material removal during dry hard turning operation of martensitic stainless steel (AISI 420).

The machining tests were carried out using the coated mixed ceramic insert (CC6050) according to the Taguchi design (L25). The analysis of the variance (ANOVA) and the Pareto chart analysis led to quantifying the influence of the on the output parameters. The response surface methodology (RSM) and the artificial neural networks (ANN) approaches were applied and compared for output parameters modeling. Attempt was further made to optimize the machining parameters using the desirability function (DF).

In this research paper results indicated that (Ra) is strongly influenced by the feed rate (in the order of 80.71%), while the depth of cut seems to be the property having the most influence on the cutting force (65.31%), the cutting power (37.56%), and the material removal rate (36.45%). Furthermore, ANN and RSM models were found to predict well experimental results with the former showing higher accuracy. The machining of AISI 420 (59 HRC) steel with coated ceramic led to achieving a quality surface comparable to that found in grinding.

In this study ANN and RSM models were found to predict well experimental results with the former showing higher accuracy.

#### **Optimization Of Tool Geometry Parameters For Turning Operations Based On The Response Surface Methodology**

**Author:** Süleyman Neseli, Süleyman Yıldız, Erol Türkes.

Department of Mechanical Technologies, Technical Science College, Selcuk University, 42003 Konya, Turkey.

In this paper researcher focuses on the influence of tool geometry on the surface finish obtained in turning of AISI 1040 steel. The

Al<sub>2</sub>O<sub>3</sub> coated insert tool was used for turning with factors like cutting nose radius, approach angle and rake angle. In order to find out the effect of tool geometry parameters on the surface roughness during turning, response surface methodology (RSM) was used and a prediction model was developed related to average surface roughness (Ra) using experimental data.

The results indicated that the tool nose radius was the dominant factor on the surface roughness. In addition, a good agreement between the predicted and measured surface roughness was observed. Therefore, the developed model can be effectively used to predict the surface roughness on the machining of AISI 1040 steel within 95% confidence intervals ranges of parameters studied.

In this research paper we study effects of nose radius, approach angle and rake angle on surface roughness and also RSM seems to be useful and safe method for optimization.

#### **Energy And Cost Integration For Multi-Objective Optimization In A Sustainable Turning Process.**

**Author:** Salem Abdullah Bagaber, Ahmad Razlan Yusoff, 2018.

Faculty of Manufacturing Engineering, University Malaysia Pahang, 26600 Pekan, Pahang, Malaysia.

In these study researchers aims to improve sustainable cutting process through the integration of energy and cost modeling. The solution is based on the multi-objective optimization of cutting parameters, including cutting speed, feed rate and cutting depth, based energy, cost and quality processes.

The multi-objective optimization using Response Surface Methodology (RSM) was compared with the Non-Sorted Genetic Algorithm II (NSGA II) before experimental confirmation tests were made. From the multi-objective optimization it was found that energy saved can be 9.2% and machining cost can be reduced by 4.6% using RSM. Moreover, the

In this study, the Cutting quality and production cleanliness are main aspects to be considered in the machining process, and determining the optimal cutting parameters is a

second-generation results of optimization using NSGA II showed an improvement of more than 70% compared to RSM optimization. A two-confirmation method validated the optimum point and dry cutting showed lower energy and cost with acceptable quality compared to wet conditions.

The model proposed in this study is effective in terms of machining energy, cost and environment so as to be integrated with the sustainable machining.

#### **Analysis And Multi-Objective Optimization For Reducing Energy Consumption And Improving Surface Quality During Dry Machining Of 304 Stainless Steel**

**Author:** Feilong Du, Lin He, Haisong Huang, Tao Zhou and Jinxing Wu, 2020.

In these research paper researchers aims to optimize machining parameters, like power consumption and surface roughness. The tungsten carbide-coated tool was used for turning of 304 Stainless Steel with factors like cutting speed, feed and depth of cut. A multi objective optimization method of Taguchi was employed to optimize machining parameters.

In this study, the regression models of specific cutting energy, surface roughness, and micro-hardness are constructed separately by the analysis of variance (ANOVA) during the turning of 304 stainless steel, and the influence mechanism between cutting parameters and three output responses are explored. Then, multi-objective optimizations are carried out using the desirability analysis method in two different modes. It is demonstrated that for specific cutting energy the feed rate is the most significant influencing factor while the correlation of cutting depth is less obvious. A higher cutting speed (210 m/min) and feed rate (0.15 mm/rev) reduce the specific cutting energy, owing to the increase of material removal rate and thermal softening effect. A better surface roughness can be achieved at a lower feed rate rather than a higher feed rate.

significant measure to reduce energy consumption and optimize surface quality.

#### **A. Summary Of Detailed Case Study**

In above detailed case study we have reviewed the recent eight research papers from reputed journals to study optimization of process parameters in turning operation and use of response surface methodology (RSM). The following points were drawn from the case study:

- Response Surface Methodology is found to be a very useful and powerful tool for design of experiments and optimization of process parameters in turning operations.
- RSM can effectively reduce the impact and costs of the machining process.
- RSM models were found to predict well experimental results with the former showing higher accuracy.
- We also studied the various input variables like cutting speed, feed rate, depth of cut, nose radius, and rake angle and how they effects on the output variables.

#### DESIGN OF EXPERIMENTS

Factor	Units	Level 1	Level 2	Level 3
Cutting Speed	m/min.	165	206.5	248
Feed Rate	mm/rev.	0.2	0.25	0.3
Depth of Cut	mm	1	1.4	1.8
Rake Angle	Degree	4	8	12

**Table 1. Cutting parameters and their levels.**

#### Work Piece Material

AISI 304 austenitic stainless steel is used widely in machinery, aerospace and medical device industry because of its good overall performance. However, it also belongs to one of the difficult-to-machine materials due to its high toughness, serious work hardening, and bad thermal conductivity. AISI 304 was chosen

Designs of experiments are considered as very useful strategy for deriving clear and accurate conclusions from the experimental observations. In this phase of experimentation a design of experimentation technique versus Response Surface Methodology has been used for studying the influence of four process parameters (cutting speed, feed, depth of cut and rake angle) on five different responses in machining of AISI 304. Central composite design is preferred in this case. Thirty one experiments are performed at three different levels. Minitab software has been used for design of experiments.

#### Selection Of The Factors And Their Levels

The turning parameters and their levels of the experiments were identified based on literature review. The four parameters, cutting speed, feed rate, depth of cut and rake angle were chosen and input factor and their levels are indicated in following table.

as workpiece material, and its chemical composition is shown in Tables.

#### TOOL MATERIAL

The cutting tool used for this study is High Speed Steel. The composition features of HSS is chromium (4%), tungsten (approx. 6%), molybdenum (up to 10%), vanadium (around 2%), cobalt (up to 9%) and carbon (1%).

Composition	C	Mn	Si	P	S	Ni	Cr	Mo	Cu	Fe
wt%	0.065	1.78	0.3	0.027	0.02	8.1	18.2	0.13	0.14	71.2

**Table 2. Chemical composition of AISI 304 austenitic stainless steel**

**Table 3. Experimental Design Using RSM**

Run Order	Cutting Speed (m/min)	Feed Rate (mm/rev)	Depth of Cut (mm)	Rake Angle (Degree)
1	206.5	0.25	0.6	8
2	206.5	0.25	1.4	8
3	206.5	0.25	1.4	8
4	165	0.2	1	12
5	165	0.2	1.8	4
6	248	0.2	1	12
7	248	0.3	1	4
8	165	0.2	1	4
9	123.5	0.25	1.4	8
10	248	0.3	1	12
11	206.5	0.25	1.4	16
12	165	0.2	1.8	12
13	248	0.3	1.8	12
14	206.5	0.35	1.4	8
15	165	0.3	1	4
16	206.5	0.25	1.4	8
17	206.5	0.25	1.4	8
18	206.5	0.15	1.4	8
19	165	0.3	1.8	4
20	206.5	0.25	1.4	8
21	248	0.2	1.8	12
22	248	0.2	1	4
23	206.5	0.25	1.4	8
24	248	0.3	1.8	4
25	248	0.2	1.8	4
26	206.5	0.25	2.2	8
27	289.5	0.25	1.4	8
28	165	0.3	1.8	12
29	206.5	0.25	1.4	0
30	206.5	0.25	1.4	8
31	165	0.3	1	12

Due to pandemic situation of covid and lockdown restrictions, we were unable to complete the further research. The following data is useful and can be use for completing this research in future.

### CONCLUSIONS

In this paper we have reviewed the recent research papers to study optimization techniques and the use of response surface methodology (RSM) for turning operations.

Following conclusions are drawn from the study.

1. RSM is found to be a very useful and powerful tool for design of experiments and optimization of process parameters in turning operations.
2. Response surface method is found to be a successful technique to perform trend analysis of power consumption in metal cutting with respect to various combinations of design variables (metal cutting speed, feed rate, depth of cut and tool nose radius).



3. RSM was also successfully employed for the analysis of parameters like tool wear, cutting forces
4. RSM can effectively reduce the impact and costs of the machining process.
5. RSM models were found to predict well experimental results with the former showing higher accuracy.
6. Due to pandemic situation of covid and lockdown restrictions, we were unable to complete the further research. The following data is useful and can be use for completing this research in future.

**Table 4**

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	Author	Workpiece Material	Tool Material	Input Variables	Output Variable/s	Remark
2002	J.Paulodavim	Aluminum T6	TMCV 16T308F	Cutting speed, feed rate and depth of cut	Power consumption, tool life and surface roughness	Feed rate has the most significant effect on the power, followed by depth of cut, tool nose radius and cutting speed.
2010	L.B.Abbang, M.Hameedullah	EN31 Steel	Tungsten Carbide Tool	Cutting speed, feed rate, depth of cut and nose radius	Power consumption	Feed rate has the most significant effect on the power, followed by depth of cut, tool nose radius and cutting speed.
2012	Rajesh Kumar Bhushan	Al 7075 Alloy	Tungsten Carbide Insert	Cutting speed, feed rate, depth of cut and nose radius	Power consumption and tool life	Cutting speed is the most significant factor followed by depth of cut, feed and nose radius.
2007	Aman Aggarwal, Hari Singh, Pradeep Kumar, Manmohan	AISI Steel P20	TiN Coated Tungsten Carbide Inserts	Cutting speed, feed rate, depth of cut and nose radius	Power consumption	Cryogenic environment is the most significant factor followed by cutting speed and depth of cut.

	Singh						
2008	Camposeco Negrete	AISI 1018	Tin Coated Carbide Tool	Cutting speed, feed rate and depth of cut	Energy consumption	Feed rate (0.2mm/rev), first level of depth of cut (1.14mm) and first level of cutting velocity (350 m/min) lead to minimum energy consumption.	
2007	V.N.Giaton de,S.R.Karnik, Luis Figueira, J. Paulo Davim	AISI Work Material	D2 GC6050WH ceramic inserts	Depth of cut and machining time	Machining force, power, specific cutting force, surface roughness and tool wear	Machining force and power are highly sensitive to machining time at higher values of depth of cut.	

**Table 5**  
**Summary of use of RSM for Energy Efficiency and Power Factor**

Year	Author	Workpiece Material	Tool Material	Input Variables	Output Variable/s	Remark
2017	J. Ma, X. Ge, S. I. Chang, S. Lei	AISI 4140	Carbide Tool	Cutting Speed, Rake Angle, Nose Radius, And Edge Radius	Energy Consumption And Energy Efficiency	Increasing rake angle or decreasing edge radius is the most effective way to reduce cutting energy. Edge radius and rake angle have significant effect on cutting efficiency, and high efficiency can be achieved by decreasing both.
2016	Paramjit Singh, Bilga, Sehijpal Singh, Raman Kumar	EN 353 Alloy Steel	Tungsten carbide	Cutting Speed, Feed Rate, Depth Of Cut And Tool Nose Radius	Energy, Consumption, Energy Efficiency, Active Energy, Power Factor	Depth of cut was revealed to be the most critical parameter for PF and EE.

**Table 6**  
**Summary of use of RSM for Surface Roughness**

Year	Author	Workpiece Material	Tool Material	Input Variables	Output Variable/s	Remark
2019	Muhammad	Al 5083	Uncoated High-Speed	Cutting Speed,	Surface Roughness.	Cutting speed and feed rate are influential on the surface

	Aamir		Steel	Feed Rate		roughness.
2011	Issam Hanafi, Abdellatif Khamlich i et al.	PEEKCF30	TiN Coated tools	Cutting Speed, Feed Rate, Depth Of Cut.	Surface Roughness, Cutting Power	Depth of cut is the most influencing parameter.
2020	Yugang Zhao, Jianbing meng.	AISI 304 Steel	Carbide Tool	Cutting Speed, Feed, Axial And Radial Depth Of Cut	Surface Roughness	Cutting speed has great impact of surface roughness and material removal rate.
2014	Girish Kant, Kultip Singh Sangwan	AISI 1045 steel	Uncoated tungsten carbide tools	Cutting Speed, Feed Rate, Depth of Cut	Surface Roughness, Power Consumption	Feed is the main influencing machining parameter for the minimization of power consumption and surface roughness followed by the depth of cut and cutting speed.
2016	Abderrahme Zerti, Mohamed Athmane Yallese et al.	AISI 420	TiN-coated mixed ceramic	Cutting Speed, Feed Rate, Depth Of Cut	Surface Roughness, Cutting Force, Power And Material Removal Rate.	(Ra) is strongly influenced by the feed rate and depth of cut seems to be most influence on the cutting force.
2017	Salem Abdullah Bagaber, Ahmed Razlanyus	AISI 306	Uncoated Carbide	Cutting Speed, Feed Rate, Depth Of Cut.	Power Consumption, Surface Roughness, Tool Wear.	The factor with the most significant influence on surface roughness was feed rate. Cutting speed was the most significant factor on tool wear.
2015	Yousef Shokoohi et al.	AISI 1045	HSS (uncoated)	Cutting Speed, Feed Rate, Depth Of Cut	Surface Roughness, Machining Power,	Adopted technique (CCM) significantly lowered the surface roughness, power consumption and resulted in smaller chips.
2018	Riadh Saidi, Brahim	Cobalt-Based Alloy	HSS	Cutting Speed, Feed Rate,	Surface Roughness, Material	Results demonstrate that both feed rate and insert nose radius

<p>Ben (Stellite 6) Fathallah , Tarek Mabrouk i, Salim Belhadi, Mohamed Athmane Yallese.</p>	<p>Depth Of Removal Cut, And Rate. Nose Radius</p>	<p>are high.  Depth of cut has the main effect on the evolution of material removal rate and it is followed by cutting speed and feed rate effects.</p>
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## Some Studies On Portable Solar Dryers And A Proposed Novel Conceptual Design Of Portable Solar Dryer

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### ABSTRACT

*The unpredictable rise and frequent scarcity of fossil fuel accelerated the continuous search for an alternative power source. Solar is one of the renewable and sustainable sources of power that attracted a large community of researchers from all over the world. This is largely due to its abundant in both direct and indirect form. As such the development of efficient and inexpensive equipment for the drying of agricultural and marine products using solar power evolved thereby improving the quality of the products as well as improving the quality of life. The use of solar dryers in the drying of agricultural products can significantly reduce or eliminate product wastage, food poisoning and at the sometime enhance productivity of the farmers towards better revenue derived. A solar crop drying system does not solely depend on solar energy to function; it combines fuel burning with the energy of the sun, thus reducing fossil fuel consumption. In this paper a review of the solar dryer is presented. The various design of the solar dryer is reported in the literature thus far is presented.*

**Keywords:** Drying, Solar Energy, Enhance productivity, Quality of life, Solar dryer.

### Introduction

Fruits and vegetables are the most important products in agriculture sector. As its contents of nutrition are very high, it has to be preserved. Keeping the products fresh is the best way to maintain its nutritional value. Moreover, fruits and vegetables are seasonal in nature and due to their low shelf life after harvest they are sold in the markets at very low prices. There is a considerable surplus of these fruits and vegetables which can be processed (dehydrated) for consumption during off-season. There are many methods for this preservation, but drying process is the most common method of food preservation because it increases the storage life. Drying needs thermal energy, which can be obtained by harnessing the solar energy. Solar drying can be used for the entire drying process for supplementing artificial drying systems. Since solar energy is abundantly available free of cost, it acts as a source competing with traditional forms for supplying heat.

The Solar Dryer is a device used mainly for drying of crops, food products, pharmaceuticals and chemicals by removing the moisture present therein through the use of solar heat as

a source of energy. Solar drying of fruits and vegetables overcomes the drawbacks of traditional open sun drying such as, contamination from dust, insects, birds and animals, lack of control over drying conditions, possibility of chemical, enzymic, and microbial spoilage due to long drying times.

### A Problem Statement

To design and develop a portable and affordable solar dryer for food and domestic industry which dries various food products with the use of solar energy and with a small amount of effort required to cut the food products. Considering the potential market opportunity of such units, the present detail project has been developed. The main objective of such initiative is to productively utilize the abundantly available resources of the local area and to enable uninterrupted supply of the products to market throughout the year.

### B Objectives of solar dryer

- To create 2D and 3D model of solar fruit dryer.
- To design and construct a solar dryer.

- To evaluate the solar dryer's performance
- To protect the product against flies, pests, rain and dust.
- The product can be left in the dryer overnight or during rain.
- To achieve better quality of product in terms of nutrients, hygiene and colour.
- To improve family nutrition because fruit and vegetables contain high quantities of vitamins, minerals and fibre.
- To improve the bargaining position of farmers.
- To encourage people to establish their own gardens.

### Case Study on Solar Dryer

#### A Introduction

Drying (or dewatering) is a simple process of excess water (moisture) removal from a natural or industrial product in order to reach the standard specification moisture content. It is an energy intensive operation. Especially essential is to reduce the foodstuff moisture content, as these have in general a water content much higher (around 25–80%, but generally for agricultural products around 70%) than the one suitable for long preservation. Reducing moisture content of foodstuff down to a certain level slows down the action of enzymes, bacteria, yeasts and molds. Thus food can be stored and preserved for long time without spoilage. Another case of drying (or dewatering) is the total removal of moisture until food has no moisture at all. Dehydrated food, when ready to use, is re-watered and almost regains its initial conditions.

Due to pandemic situation of covid and lockdown restrictions, we were unable to complete the final fabrication work of solar dryer with testing and analysis. So we have decided to do a detail case study on solar dryer to optimize our design. We have selected eight research papers of worldwide well known publishers which relates somewhat to our design. Their detailed case study is as stated below –

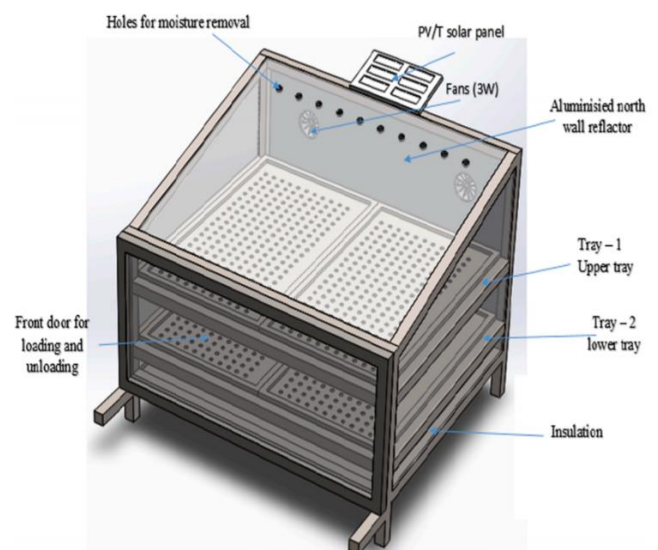
#### B Case study

Design, modeling and analysis of efficient multi-rack tray solar cabinet dryer coupled with north wall reflector[1]

Author- Saloni Spall, V.P. Sethi (2020)

Significant variation in solar radiation capture by the Multi Rack Tray (MRT) solar cabinet dryer was observed at selected latitudes during each season and in general decreased with increase in latitude. In retrospect, the Reflective North Wall (RNW) could enhance the TSR by 25%.

Under natural convection mode, the daily average efficiency  $\eta$  (avg) of MRT solar dryer with RNW was about 5% higher and maximum  $\eta$  (max) was about 20% higher as compared to without using RNW. However, in summer (April) RNW could enhance the  $\eta$  (avg) only 1.27% and  $\eta$  (max) was also only about 7% higher with using RNW as compared to without using it. Similarly, under forced convection mode RNW could enhance the daily average efficiency  $\eta$  (avg) of MRT solar cabinet dryer by 4.35% and about 12.88% increase in maximum  $\eta$  (max) was observed. However, in summer (April) the effect of RNW was small as  $\eta$  (avg) was only 1.48% higher as compared to when RNW was not used.  $\eta$  (max) was also only 5.12% higher as compared to when RNW was not used.



**Fig 1 Isometric view of MRT solar dryer**

Under natural convection mode, daily average chamber temperature  $T_{ch}$  was observed 4 °C -

7°C higher with using RNW as compared to without RNW however; T<sub>ch</sub> was 2 °C -5°C higher under forced convection mode in winter conditions.

The moisture content % decreased with increase in drying time and increase in chamber temperature for all experiments. In all the experiments, almost two drying days were required to bring the carrots at equilibrium moisture of 8%. Reduction in drying time for carrot drying was about 20% and 15% under natural convection (NC) and forced convection (FC) modes respectively by using RNW in winter. However, reduction in drying time during summer was not much significant (less than 10%).

It can thus be concluded that use of RNW on MRT solar cabinet dryer can play significant role in reducing the drying time in winter when solar radiation availability is low due to lower solar altitude angle of the sun at 30°N latitude. RNW can also lower the drying time at higher latitudes of 40°N and 50°N as the effect of RNW is significant on solar radiation enhancement at these latitudes both in winter as well as in summer.

This paper does a detail study of heat transfer and goes deep into analysis of parameters and goes to length to account for any kind of heat loss. It taught us how to account for direct heating aspect for our mixed type solar dryer. On the other hand we decided not to use RNW as our dryer is made to be used in summer season for low latitude of 20°.

Thermal performance of a passive, mixed-type solar dryer for tomato slices (*Solanum lycopersicum*) [2]

Authors - Lopez-Vidana Erick, Cesar - Munguía Ana Lilia , García-Valladares Octavio ,Pilatowsky Figueroa Isaac , Brito Orosco Rogelio (2020)

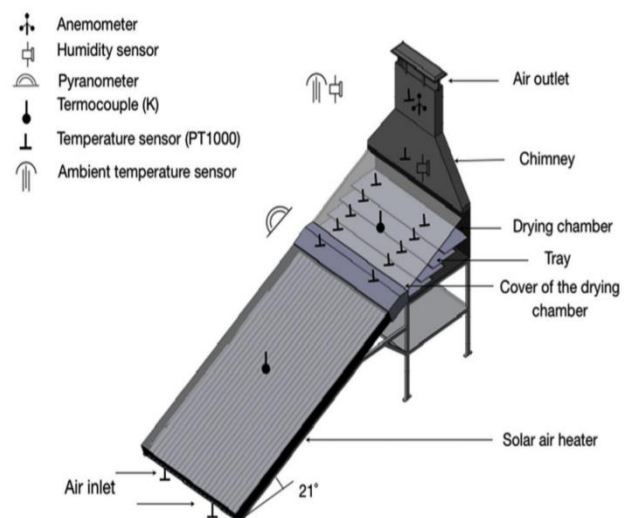
In this work, the performance of the mixed type solar dryer in natural convection was evaluated successfully. Two modes of operation of the dryer were compared, obtaining drying kinetics about two and three days for MSD and ISD respectively. The model that in both cases was better adjusted to the experimental data was the modified Henderson & Pabis. The quality of the adjustment was evaluated using the coefficient

of determination ( $r^2$ ), the mean square error (RMSE) and Chi-square ( $c^2$ ).

The overall efficiency of the solar dryer was 8.80% and 10.66% for the ISD and MSD respectively; MSD is higher because overall efficiency considers the total energy received by the system and for the same reason ISD was 8.6 h longer process than the MSD. Comparing the dryer efficiency with the overall efficiency takes into account the possible useful energy at the outlet of the system. The drying efficiencies of MSD (5.47%) and ISD (4.48%) are values similar to that reported in other works, the efficiency of the solar collector for air heating was between 55.45% and 52.30% for both modes of operation of the system.

The average temperature of the chamber was higher when the solar radiation goes through the drying chamber reaching maximum temperatures of 73.6°C. Since the tomato is one of the foods with the highest moisture content and its structural characteristics makes a prolonged drying, it is desirable to use the dryer in direct mode in natural convection or in indirect mode with forced convection to guarantee a better quality and less time of drying.

This paper proved to be a brilliant and sophisticated comparative analysis for mixed and indirect solar dryer. We decided to choose a mixed cabinet solar dryer design for the purpose to create our own domestic solar dryer based on the results of this study.



**Fig 2 Isometric view & instrumentation of the passive, mixed type solar dryer**



Pineapple drying using a new solar hybrid dryer[3]

Author-David Gudiño-Ayala\*, Ángel Calderón-Topete (2014)

The total drying time when operating in solar mode is in average 31.2% longer (2 hours) than when the dryer operated in hybrid mode, taking into account similar conditions, especially when related to pineapple moisture content.

Initial moisture content is a determining factor in the pineapple drying velocity. The higher the moisture content, the longer it will take to complete the drying process.

Under similar operating conditions the solar mode process is almost twice as efficient as the hybrid mode; Water vaporization efficiency ( $\eta_{\text{evap}}$ ) =23.4 and  $\eta_{\text{evap}}$ =13.4% respectively. Apparently a great amount of heat from the hot water is lost to the environment.

The process in both of its modes (solar or hybrid) is basically homogeneous when the trays containing the product are placed towards the middle of the dryer.

Through this research paper we gained major insights into the hybrid solar dryer. We learned about the core difference between a standard and a hybrid solar dryer in terms of its principle, practicality and analysis. Ultimately we agreed not to pursue hybrid solar dryer because of its cost, bulkiness and design complications.

Design and Analysis of Solar Dryer for Mid-Latitude Region[4]

Author - Maundu Nicholas Musembia \*, Kosgei Sam Kiptoob, Nakajo Yuichic\* (2016)

Psychrometry is important as it refers to the properties of air-vapor mixture that control the rate of drying. It was found useful in determining humidity ratios and thus giving an idea on changes in humidity ratio between the drying chamber inlet and outlet.

Based on relative humidity and the dew points obtained at the inlet and outlet of the drying chamber and the temperatures, the chamber can accommodate one additional drying tray column by expanding vertically thus improving on its performance efficiency.

From this research, the solar dryer of the same design requires a collector area of 0.658 m<sup>2</sup> to dry one kilogram of sliced apples from moisture content of 86% to moisture content of

8.12 % within 9 hours at an average irradiance of 534.4 W/m<sup>2</sup>.

Duplication of this design in large scale within mid-latitude regions can mitigate the impact of post harvesting losses especially to the developing countries thus improving the state of food insecurity and providing higher returns to the farmers.

This design may present some challenge for a large scale system design, the dryer may require special design for elevation angle variation mechanism of the collector due to increased size and weight. The airflow for natural convection solar dryer cannot be kept constant since the flow and temperature are determined by irradiance and hence it may not be possible to predetermine when the material will be completely dried especially in areas with hourly variable weather conditions.

Indirect natural convection flow solar drying was found to be a suitable method for drying apples since the results gave good color, texture and taste.

This research paper played a crucial part in the design of our domestic mixed solar dryer. The design numerical and assumptions of our project took a huge chunk of reference through the design aspect of this paper.



**Fig 3 Experimental setup during drying, side view (left) front view (right)**

Design and performance evaluation of a passive flat plate collector solar dryer for agricultural products[5]

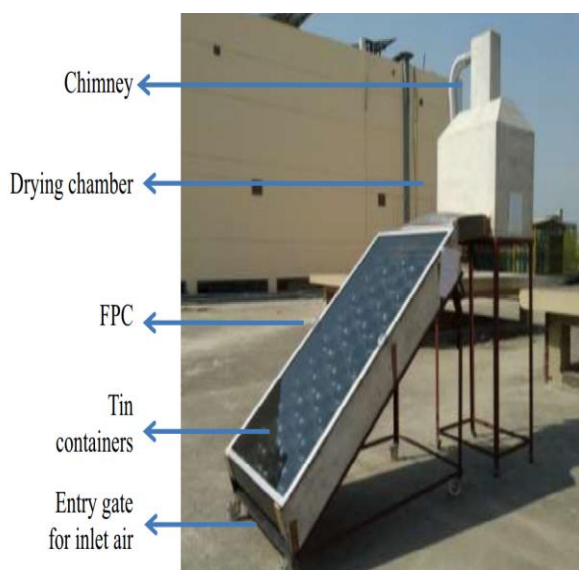
Authors - Onkar A Babar | Ayon Tarafdar | Santanu Malakar | Vinkel Kumar Arora |Prabhat K. Nema (2020)

For farm level operation, a Passive Flat Plate Collector (FPC) with thermal storage and natural convection solar dryer with phase change material was designed and developed with capacity of 7.5 kg (maximum) of raw agricultural products.

Maximum temperature at the exit of collector that is, at the inlet of drying chamber achieved was in the tune of 56–57°C. Drying chamber cross-sectional area is 0.74 m × 0.585 m whereas, FPC dimensions are 2 m × 1 m, with aspect ratio (L:W) of 2, the collector depth was 0.255 m; it occupies volume of 0.5 m<sup>3</sup>. The difference between the average dryer inlet and average ambient temperature was found to be 24.6°C measured at 13.30 p.m., with average daily solar insolation of 882.35 W/m<sup>2</sup>.

Performance was evaluated by a comparative study of button mushroom drying in FPC solar dryer and open sun drying. Solar drying of button mushrooms using FPC-solar dryer consumed 36.36% less time than open sun drying.

We took some design reference of this research paper for our project. Though we decide against the thermal storage aspect because our design already took huge efforts to utilized major solar radiation coming from the sun by using a solar collector to catch solar radiation which seeped through the seeped through the trays. Also thermal storage will make our project more costly.



**Fig 4** Passive solar dryers with PCM containers

Performance Evaluation of a Solar Greenhouse Dryer at different bed conditions under passive mode[6]

Authors - Asim Ahmad, Om Prakash (2019)

The thermal energy storage concept was applied to the bed of greenhouse dryer. Further, the setup was tested at different bed conditions operating in no-load and load condition. The purpose of testing in no-load condition was to get a complete thermal profile of the system without any hindrance by crop.

The heat storage capacity was maximum for black painted gravel bed condition in comparison with other bed conditions such as concrete bed, gravel bed, and ground bed. Maximum heat gain at floor takes place at black painted gravel bed condition, i.e., 53% at 13h. Maximum heat gain of greenhouse dryer takes place at black painted gravel bed condition, i.e., 50% at 13 h. The maximum heat storage capacity was observed in black painted gravel bed condition in



**Fig 5 a)** Rear view of dryer in no-load condition **b)** Rear view of dryer in load condition

comparison with the existing greenhouse dryer. The maximum room temperature (inside the greenhouse dryer) for black painted gravel bed condition has been calculated as 64.4 °C. The maximum COP for black painted gravel bed has been calculated as 0.924, which concludes that the heat storage capacity was higher in this particular type of bed condition.

Black painted gravel bed condition shows minimum Heat Utilization Factor (HUF) value in comparison with other bed conditions. In comparison with four types of bed conditions, Overall Heat Transfer Coefficient (OHTC) was found to be maximum at 13 h in the case of black painted gravel bed, i.e., 3.88.

The shrinkage percentage of tomato flakes in the proposed setup varies from 96% to 9.1% in 13 h, whereas in the study by Prakash and Kumar the shrinkage percentage reaches up to 10.26% in 16 h. Therefore, moisture removal drying duration is more significant in the proposed setup. The average drying efficiency of the proposed setup was found to be 23.49% which was more than that reported by Prakash and Kumar. The CO<sub>2</sub> emission of the dryer was found to be 23.94 kg for 1.5 kg of coal. The embodied energy was evaluated as 530.4976 kWh for the proposed greenhouse dryer.

The food screens and collector plate is painted black due to the astounding results we go from this research paper. Also some design elements used in this paper were extremely helpful for our project.

Analysis of an indirect air heater solar dryer with multiple PCM[7]

Authors - T.S. Sreerag and K.S. Jithish (2016)  
An experimental model of indirect solar air heater-dryer with thermal energy storage was designed and fabricated. The model was fabricated as a double frame structure with mild steel sheets. It is insulated from all the sides by using glass wool.

In the system with PCMs installed, the air temperatures at elevated levels can be maintained for the evening hours. This will keep the process of drying continuous. It is observed that the drying rate for the advanced system is an improved one. Thus the energy absorbed into the PCM during the early stages is given back in the later stages. Also in the process of drying, the amount of water removed in early stages will be low as the transportation of moisture from inside to outside of crop take place in different steps. But as soon the moisture removal start to take place in large quantity, if continuous heat is supplied the drying will take place in a steady and fast rate. Thus upon using system with PCM, more constant rate of heat energy can be supplied at evening hours, which have helped in making the specimen dry faster.

PCMs used in the experimental model are not of commercial grade. So after a number of cycles of experiment it will lose the quality. Wide range of PCMs is available with a large range of melting temperatures. System can be

improved by experimenting with different types of PCMs. This will make system performance optimized.

Heat transfer from PCMs to air is always low. So implementing a system to improve heat transfer to air can be considered. This experimental model is a single pass system. If number of passes is increased, system is expected to improve its performance.

The design procedure of this project is comprehensive and extremely helpful for confirm the design procedure of our project. We opted against the PCM because our project design alone in itself gave satisfactory results. Utilization of phase change material will increase cost and size to improve an already satisfactory design.

Solar Drying[8]

Authors - V. Belessiotis \*, E. Delyannis (2010)  
In this paper about solar drying various direct and indirect solar drying applications and some of the numerous solar dryers are described. A very short historical description of solar drying through the centuries is also given. Some drying phenomena, independently of the type of energy used, and the general laws that govern drying methods by convection are shortly analyzed in order the reader to easily follow the details of the solar drying procedure. Special solar collectors used in drying and methods of coupling to the various solar dryers are described as an indirect solar thermal energy source. At the end an example of drying of grapes to produce black current raisins, by indirect solar radiation, is given as well.

We learned the basic and core ideas and principle behind solar drying, types of solar and the detail descriptions of those dryers. The calculations at the end of this paper helped us to figure out the design conception of our project. Also it provided us further design requirements our project needed to satisfy.

### C Summary of case study

After having a detail case study on solar dryer of various research papers, we have come to some conclusive points. Basically after seeing all the previous researchers existing designs we have optimize the design of our solar dryer. We studied hybrid type of solar dryer and after seeing its limitations we have decided to go with mixed type of solr dryer.

We study various new concepts like heat storage, mirror wall reflector, etc. So, after studying all the previous research papers and by overcoming their limitations, we have designed and proposed our solar dryer for effective drying purposes.

**Design of Solar Dryer**

**A Design assumptions**

Sr. No.	Parameters	Value
1	Crop	Tomato
2	Drying per batch (Db)	2 kg
3	Initial humidity (Min)	90%
4	Final humidity (Mout)	10%
5	Maximum temp (Tmax)	60°C
6	Ambient temp (Ta)	30°C
7	Estimated drying time (t)	0.5 hr.
8	Relative humidity (φ)	60%
9	Wind Speed (Vw)	1.5 m/sec
10	Collector Efficiency (η)	43%
11	Incident solar radiation (I)	21.6 MJ/m <sup>2</sup> /day

**B Design procedure**

1. Based on wet material moisture content, as is the basis for agricultural products, the water that has to be moved is:

$$\dot{m}_w = \frac{Min - Mout}{100 - Mout} \times 100$$

$$\dot{m}_w = \frac{90 - 10}{100 - 10}$$

$\dot{m}_w$  is 0.88 kg of moisture /kg tomatoes

And, the amount of moisture removed from tomatoes ( $m_o$ ) =  $\dot{m}_w \times Db$

$$m_o = 0.88 \times 2$$

Therefore,  $m_o = 1.76$  kg of water content

2. Average drying rate (Adr) can be determined from the mass of moisture removed by solar heat and drying time (t):

$$Adr = \frac{m_o}{t}$$

$$Adr = \frac{1.76}{0.5}$$

$$\therefore Adr = 3.52 \text{ kg/hr.}$$

From the enthalpy–humidity Mollier diagram for air temperature 30°C and relative humidity (φ) is 60% the absolute humidity will be 16.0 g/kg and its corresponding enthalpy will be 73 kJ/kg. For air 60°C, relative humidity is going to be 13.5% and enthalpy will be 100 kJ/kg.

3. For final humidity of 10% for tomatoes the corresponding water activity ( $a_w$ ) will be,

$$a_w = 1 - \exp \left\{ -\exp \left[ 0.914 + 0.5369 \times \ln \left( \frac{Mout}{100 - Mout} \right) \right] \right\}$$

$$a_w = 1 - \exp \left\{ -\exp \left[ 0.914 + 0.5369 \times \ln (0.1111) \right] \right\}$$

$$\therefore a_w = 0.514 \text{ or } a_w \approx 0.51$$

Many research papers have mentioned water activity value to be in between 0.45 to 0.55 for dried tomatoes. So, the obtained water activity is correct.

And the mean relative humidity of air (φ<sub>m</sub>),

$$\phi_m = (100 + 51) / 2 = 75.5\%$$

From enthalpy-humidity diagram for mean air humidity 75.5% the air humidity at the exit of the dryer is 28 g/kg and the corresponding temperature is 35°C.

4. The latent heat of vaporization (hfg) was calculated using equation given by,

$$hfg = 4.186 \times 10^3 (597 - 0.56Tp)$$

$T_p$  is the product temperature which could be calculated by measuring the tomato during the process of drying. Here, we took mean of  $T_{min}$  &  $T_{max}$  i.e. 45 degree to be the value of ‘ $T_p$ ’.

$$\text{So, } hfg = 4.186 \times 10^3 (597 - 0.56 \times 45)$$

$$\therefore hfg = 2938.56 \text{ kJ/kg}$$

The quantity of heat required to evaporate water during drying (Q),

$$Q = m_o \times hfg$$

$$Q = 1.76 \times 2393.56$$

$$\therefore Q = 4212.65 \text{ kJ}$$

5. For a controlled drying rate, the mass of air needed for drying ( $m_a$ ) can be calculated as,

$W_o$  &  $W_i$  are the final and initial humidity ratio in kg H<sub>2</sub>O/kg dry air respectively.

$$m_a = \frac{Adr}{W_o - W_i}$$

$$m_a = \frac{3.52}{0.028 - 0.016}$$

$$\therefore m_a = 293.33 \text{ kg/hr.}$$

For a controlled drying rate, total energy needed for drying (E) can be calculated as,

$$E = m_a (h_2 - h_1) t$$

$h_2$  and  $h_1$  are final and initial enthalpy in kJ/kg respectively.

$$E = 293.33 \times (100 - 73) \times 0.5$$

$$\therefore E = 3959.96 \text{ kJ}$$

6. The main source of solar radiation for both direct heating and indirect heating is through the glass glazing. So, the solar radiation coming through the glass should account for both direct heating, indirect heating by collector and some energy losses.

Energy coming through the glazing ( $E_g$ ) =  
Energy required to dry by direct heating +  
Energy required to dry by indirect heating +  
Energy loss

Assume that the energy losses to be 20%

$$\therefore E_g = E + E + 0.2E = 2.2E$$

$$\therefore E_g = 10160.1216 \text{ kJ}$$

7. We know,  $E_g = I A_g \square g$

Where,  $A_g$  = Area of glazing

$\square g$  = Transmittance of glazing (glass) = 0.9

$$10160.1216 = 21.6 \times 10^3 \times A_g \times 0.9$$

$$A_g = 0.5226 \text{ m}^2$$

Take width of glazing = 0.695 m

$$A_g = w_g \times l_g$$

$$\therefore \text{Length of glazing} = 0.752 \text{ m.}$$

8. We also know,

$$A_c I \eta = E$$

Here,  $A_c$  = collector area =  $w_c \times l_c$

$\eta$  = collector efficiency = assumed to be 43%...  
a general collector efficiency

$$\text{So, } A_c = \frac{3959.96}{(21.6 \times 1000 \times 0.43)}$$

$$A_c = 0.4167 \approx 0.42 \text{ m}^2$$

Assume, width of the collector ( $w_c$ ) = 0.56 m

$$\therefore \text{Length of collector} (l_c) = 0.75 \text{ m}$$

9. Volumetric air flow rate ( $V_a$ ) =  $m_a \times \rho_a$

Here, density of air ( $\rho_a$ ) = 1.2 kg/m<sup>3</sup>

$$V_a = \frac{293.33}{1.2}$$

$$\therefore V_a = 0.0679 \text{ m}^3/\text{sec}$$

We know,

$$\text{Area of vent} (A_v) = \frac{V_a}{V_w}$$

Here,  $V_w$  = velocity of wind = 1.5 m/sec

$$A_v = \frac{0.0679}{1.5}$$

$$\therefore A_v = 0.0453 \text{ m}^2$$

But,  $A_v = l_v \times b_v$

Here,  $l_v$  = length of vent

$b_v$  = width of vent

Take  $l_v = 0.737 \text{ m}$

$$\text{Then, } b_v = \frac{0.0453}{0.737}$$

$$\therefore b_v = 0.0635 \text{ m}$$

10. The pressure difference across the tray solely due to the density difference between hot air and ambient air ( $P$ ) in Pascal:

$$P = 0.00308 \times g (T_{\max} - T_{\text{amb}}) H$$

Here,  $H$  = height of the hot air column from the base of the dryer to the point of air discharge from the dryer = 0.343 m

$g$  (m/s<sup>2</sup>) = is the acceleration due gravity

$$P = 0.00308 \times 9.81 (60 - 30) \times 0.343$$

$$\therefore P = 0.311 \text{ Pa}$$

11. Reflected energy from the absorber ( $Q_p$ ):

$$Q_p = \rho \tau I A_c$$

Here,  $\rho$  = reflection coefficient of absorber = 0.07

$\tau$  = transmittance of glass = 0.9

$$Q_p = 0.9 \times 0.07 \times 9000.72$$

$$\therefore Q_p = 567.05 \text{ kJ}$$

12. Angle of tilt ( $\beta$ ):

The practical range for angle of tilt is in the range 10° to 30°

If,  $\beta < 10^\circ$  then there is a chance of water accumulation

$\beta > 30^\circ$  then sunshine during prime summer time would be wasted

A city like Nasik situated in northern hemisphere the range gets skewed down to 10° to 20°

For optimal flow of air inside dryer an angle of 12° is suitable.  $\therefore \beta = 12^\circ$

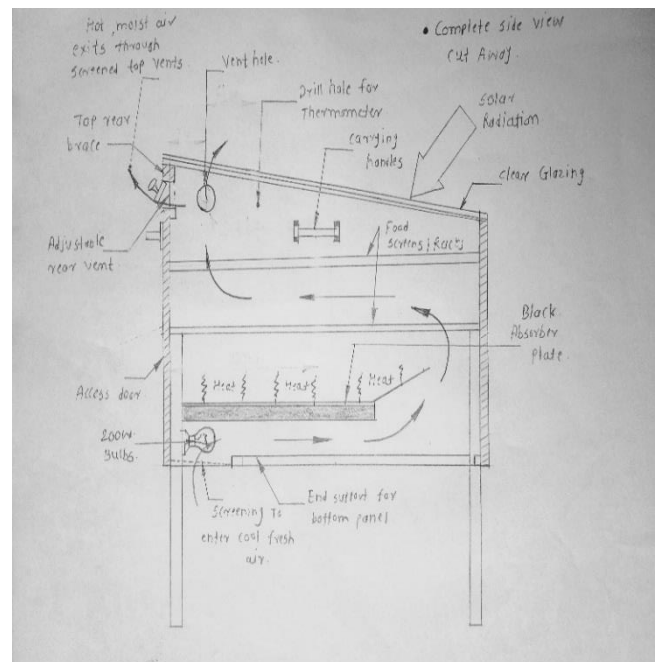
### Working Of Solar Dryer

1. Fig 6 shows how the working model of solar dryer's solar collector works with the absorber plate converting solar radiation into heat.
2. The solar dryer we created is a mixed flow solar heating dryer.
3. In broader terms this solar heater uses both direct heating (like the solar hot box dryer) and indirect heating from the absorber plate.
4. The air flows in the solar dryer are designed to optimize performance and achieve drying and ventilation which is powered by natural convection.
5. Buoyant warm air rises and exits the upper rear vent and cool air is drawn in through the bottom vent inlet to replace the warm air.

6. The cool air is warmed as it flows under the absorber plate from the back to the front of the dryer.
7. The air then rises and warms farther as it flows back across the top of the absorber plate.
8. As the warm air flows back towards the rear vent it passes over the food on both trays.
9. This enables the warm air to remove as much moisture as possible from the food before exiting.
10. The solar dryer also includes a 400-Watt backup electric heating system that can be switched on when the sun goes into hiding or in case of winter when you need to do some off- season drying
11. The backup heating system uses the same natural convection air flow as it did during solar heating. So no fans are needed.



**Fig 6 3-D view of dryer**



**Fig 7 Working fig of dryer**

### CONCLUSION

The driving force behind this project has been the rising awareness and renewed public interest in solar drying. Unfortunately the tiny market share that the solar dryer holds is concentrated towards industrial application. Through this project we intend to manufacture a solar dryer primarily for domestic application.

We took all necessary steps to make this solar dryer more customer pleasing by designing a solar dryer that is compact, light in weight, affordable, appreciable loading capacity and reasonably efficient. This solar dryer is made with a backup electric heating system is pre-installed in the solar dryer for emergency only. This backup heater could be easily powered by an environment friendly power source.

We studied numerous research papers to understand the general concept of solar drying as well as to get a clear idea about the working of various types of solar dryer. After reviewing those papers we chose eight recent research papers from reputed institutions for case study. These eight research papers have substantial detail content and push the research boundaries in their own way. Making the case study helped us to learn the crucial facets of solar dryer which ranges from selection of heating pattern to choosing a suitable design procedure for our project. Case study also played a vital role in creating the design

procedure for our solar dryer. The solar dryer we ultimately designed uses mixed flow type

of heating. The cabinet houses both absorber and drying chamber in a single unit.

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## Hybrid Electric Vehicle

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### ABSTRACT

Automobile hybridization is considered as an important step in reducing greenhouse gases and related automotive emissions. However, current hybrid electric vehicles are a temporary solution on the way to zero emission road vehicles. This paper discusses the use of hybrid electric vehicle power train. This vehicle allows a control strategy which includes both fuel-economy and performance modes. Recently there has been a lot of interest in the concept of hybrid electric vehicles, which have great potential to attain higher fuel economy and efficiency.

How does a hybrid automobile work? What goes on under the hood to give you 20 or 30 more miles per gallon than the standard automobile? And does it pollute less just because it gets better gas mileage? This paper helps us to understand the technology behind these hybrid vehicles. A brief review of design considerations and selection of major components for hybrid electric vehicles is provided.

**Keywords:** Hybrid Vehicles, Energy Saving, Regenerative Braking, Eco Friendly

### Introduction

A hybrid electric vehicle (HEV) has two types of energy storage units, electricity and fuel. Electricity means that a battery (sometimes assisted by ultra caps) is used to store the energy, and that an electromotor (from now on called *motor*) will be used as traction motor. fuel means that a tank is required, and that an Internal Combustion Engine (ICE, from now on called *engine*) is used to generate mechanical power, or that a fuel cell will be used to convert fuel to electrical energy. In the latter case, traction will be performed by the electromotor only. In the first case, the vehicle will have both an engine and a motor.

- Depending on the drive train structure (how motor and engine are connected), we can distinguish between parallel, series or combined HEVs.
- Depending on the share of the electromotor to the traction power, we can distinguish between mild or micro hybrid (start-stop systems), power assist hybrid, full hybrid and plug-in hybrid.
- Depending on the nature of the non-electric energy source, we can distinguish between combustion (ICE), fuel cell, hydraulic or pneumatic power, and human power. In the first case, the

ICE is a spark ignition engines (gasoline) or compression ignition direct injection (diesel) engine. In the first two cases, the energy conversion unit may be powered by gasoline, methanol, compressed natural gas, hydrogen, or other alternative fuels.

**Motors** are the "work horses" of Hybrid Electric Vehicle drive systems. The electric traction motor drives the wheels of the vehicle. Unlike a traditional vehicle, where the engine must "ramp up" before full torque can be provided, an electric motor provides full torque at low speeds. The motor also has low noise and high efficiency. Other characteristics include excellent "off the line" acceleration, good drive control, good fault tolerance and flexibility in relation to voltage fluctuations. The front-running motor technologies for HEV applications include PMSM (permanent magnet synchronous motor), BLDC (brushless DC motor), SRM (switched reluctance motor) and AC induction motor.

A main advantage of an electromotor is the possibility to function as generator. In all HEV systems, mechanical braking energy is regenerated.

The max. operational braking torque is less than the maximum traction torque; there is



always a mechanical braking system integrated in a car.

**The battery pack** in a HEV has a much higher voltage than the SIL automotive 12 Volts battery, in order to reduce the currents and the I<sup>2</sup>R losses.

**Accessories** such as power steering and air conditioning are powered by electric motors instead of being attached to the combustion engine. This allows efficiency gains as the accessories can run at a constant speed or can be switched off, regardless of how fast the combustion engine is running. Especially in long haul trucks, electrical power steering saves a lot of energy.[1]

### Literature Review

## BASICS OF HEV'S

### 1) Hybridization

A hybrid vehicle is a vehicle with multiple energy sources which could be separately or simultaneously operated to propel the vehicle. Many hybridization configurations such as fuel cell, gas turbine, solar, hydraulic, pneumatic, ethanol, electric and many more were proposed over the years. Among these, the hybrid electric vehicles, integrating two technically and commercially proven and well established technologies of electric motors and I.C. engine, allowing drawing upon their individual benefits have been widely accepted by the technologies and users across the world.[2]

### 2) Hybrid Electric Vehicle (HEV)

This is the most commonly adapted hybrid vehicle. It combines the propulsion system of an electric motor and an I.C. engine. The power supply to the electric motor comes from the onboard batteries. In a HEV, the I.C. engine combines with an electric motor which leads to a more optimal use of the engine. Driving in city traffic involves request starts and stops of the vehicle. During idling, the engine consumes more fuel without producing useful work thus contributing to higher fuel consumption, less efficiency and unnecessary emission from exhaust. The HEV solves the problem by switching to power transmission through the motor and shutting off the engine.

This way no fuel will be consumed during idling with no exhaust emission. Another major advantage of HEV is that when fuel tank gets empty while driving the engine, the vehicle can be driven on electric power within its maximum range.

### TYPES OF HYBRID POWER TRAIN'S

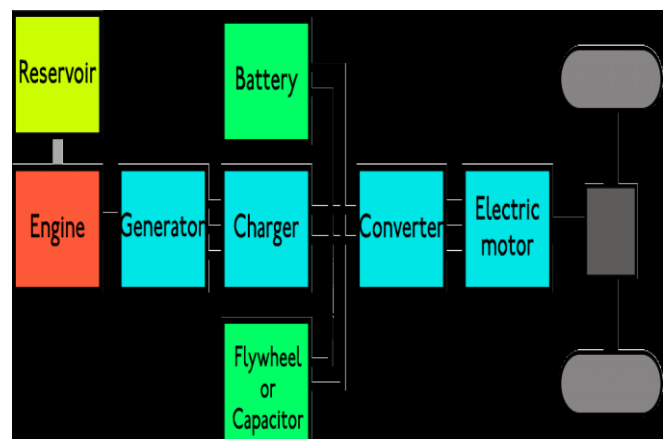
Power train of any vehicle refers to the group of components that generate power and deliver it to the road surface. Hybrid vehicles can be classified into three basic categories of power train systems which are briefly discussed below[2]

- Series hybrid
- Parallel hybrid
- Series parallel hybrid

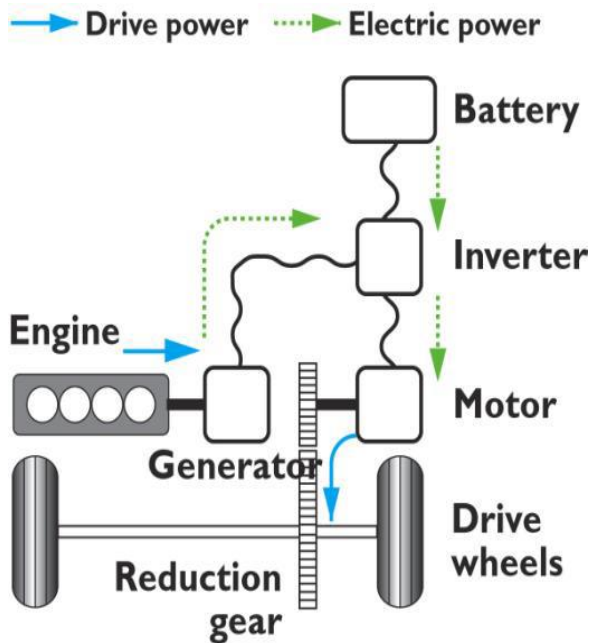
#### 1. Series hybrid

In a series hybrid system, the combustion engine drives an electric generator (usually a three-phase alternator plus rectifier) instead of directly driving the wheels. The electric motor is the only means of providing power to the wheels. The generator both charges a battery and powers an electric motor that moves the vehicle. When large amounts of power are required, the motor draws electricity from both the batteries and the generator.

Series hybrid configurations already exist a long time: diesel-electric locomotives, hydraulic earth moving machines, diesel-electric power groups, loaders.



**Fig No:-1**  
(Series hybrid Vehicle)

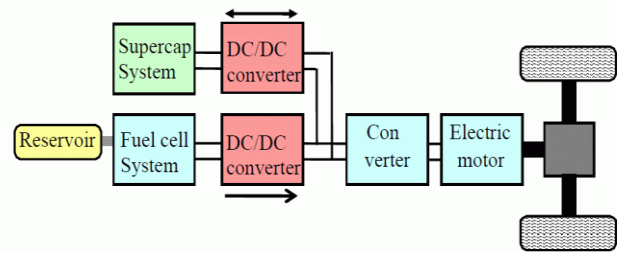


**Fig No:-2 Structure of a series hybrid vehicle  
(below with flywheel or ultra caps as peak power unit)**

Series hybrids can be assisted by ultra caps (or a flywheel: KERS=Kinetic Energy Recuperation System), which can improve the efficiency by minimizing the losses in the battery. They deliver peak energy during acceleration and take regenerative energy during braking. Therefore, the ultra caps are kept charged at low speed and almost empty at top speed. Deep cycling of the battery is reduced, the stress factor of the battery is lowered. A complex transmission between motor and wheel is not needed, as electric motors are efficient over a wide speed range. If the motors are attached to the vehicle body, flexible couplings are required.

Some vehicle designs have separate electric motors for each wheel. Motor integration into the wheels has the disadvantage that the unsprung mass increases, decreasing ride performance. Advantages of individual wheel motors include simplified traction control (no conventional mechanical transmission elements such as gearbox, transmission shafts, differential), all wheel drive, and allowing lower floors, which is useful for buses. Some 8x8 all-wheel drive military vehicles use individual wheel motors.

A fuel cell hybrid electric always has a series configuration: the engine-generator combination is replaced by a fuel cell



**Fig No :- 3  
(Structures of a fuel cell hybrid electric vehicle)**

#### Weaknesses of series hybrid vehicles:

- The ICE, the generator and the electric motor are dimensioned to handle the full power of the vehicle. Therefore, the total weight, cost and size of the powertrain can be excessive.
- The power from the combustion engine has to run through both the generator and electric motor. During long-distance highway driving, the total efficiency is inferior to a conventional transmission, due to the several energy conversions.

#### Advantages of series hybrid vehicles:

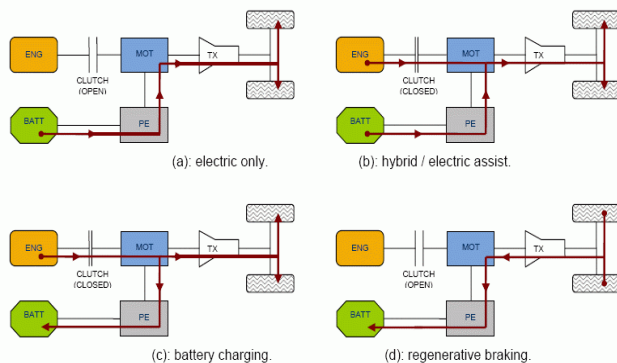
- There is no mechanical link between the combustion engine and the wheels. The engine-generator group can be located everywhere.
- There are no conventional mechanical transmission elements (gearbox, transmission shafts). Separate electric wheel motors can be implemented easily.
- The combustion engine can operate in a narrow rpm range (its most efficient range), even as the car changes speed.
- Series hybrids are relatively the most efficient during stop-and-go city driving.

**Example of SHEV: Renault Kangoo.****2.Parallel Hybrid :-**

Parallel hybrid systems have both an internal combustion engine (ICE) and an electric motor in parallel connected to a mechanical transmission. Most designs combine a large electrical generator and a motor into one unit, often located between the combustion engine and the transmission, replacing both the conventional starter motor and the alternator. The battery can be recharged during regenerative braking, and during cruising (when the ICE power is higher than the required power for propulsion). More mechanically complex than a series hybrid, the parallel power train is dual-driven, allowing both the combustion engine and the electric motor to propel the car. The given fig shows that the I.C. engine and motor operate in tandem. Usually the combustion engine operates as the primary means of propulsion and the electric motor acting as a backup or torque/power booster. The advantages of this are smaller batteries (less weight) and generally more efficient regenerative braking to both slow the car and capture energy while doing so. Another advantage is that it can easily be incorporated into existing vehicle models.

**Operation Modes :-**

The parallel configuration supports diverse operating modes:

**Fig No:- 4**

(Some Typical Modes For A Parallel Hybrid Configuration)

PE= Power Electronic

TX= Transmission

(a) electric power only: Up to speeds of usually 40 km/h, the electric motor works with only the energy of the batteries, which are not recharged by the ICE. This is the usual way of operating around the city, as well as in reverse gear, since during reverse gear the speed is limited.

(b) ICE power only: At speeds superior to 40 km/h, only the heat engine operates. This is the normal operating way at the road.

(b) ICE + electric power: if more energy is needed (during acceleration or at high speed), the electric motor starts working in parallel to the heat engine, achieving greater power

(c) ICE + battery charging: if less power is required, excess of energy is used to charge the batteries. Operating the engine at higher torque than necessary, it runs at a higher efficiency.

(d) Regenerative braking: While braking or decelerating, the electric motor takes profit of the kinetic energy of the he moving vehicle to act as a generator.

Sometimes, an extra generator is used: then the batteries can be recharged when the vehicle is not driving, the ICE operates disconnected from the transmission. But this system gives an increased weight and price to the HEV

**Weaknesses of parallel hybrid vehicles:**

- Rather complicated system.
- The ICE doesn't operate in a narrow or constant RPM range, thus efficiency drops at low rotation speed.
- As the ICE is not decoupled from the wheels, the battery cannot be charged at standstill.

**Advantages of parallel hybrid vehicles:**

- Total efficiency is higher during cruising and long-distance highway driving.
- Large flexibility to switch between electric and ICE power
- Compared to series hybrids, the electromotor can be designed less powerful than the ICE, as it is assisting traction. Only one electrical motor/generator is required.

**Example of PHEV:**

Honda Civic. Honda's IMA (Integrated Motor Assist) uses a rather traditional ICE with

continuously variable transmission, where the flywheel is replaced with an electric motor

### Series Parallel Hybrid

In this type of drive train, it is a combination of the two drive train types, allowing for the vehicle to operate as all-electric (as a series hybrid), as an all combustion vehicle, or as a combination of the two (as a parallel hybrid). This is the most complex and least efficient power train for most applications. Combined hybrid systems have features of both series and parallel hybrids. There is a double connection between the engine and the drive axle: mechanical and electrical. This split power path allows interconnecting mechanical and electrical power, at some cost in complexity.

Power-split devices are incorporated in the power train. The power to the wheels can be either mechanical or electrical or both. This is also the case in parallel hybrids. But the main principle behind the combined system is the decoupling of the power supplied by the engine from the power demanded by the driver. In a combined hybrid at lower speeds, this system operates as a series HEV, while at high speeds, where the series powertrain is less efficient, the engine takes over. This system is more expensive than a pure parallel system as it needs an extra generator, a mechanical split power system and more computing power to control the dual system.

Use of this powertrain system, the overall fuel consumption and fuel economy is improved. Such vehicle would run on fuel but would use its electric motor to boost the power when needed. The costs of HEVs are a little more than the conventional cars but they more efficient and the exhaust emissions are less.

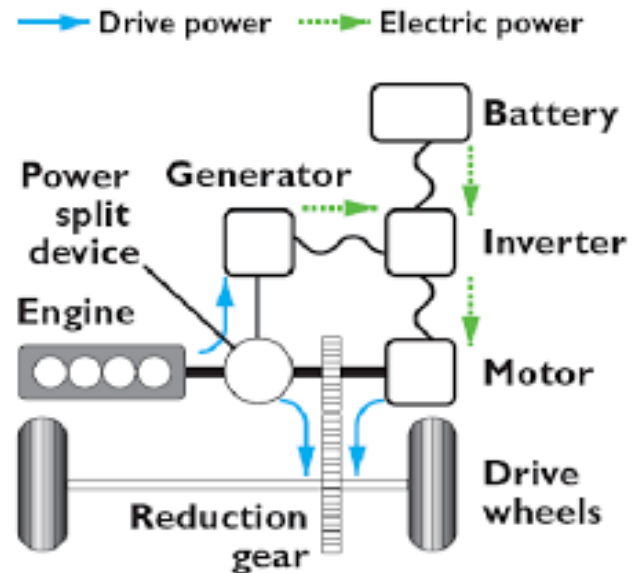


Fig No:-5  
(Series Parallel Hybrid)

#### Weaknesses of combined hybrid vehicles:

- Very complicated system, more expensive than parallel hybrid.
- The efficiency of the power train transmission is dependent on the amount of power being transmitted over the electrical path, as multiple conversions, each with their own efficiency, lead to a lower efficiency of that path (~70%) compared with the purely mechanical path (98%).

#### Advantages of combined hybrid vehicles:

- Maximum flexibility to switch between electric and ICE p
- Decoupling of the power supplied by the engine from the power demanded by the driver allows for a smaller, lighter, and more efficient ICE design.

**Example of CHEV:** Toyota Prius, Auris, Lexus CT200h, Lexus RX400h.

#### Conclusion

Hybrid-electric vehicles (HEVs) combine the benefits of both IC engines and electric motors and can be configured to obtain different objectives, such as improved fuel economy, increased power, or additional auxiliary power for electronic devices and power tools. The transmission of power using freewheels and chain wheels are very cheap and reliable. One disadvantage is that driving

on electric power is not a good option for a long distance travel. Though this combined power train system can become much useful in more stop and go traffic situations. With the use of this powertrain system, the overall fuel consumption and fuel economy is improved. Such vehicle would run on fuel but would use its electric motor to boost the power when needed. The costs of HEVs are a little more than the conventional cars but they more efficient and the exhaust emissions are less.

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**Higher Technical Education and Employment****Dr. Shinde Dnyandeo Dattatraya<sup>1</sup>, Mr. Darshan Baphana<sup>2</sup>**<sup>1,2</sup> Department of Mechanical Engineering, SOET, Sandip University, Mahiravani, Trimbak Road  
Nashik - 422013, IndiaEmail: <sup>1</sup> ddshinde14@gmail.com <sup>2</sup> darshanbafna89@gmail.com**ABSTRACT**

*The Indian education system has to be improved in today's globalised world. This paper focuses on the most recent literature on learning approaches. The goal is to examine the admissions and educational conditions in technical schools. The fishbone diagram technique is recommended for determining the underlying cause of failure, with students as one of the stakeholders involved. Possible solutions for improvement are provided after analysing the causes. A case study of engineering institutes in general is used to conduct a detailed investigation of student-staff issues.*

**Keywords:** Mobile Learning, e-learning, ICT in education

**Introduction**

In a constantly changing country like India, high-quality education is critical to the country's future development. India is currently experiencing a youth bulge. It has the world's greatest youth population, with 600 million people under the age of 25 making up a formidable army. With more than 30 new born per minute, about a quarter of the population is under the age of 14. Nearly half of India's 1.2 billion population are under the age of 26, and the country is expected to be the world's youngest country by 2020, with a median age of 29. If India can modernize and extend its education system, boost educational attainment levels, and provide skills to its youth, it will have a substantial competitive advantage over China. Indeed, India has surpassed China as the world's fastest expanding major economy.

Science and technology are critical to economic progress. Proper education will play a critical role in directing the youth and accelerating economic progress by producing skilled workers, allowing the country's industrial development to move more quickly. It includes topics such as the teaching-learning process, staff and student evaluations/grading, instructional tools, industry-institute interaction, and more. Academic research is used to evaluate faculty and students.

The University Grants Commission is India's primary governing authority at the tertiary level, enforcing its standards, advising the government, and assisting in coordination between the Centre and the states. As of 2020,

India has over 1000 universities, with 54 central universities, 416 state universities, 125 deemed universities, 361 private universities, 7 Institute under State Legislature Act, and 159 National Institutes which include IIMs, AIIMS, IITs, IIITs, IISERs and NITs among others.

Internet lab installations or lectures in the classroom are used in e-learning. The time it takes to get to a specific element of the website, as well as the transit time and availability, are significant. M-learning, on the other hand, is available at any time, anywhere, with no geographical limitations and no travel time thanks to wireless internet access.

**Literature Review**

**Constraints, Challenges, and Uneven Development: Islands of Prosperity amid a Sea of Poverty.**

At the same time, India remains a massively developing country with the world's largest population of poor people, second only to Nigeria. Consider that 45% of India's roads are still unpaved, yet the country is responsible for over a quarter of all new Covid-19 cases. In addition, India has one of the highest rates of child death among children under the age of five. According to the World Bank, India was able to lift 133 million people out of poverty, in 2012.

If current trends continue, India faces separating into parallel communities with different economic realities. In light of these

challenges, it remains to be seen if India can use its youth dividend to achieve inclusive economic development or if population growth would overcome the country. India is actually dealing to educate and employ its rapidly rising population. Around, 27% of the country's youths are not enrolled in school, employment, or training.

The use of mobile devices for education has been revived and recommended by a UNESCO project on the working paper series on mobile learning. The review describes numerous projects that have been used to enhance teaching-learning and language learning through SMS. In India, many teaching initiatives have been implemented successfully. Mobile learning is on the rise, according to the UNESCO paper series. In comparison to computer laboratories and laptops, teachers and students are using smartphones in the classroom. Mobile phones have empowered women and connected them to their communities outside of the house, and M-learning on mobile devices is improving every day.

The journey of e-learning to m-learning discussed herewith the present technical, and development challenges. Involvement of all the stakeholders such as developers, educators, also students playing an essential role.

Pre and post testing are used to further examine the adaptable technique of m-learning for stakeholders with challenges. As a result, these can readily reflect actual university results. M-learning is used in more than only technical fields; it is also used in physical education. M-learning finds its practical use in technical education.

Additional tools like PowerPoint, films for better teaching, and OBE (outcome based education) are used to implement m-learning. The following are some of the different elements that have been employed to influence: (Skill, Time, User-friendliness, Motivation).

### ICT in India

The Indian Government has undertaken various steps for increasing enrollment in higher education and improvement of the quality of education. Multiple activities, schemes are being driven for this purpose.

Ministry of Human Resource Development's mission document reflects the importance of Information and Communication Technology (ICT) to enhance the current enrollment rate in Higher Education. ICT is the tool available. Web portal named "SAKSHAT," is launched by the Indian ministry, and also launched a 'One-Stop Education Portal.' The National Mission on Education through ICT has, under its aegis, created Virtual Labs, Open Source and Access Tools, Virtual Conference Tools, Talk to Teacher programs.

The Various Programs undertaken by the Government of India under ICT are listed below:

**NPTEL** – National Program on Technology Enhanced Learning. Video-based / web-based teaching-learning material of high quality is made available for engineering education, by Indian Institutes of Technology (IIT) and Technical Teacher Training Institutes (TTTI).

**Virtual Labs** - Labs in various disciplines of Science and Engineering get remote-access through this. These Virtual Labs would benefit UG, PG, and research scholars.

**Talk to Teacher** – Live audio-video streaming makes it possible for a large number of learners, from multiple locations, to learn through a single teacher on a real-time basis. An advanced multi-platform, collaborative e-learning solution is provided for this.

**Spoken Tutorial** – It is an online discussion forum.

**CEC** - The Consortium for Educational Communication (CEC), set up by the University Grants Commission of India. It addresses the needs of Higher education through Television with the use of ICT.

**E-Yantra** – To help to shape next-generation embedded systems engineers, undertaken by IIT, Bombay.

**Digital Library InFLIBnet** - Information and Library Network (INFLIBNET) Centre. Aims in modernization and digitization of libraries.

**Quantum and Nano Computing** - Dissemination of knowledge in Quantum-Nano Computing to Industries / Research and Development Organizations and academia.

**ERP** - The ERP mission is to Implement, maintain, improve, and support the County's integrated financial, procurement, human resource, and payroll information systems.

Indian Sign Language Education and Recognition System.

**MHRD** - Ministry of Human Resource Development (MHRD) established for the development of human resources. The Digital Saksharta Abhiyan (DISHA) or National Digital Literacy Mission (NDLM) Scheme formulated to impart IT training.

To transform the entire ecosystem of public services through the use of information technology, the Government of India has launched the Digital India program keeping the vision of "transforming India into a digitally empowered society and knowledge economy" [20].

**The Digital India program** is a flagship program of the Government of India with a vision to "transform India into a digitally empowered society and knowledge economy." Digital India is an umbrella program that covers multiple Government Ministries and Departments. The Government will implement it with coordination done by the Department of Electronics and Information Technology (DeitY). Digital India aims to boost nine pillars of growth areas, viz. Universal access to mobile Connectivity, Public internet access program, Broadband highways, e-Kranti, Electronic Delivery of services, e-Governance, Information for all, IT for Jobs and early harvest programs, Electronics manufacturing.

The project – Mobile and Immersive Learning for Literacy in Emerging Economies (MILLEE) in India investigates how mobile phones find its application to enhance English Language skills, a research-based initiative [21]. The Mobile Vocational Educational Programme (MOVE) for rural India operates through the Sakshat Amrita Vocational Education (SAVE) project [22].

**SWAYAM:** SWAYAM or Study Webs of Active –Learning for Young Aspiring Minds is a program initiated by the Government of India has designed to achieve the three cardinal principles of education policy viz., equity, access, and quality. Keeping the objective to take the best teaching-learning resources to all. SWAYAM courses hosted has four quadrants –

- (1) Audio-video lecture
- (2) Reading material with downloaded or printed options.

(3) self-assessment tests through quizzes and experiment, and

(4) an online discussion forum for clearing the doubts. Massive Open Online Courses (MOOCs) have the tremendous potential to make higher education accessible to India's youth.

M-learning as a tool in technical education

In India, various projects operate under ICT and Digital India. However, the learning observed is more informal than formal learning. Mobile users are increasing day by day. Students from schools and colleges are using mobile, but the applications are games and social media. The use of mobile for formal learning is missing. The use of social media like Whatsup and Facebook is increasing in students. Social messages are being circulated instead of actual knowledge.

As seen in the literature, the size of SMS is one of the challenges in sending study material. For this above mentioned, social media sites and software are readily available. Groups of the students, teachers can be formed for chatting. It is the fastest and readily available mode of communication.

For professional learning, animations can be created based on the concept and working principals and circulated amongst the students. Discussion and doubt solving regarding the animated clip recommended, which will solve the purpose of the assignments. Increase student's involvement in developing the apps and animation with better use of the audiovisual effects for enhancement of the teaching-learning process through organizing various competitions. Training to teachers' and awareness regarding mobile use planned for productive use. It will enable them for effective use of the mobile phone for attendance, circulation of notes, assignments, tutorials, and discussions.

ICT in Sandip University

In terms of the many ICT applications available in India.

Sandip University has taken the lead in incorporating the same into the technical education curriculum across all degrees, beginning with the curriculum pattern and continuing internal assessment scheme. The NPTEL programme has been effectively executed. Students can



access all of the conducted lectures and practicals through the university's e-library. Students can also choose minor courses through online course options based on their preferences and areas of interest.

Additionally, students have the benefit of receiving credit in their specific course after receiving an online certificate of attending the programme. All members of the staff use Google Classroom to upload study materials and related documents such as notes, assignments, and presentations on a regular basis. Online lectures are also encouraged on a regular basis, with the help of students, via Zoom or Google Meet.

## Conclusion

This article discusses the utilization of ICT in the education sector. Due to fast expanding technology in electronics and lower-cost smarter mobiles, E-learning is being transformed into m-learning. It contributes to a shift in perspective from poverty to wealthy. Certain issues in India can be overcome by utilising the Digital India project. By developing education programmes, animations, and approaches, m-learning may be efficiently employed in field of technical education.

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**Design & Development of Alcohol Detection with Safety Braking System****Shelke Gajanan N<sup>1</sup>, Sonawane Samruddha<sup>2</sup>, Taide Jaideep<sup>3</sup>, Rupwate Pranav<sup>4</sup>, Pawar Aditya<sup>5</sup>**

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**ABSTRACT**

The prototype that we have created is to make human help to drive safe and avoid accidents. This prototype is made by combining Arduino board and alcohol sensor ATmega 328 is multipurpose metal microcontroller and can be used conventionally, MQ3 is the alcohol sensor used in which to help detect alcohol in the driver's breath. Alcohol can be scenes from 2 meters by the alcohol sensor. This prototype can go with any of the vehicle it can be.

**Keywords:** Vehicle, Alcohol, Sensor, Braking, Micro controller

**Introduction**

These days most of the accident occurs due to careless or attention less a driving of drivers due to increase industrialisation modern lifestyle, lead to increase in population in urban areas. Many automated systems are being developed to increase efficiency and the attention of the driver in this day. As Well as various techniques have been deployed in vehicles to track the movement of vehicles as well as various systems have been implemented In a vehicle for safety purposes if any kind of accident happened at the location of the vehicle will be transmitted with the help of GSM technology. This automatic system is used to overcome various accidents caused by drowsy drivers and also can be used for security or safety purpose of the driver. Further modifications can be made into system by implementing hardware, algorithms or interfacing sensor. For this problem we can implement many solutions such as speed control using brakes can help you avoid accidents. Project they can develop drowsy detecting alarm to keep driver active while driving. The concept of developing such a system for accident prevention Arises due to people migrating from the rural area due to increase in industrialization in search of jobs which leads to increase in population as well as vehicles on the road. People do violation of laws drinking and driving carelessness due to which we can see the rise in road accidents and

the major role is played by alcoholic drivers. If this Situation can be controlled, then we can see decrease in the number of accidents. An alcohol level detection system for drivers is a step to reduce the accident on the roads. The most dangered are pedestrians which actually face this kind of accidents at a severe level. The system which we have built is an automated intelligent system which helps to overcome this issue. Accidents due to careless drivers who drink and drive due to alcohol motor skills such as walking what functions well and which can lead to rash driving. Which is like putting the life of driver in danger as well as people on roads.

**RELATED EXPERIMENT**

Dhanya K. R. [1] has proposed a technology of an advance automatic braking system with sensor fusion concept. In this they uses the properties of both capacitive & ultrasonic sensor for detecting the obstacle & also for calculating the distance between the vehicle & the obstacle and this distance measurement is used to control automatic braking system for safety application. In this system they use the 32-bit microcontroller with ARM processor (LPC2138) as the brain of this system for controlling process. The programming is done by using c-language. The additional feature included in the system are automatic retarding & automatic horn disabling in restricted area, this is done through RF signal communication. The RF transmitter is placed in restricted area,

where the speed is limited & horn is restricted. RF transmitter placed in the traffic signal, transmit the value of limited speed in km/hr & a signal corresponding for disabling horn and then automatically reduce speed into particular rate & horn is disabling in that area.

S. P. Bhumkar [2] presents a system of about accidents avoidance & detection on highways. This system is about advance technology in cars for making it more intelligent & interactive for avoiding accidents on roads. ARM7 is using for making this system more efficient, reliable & effective. In this system, they have described real-time online safety prototypes that control the vehicle speed under driver fatigue.

The purpose of this system is to avoid accidents. The main component of this system consist of number of real time sensor like gas, eye blink, alcohol, fuel impact sensor & a software is interface with GPS & Google maps APIs for location. Through this research work, they have proposed an intelligent car system for accident prevention & making the world a much better & safe place to live.

Vidyadhar M. [3] presents a system that can enhance the safety of vehicle. This system give solution can assist the driver by warning the driver about impeding obstacle & approaching vehicle that may lead to collision in addition to this they are also implementing & auto retarding system which helps in avoiding accidents. In this system ultrasonic sensor, motor driver and LCD are used. In addition to this, they have implemented an automatic wiper speed control which control speed of wiper is based on the intensity of rainfall. In the wiper speed control system the IR sensor is very sensitive & can detect very small quantities of moisture. In case even slight rainfall the system will get activated, in higher amount of rain the motor faster & will implies the wiper runs faster & save the driver from distraction & provide convenience & safety.

Muqaddas Bin Tahir [4] have Proposed a new technique distance measuring (Hurdle Detection) for safe environment in vehicle through ultrasonic rays. In this system eight ultrasonic sensor are used to sense the different type of object. By implementing a possible improvement in safety system in vehicle, the

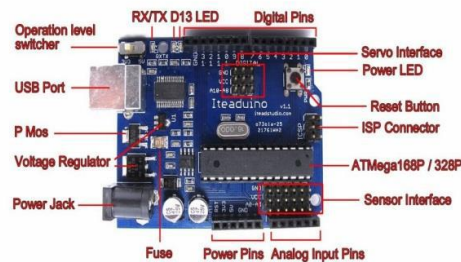
vehicle & sensor will be able to operate normally until the sensor detects possible risk. In this the sensor does not give output or signal until the car comes within 75 feet of an object, at which timer sends information of hurdle to driver. The sensor only indicates the presence of an object; it is up to user or driver to tackle the hurdle.

### Experimental Setup and Procedure

Alcohol detection in vehicle system is continuously growing over years which could resolve drunken driving accidents worldwide. The entire system adopted the Arduino uno microcontroller board (Based on ATMEGA 328 ), the principle of the hardware chart as shown in fig1. The core functions modules are Arduino uno alcohol sensor module (MQ3), buzzer, relay. ARDUINO:- The arduino board is the central unit of the system. all the components are interface to the board and programmed as per their functionality to operate in synchronization . ALCOHOL MODULE:- It is used to sense the alcohol. The analog output of which is applied to the arduino board

### Arduino Board

The arduino board is the central unit of the system. The arduino uno is the microcontroller board based on the ATmega 328. It is a programmable microcontroller for prototyping electromechanical devices.it has 14 digital inputs/output pins (of which 6 can be used as PWM output),6 analog inputs , a 16 MHz ceramic resonators the arduino differs from all preceding board is that it does not use the FTDI USB to serial driver chip.



### FEATURES Microcontroller ATmega328

- i. Operating Voltage 5V

- ii. Input Voltage 7-12V
- iii. Input Voltage (limits) 6-20V
- iv. Digital I/O Pins 14
- v. Analog Input Pins 6
- vi. DC Current per I/O Pin 40 mA
- vii. DC Current for 3.3V Pin 50 mA
- viii. Flash Memory 32 KB (ATmega328)
- ix. SRAM 2 KB (ATmega328)



#### Features:

1. The PS series are high performance buzzers that employ uni-morph piezoelectric elements and are designed for easy incorporation into various circuits.
2. They feature extremely low power consumption in comparison to electromagnetic units.
3. Because these buzzers are designed for external excitation, the same part can serve as both a musical tone oscillator and a buzzer.
4. They can be use with automated inserters, moisture- resistant models are also available

#### Alcohol Sensor (MQ3)

The analog gas sensor- MQ3 is suitable for alcohol detecting, this sensor can be used in a breath analyser. It has a high sensitivity to alcohol and small sensitivity to benzene. The sensitivity can be adjusted by the potentiometer sensitive material of MQ3 gas sensor is SnO<sub>2</sub>, which with lower conductivity in clean air. When the target alcohol gas exist, the sensors conductivity is higher along with the gas concentration rising, use of simple electro circuit, convert change of conductivity to correspond output signal of gas concentration.



MQ-3 gas sensor has high sensitivity to Alcohol, and has good resistance to disturb of gasoline, smoke and vapour. It has fine sensitivity range around 2 meters. The sensor could be used to detect alcohol with different concentration; it is with low cost and suitable for different application.

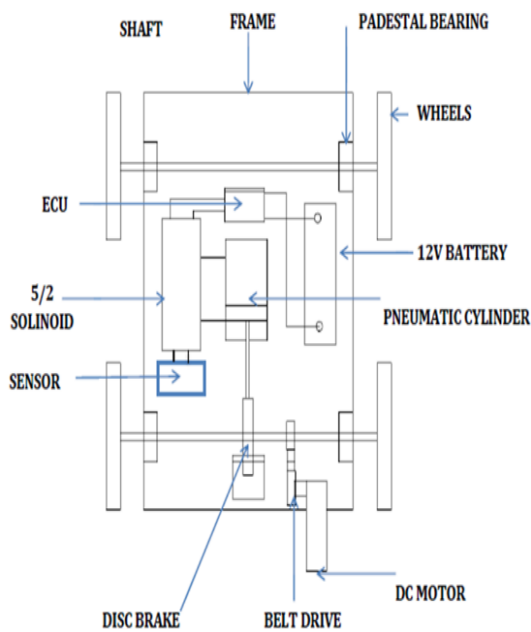
#### Specification:

1. Power supply requires 5 volts.
  2. Interference type: analog only.
  3. Pin specification: 1-output, 2-GND, 3-VCC
  4. High sensitivity and fast response.
  5. Stable and long life
  6. Small towards benzene and High sensitivity to alcohol
- Simple drive circuit with size:40\*20mm

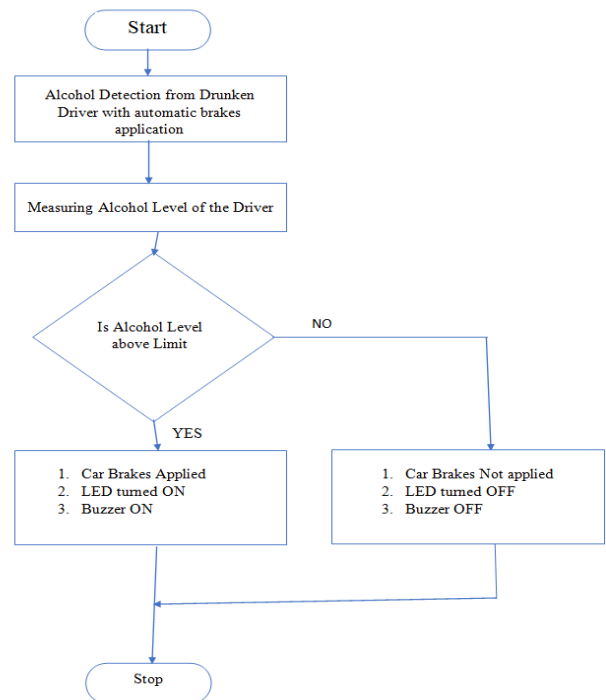
#### c) Buzzer

#### EXPERIMENTAL WORKING

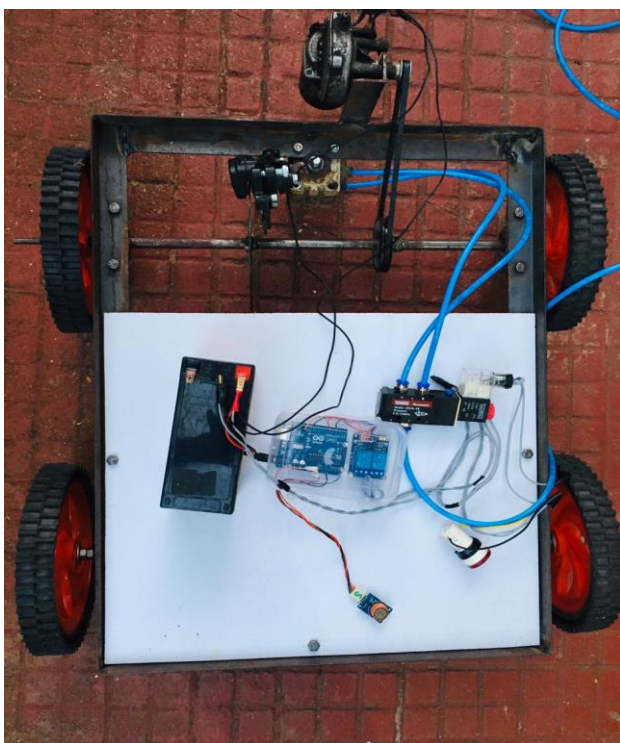
As this system is used prevent the drunk & drive for vehicle safety. In normal travelling of vehicle this system is ON and working. When any driver having drunk & drive then the alcohol sensor senses that drunken condition & the received signal by alcohol sensor is provided to the control unit. This control unit operates the relay according to the input signal and vehicle brake solenoid valve is operate to lock the brake to stop the vehicle. When the brakes are working the motion of vehicle reduces for passenger safety. The complete system working on supply of 12 volt battery supply & electro-pneumatic control.



**Fig.4.1 Concept Model of Alcohol Detection with Safety Braking System.**



**Fig.4.3. Flow Chart of entire System**



**Fig.4.2 Working model of Prototype**

**RESULT AND DISCUSSION**

**Alcohol checking stage**

In this stage, when the car is switched on the system measures the level of alcohol from the driver breath to check whether the driver is intoxicated, slightly drunk and whether if he is extremely drunk. Based on this, the microcontroller only locks the engine when the level exceeds 40% in which case car brakes are applied and the vehicle stops so that the driver can manage to stare the car to the road side.

**Alcohol detection unit**

The alcohol sensor unit has four pins; test pin, vcc, dout and ground. The test pin is used to accept logic signals of 0 or 1 by using logic state pin. The LED is used to show when the sensor detects alcohol, when the logic state is 1 the led goes on (Red) to indicate that alcohol is present and off to show the absence of alcohol.

**FLOW CHART**

<b>Voltage</b>	<b>200- 300ppm</b>	<b>400–500ppm</b>
<b>Output</b>	<b>1 – 1.5V</b>	<b>2– 2.5V</b>
	<b>20 – 30%</b>	<b>40 – 50%</b>

LED Display	OFF	ONN
Alarm	OFF	ON
Ignition SYS	ON	OFF

The graph below shows the output voltages for alcohol detection in ppm obtained with the help of the above readings for different alcohol content samples. The response of the different samples is in parts per million (PPM) vs Alcohol Sensor Operating voltages in Volt.

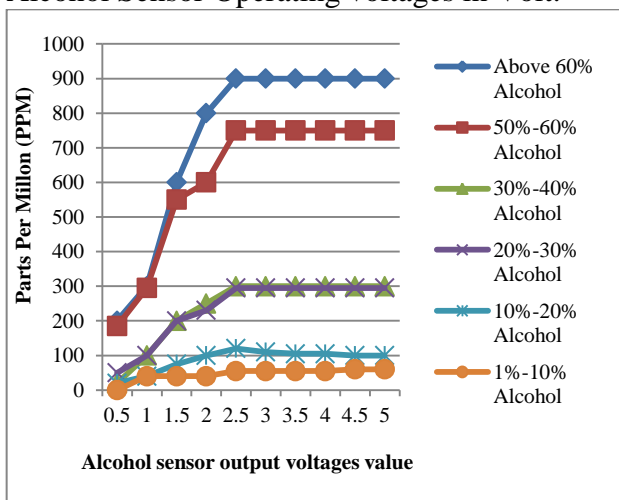


fig no.5.1:Response of ppm (In Percentage) via alcohol sensor output voltages value

**CONCLUSION AND FUTURE SCOPE**

This study suggests that there may be safety benefits from using this technology, such as reduction in stress, decreased lane changes and longer following distances for younger drivers. However, many drivers are not aware of the limitations of their systems, which raise safety

concerns. The misunderstandings evidenced in the study, such as the false assumption that systems will help avoid a collision with a stopped vehicle. Drivers need to be better informed about situations in which their system is unlikely to react. Based on the potential safety benefits and problems more research is needed to determine the overall safety impact of these systems. The future scope of the system is implementation on hardware. We can also include buzzers, indication lights and can set speed by using keyboard and keyboard encoder IC in this system.

Although the design criterions imposed challenging problems which, however were overcome by us due to availability of good reference books. The selection of choice raw materials helped us in machining of the various components to very close tolerance and thereby minimizing the level of balancing problem. Needless to emphasis here that we had lift no stone unturned in our potential efforts during machining, fabrication, and assembly work of the project model of alcohol detection with braking system to our entire satisfaction. Although the design criterions imposed challenging problems which, however were overcome by us due to availability of good reference books. The selection of choice raw materials helped us in machining of the various components to very close tolerance and thereby minimizing the level of balancing problem. Needless to emphasis here that we had lift no stone unturned in our potential efforts during machining, fabrication, and assembly work of the project model of alcohol detection with braking system to our entire satisfaction

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## Implementation of Smart KYC Validation System using CNN based Real Time Face Recognition in Prohibited Premises

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### ABSTRACT

Visitors monitoring and identification in multi-stored building apartments and high rise apartments having population of more than 200 people is a ticklish issue. In such a crowded residence, many visitors are visiting, every now and then for multiple reasons. In most of the Apartment complexes, manual visitor management system is in place. In existing visitor management system it revealed many limitations such as security, accuracy, trustworthiness, time consuming pre-registration by book entry, inefficient monitoring, cross checking for the visiting purpose etc. The e-KYC based visitor identification is the solution for these problems. In this paper, multi biometric based e-KYC system is proposed for identification of the visitors visiting the high rise apartments. This biometrics are captured with camera and matched with KYC linked with Aadhaar database. Correct match will validate the identity of the visitor and his visit date and time will be recorded in the database. The proposed system is developed using a camera, ARM processor and display unit to display visitor's KYC. To develop software for the system, Thonny Python with multi CNN and Facenet is used to process the KYC validity through face image processing. The experimental result showed the successful identification of the visitor after validating person's KYC documents linked to their respective biometrics.

**Keywords:** Face Recognition System, KYC Validation, MTCNN, Triplet Loss.

### Introduction

Know Your Customer (KYC) is a mandatory procedure now days in almost all sectors apart from banking sector. Objective of doing KYC is identify and verify the identity of a person based on independent and assured source of document. Initially identity was used to check by means of the identity (ID) card which requires a photo of the owner, his affiliation, his address with city name and PIN code, mobile number. It is observed that people are using fake ID cards to make a fraud or for any unfair means. In 2010, The Unique Identification Authority of India (UIDAI) introduced the Aadhaar Card as a unique identity proof. Aadhaar is a 12 digit individual identification number which serves as proof of identity and proof of address for residents of India [1]. It is a reliance document which serves as a proof of identity, address and the date of birth of a particular person which can rectify the duplicate and fake identities.

To meet the paperless office expectations and to support Digital India mission campaign, e-KYC is introduced. To deal with the international affairs e-KYC plays a significant

role to reduce the KYC verification period. The biometric linked KYC found a milestone in the identity proofing system. Physical or behavioral characteristics of the human are used as a biometric that is unique for the individual person. Fingerprints, facial patterns, IRIS, voice and typing cadence are some of the biometrics which can be used for the identity of the person. For assured identification of the identity, multiple biometric can be linked and used for the e-KYC. The Aadhaar document is generated by capturing the images of face, eyes (for IRIS) and finger prints and is linked with the address, bank account through PAN document which makes it full proof for the human identification. Biometrics of the child below five years is not considered as it is an incubation period of the child and biometric is not matured enough. With growing age, the biometrics reformed. So, KYC can be done for the person whose age is 18 years or above 18 years [1].

To avoid the financial crimes and other cheating, there are certain measures like, avoid false positives in KYC searches, having regular cross communication and frequently analyses the KYC data. Multiple biometric based

identifications which are linked with KYC documents will avoid the false positives in KYC searches. A smart system, which identifies a person with help of the multiple biometric identifications, is the need of hour.

Visitors monitoring and identification in multi-stored building apartments and high rise apartments having population of more than 200 people is a ticklish issue. In such a crowded residence, many visitors are visiting, every now and then for multiple reasons. In most of the Apartment complexes, manual visitor management system is in place. The security, accuracy, trustworthiness, time consuming pre-registration by book entry, inefficient monitoring, cross checking for the visiting purpose are common issues in the manual visitor management system. The e-KYC based visitor identification is the solution for these problems. In this paper, multi biometric based e-KYC system is proposed for identification of the visitors visiting the high rise apartments.

The Paper is structured as follows: Section II described the concept of face recognition techniques. Section III explained the Facenet and MTCNN model followed by the block diagram, flowchart of proposed system. The experimental set up and its respective results are shown and discussed in Section IV. In the end, the conclusion is provided in Section V.

### Real Time Face Recognition System

Face detection and Face recognition may be a set of Machine learning with a decent variety of analysis topics targeted on improve the prevailing algorithms. This application has several smart options that have several benefits of Face detection and Face recognition in real time. The various step of Face Recognition System is shown in Fig. 1.

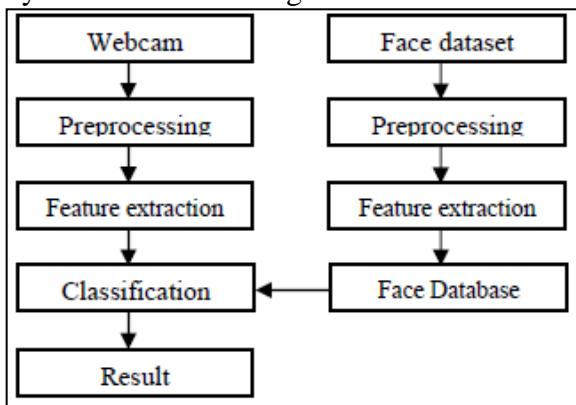


Fig 1: Typical Face Recognition System [2]

This can be an automatic or semi-automated methodology of matching face pictures. Face recognition is that the task or methodology of distinguishing an already detected object as a notable or unknown face, and provides precisely face it's and exploitation for an information of faces to validate this input face. Face detection is distinguishing the thing of face and find as an input image. There are researches on the sensible camera conception, wherever algorithms and technology area unit embedded into camera device to find external body part to straightforward the most in term of process and performance.

The connected work on this projected system has exceptional variety of technologies that takes user towards Jose et.al introduced Face Recognition primarily based closed-circuit television exploitation FaceNet and MTCNN rule on Jetson TX2 [3].

Tharmila et.al introduced to develop a system for face detection and recognition within the real time which will be economical and provides answer for several issues. The system was developed exploitation C# .Net programming, Viola-Jones rule (Haar Cascade Classifier), PCA (classified as either feature primarily based and image based) and EmguCV (Computer vision Library and wrapper category of Open CV) in [4].

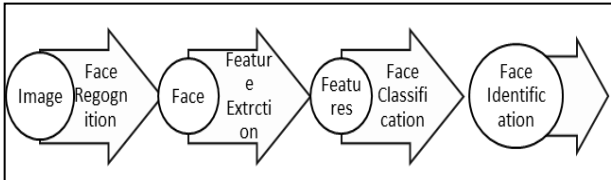
Dahake and Mandaogade introduced an easy and straightforward hardware implementation of face detection system exploitation Raspberry Pi. The system is programmed exploitation Python artificial language in [5]. Maliha Khan and Sudeshna Chakraborty introduced a camera-based period face recognition system and set a rule by developing programming on OpenCV, Haar Cascade, Eigenface, Fisher Face, LBPH, and Python [6]. Authors in [7]-[15] introduced face detection exploitation using Raspberry-pi board for various real time applications.

Based on various face recognition system, it is observed that most of the researcher worked on standard datasets available with them which is insufficient to validate the systems in prohibited premises such as residential apartments, child care center, worship places, stadium etc. Our main contribution is to develop a real time face recognition system with KYC validation by the support of Unique

Identification Authority of India, Government of India (GoI). The main objective is to avoid false detection using multiple biometric based face identification and to develop contactless visitor registration system to avoid contamination in COVID pandemic.

**Proposed Methodology**

Visitor Face recognition and identification is the main element of this research work. It is achieved in multiple steps. The Fig. 2 shows pipeline of our proposed system.



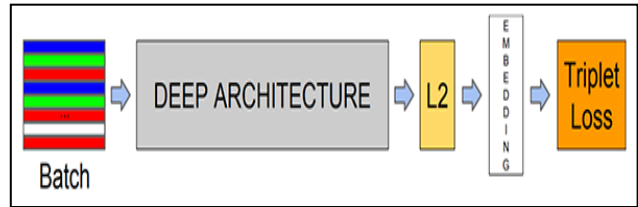
**Fig 2 :Face Recognition Pipeline**

There are three main components of proposed system viz. Face detection, Feature extraction and Face classification. Face detection detects one or a lot of faces in a picture. Feature extraction extracts the foremost necessary options from a picture of the face. Face classification classifies the face supported extracted options. In this paper, MTCNN model is used for face detection, FaceNet model is used for feature extraction and for classification exploitation SoftMax is employed.

*FaceNet Model*

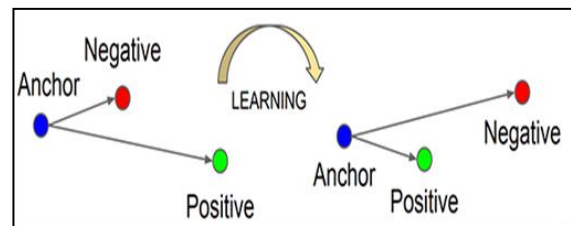
Google researchers introduced Facenet around 2015, using Deep Learning Convolutional Network for face recognition. FaceNet model created is trained for triplet loss to capture the similarities by measuring the Euclidian distance and variations on the image’s dataset provided. FaceNet embedding as a feature vectors, functionalities like face recognition, and verification may well be enforced once the making the vector house [1].

Fig. 3 shows typical structure of FaceNet Model. The captured images are fed to the deep learning architecture and then normalized as L2. Extracted features (embedding) are trained using the Triple Loss.



**Fig 3 : FaceNet Model for Face Recognition [2]**

Triplet Loss method is illustrated in Fig. 4 which arranges similar images closer and different images farther. If the sample is positive, the gap is decreased and signifies an equivalent identity; similarly, gap will be decreased if the sample is negative that signifies a special identity is maximized.



**Fig 4 Triplet Loss [2]**

Thus, triplet loss is one in all the simplest ways in which to be told smart 128-dimensional embedding for every individual faces. Here the anchor image refers to the reference image that will be taken from that dataset so as to calculate the triplet loss. For calculate a triplet loss, we have three images associated with anchor, a positive and a negative image.

*Multi-task Cascaded Convolutional Neural Networks (MTCNN) Model*

MTCNN is one of the most popular and most accurate face detection tools today. MTCNN algorithm or formula is used for to discover face thus works in three steps and uses one neural network for every method. The initial half could be a proposal network which is able to foreseen potential face positions and their bounding boxes sort of a network in quicker R-CNN. The results of this method could be a sizable amount of face detections and reduce the false detections. MTCNN is very useful as it can run real-time even on small devices. There have been many algorithms after MTCNN but still it remains one for frontal face detection.

Figure 5 shows the block diagram of the proposed system and working is demonstrated with the flow chart which is shown in Fig. 6. The Arm Cortex M1 processor is used for

various image processing operations. The camera captured real time images and then image is read by using OpenCV. It is an open-source computer vision & machine learning library. For this proposed system Thonny Python as the programming language used for the facial recognition system source code. After that face detection using MTCNN, face embedding with triplet loss and then face recognition with cascaded classifier. In this proposed system face recognition is done with the help of FaceNet algorithm, and storing the recognized face for further analysis. If the face is matched with the stored database, then the output or result on the LCD screen shows visitors Name, Aadhaar number, in time out time and Date. When the face is not matched with the stored database, then the output or result shown on the LCD screen is “unknown”.

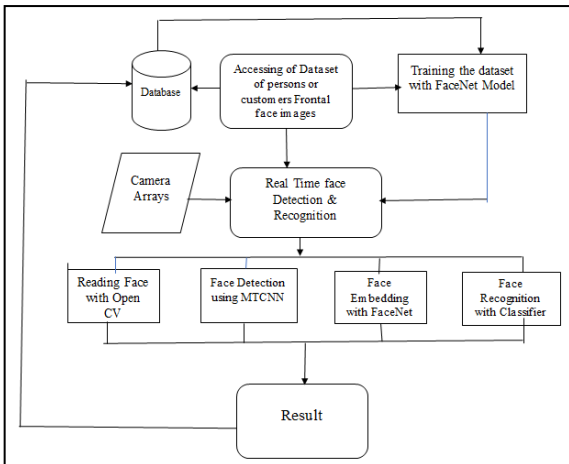


Fig 5 :. Block Diagram of Proposed System

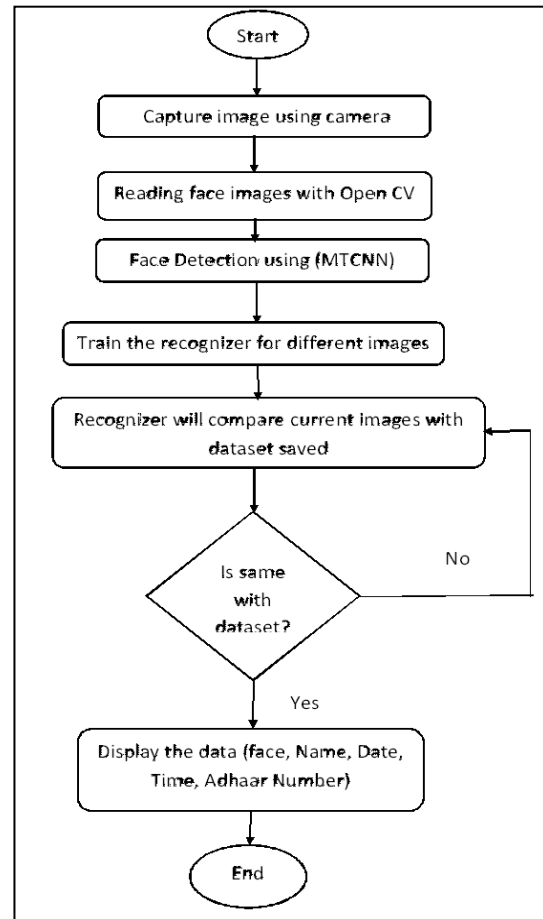


Fig 6: Dataflow of Proposed System

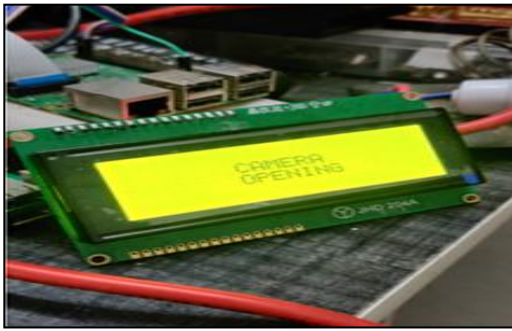
**System Performance**

The experimental setup consists of ARM Processor, camera and LCD which is shown in Fig. 7.



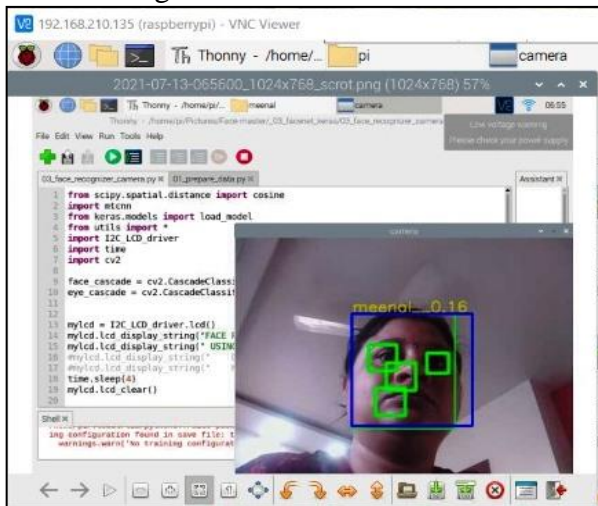
Fig 7 :Experimental Setup

The performance of proposed system is tested by means of the various hardware parts like camera and LCD which is shown in Fig. 8.



**Fig 8 .Testing of Imaging Sensor**

When any visitors come in front of camera in the premise, then the face is detected using MTCNN model as shown in Fig. 9. The features are extracted and recognized using FaceNet. If the visitor is resident or known person in the premises, then it showed the KYC details of the visitor on the LCD display and in this way the identification is validated as shown in Fig. 10.



**Fig 9 .Real Time Face detection using MTCNN Model**



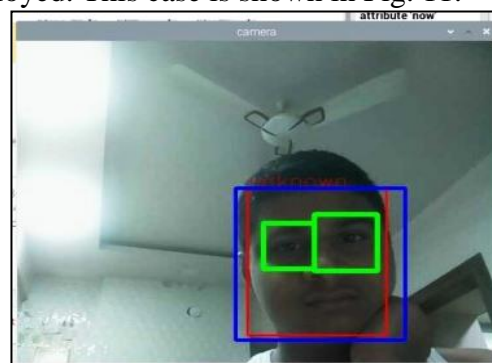
**Fig 10 : Identification of Aadhar and PAN Card details of Visitor**

We have developed the linking of KYC details of person who is resident in housing apartment and based on it the contactless visitor in-out management system is tabulated in Table 1.

**Table 1: Results of Visitor KYC Details**

Name of Face Identifie d Visitor	Aadhar Number	In Time	Out Time	Date
Minal Patil	xxxxxxx 5478	08:30	18:30	30/05/ 21
Sujal Patel	xxxxxxx 5006	09:00	16:00	08/06/ 21
Mayur Mahajan	xxxxxxx 6932	07:00	19:30	14/06/ 21

For new person or intruder, the identification will not be validated unless its KYC details are furnished at center where this prototype has deployed. This case is shown in Fig. 11.



**Fig 11: Real Time Face Recognition of Unknown Person**

The system showed the red colour box by extracting various features from image and using FaceNet, it showed unknown person whose KYC details have not verified and is considered as unauthorized user in that particular premises.

**Conclusion**

We investigated various real time face recognition technique in this paper. We developed proposed system through Face detection using MTCNN, face embedding with FaceNet and face recognition using classifier method. The hardware setup is implemented by using ARM Processor and imaging sensor is used to acquire real time images. The complete setup is deployed in prohibited premises and visitors are monitored and their KYC details are verified. This system is touch-less, fewer complexes and inexpensive which is very effective in COVID-19 pandemic situation to avoid contamination. Further, this system will be integrated with real time database of Aadhaar to obtain effected results.

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**Energy Audit of Boys Hostel (B-1) at Sandip Foundation, Nashik- A Case Study****H. R. Kulkarni<sup>1</sup>, Mrs H H Kulkarni<sup>2</sup>, Abhijit Surve<sup>3</sup>, Rahul Mahale<sup>4</sup>, R.P. Rajput<sup>5</sup>**

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**ABSTRACT**

*The electrical energy is used all over the world due to its huge applications. This makes maximum demand all over the world. India falls under the category of developing country. It has maximum electrical energy demand during peak hours, when compared to the generation of electrical energy it is not enough. Here we can say that our supply side management is not fulfilling the demand. At consumer level we have to develop awareness on saving of electrical energy as well as we must use electrical energy in efficient way. In this paper authors have audited electrical load of the boy's hostel, of an educational institute.*

**Keywords:** Energy audit, Energy conservation, Energy management, Payback period.

**Introduction**

Sandip Institute of Engineering and Management, is one of the premier institutes of Sandip Foundation. We author of this paper are studying in third year electrical engineering and are part of this institute. The Energy conservation is very important and concerned topic for all engineers. During our stay in hostel, we have worked and given few suggestions to conserve the energy to concerned authorities. An electrical energy audit is conducted at Hostel B1, the energy calculations for light, Fan and other appliances are shown and few suggestions are presented. This paper is organised as objectives, connected load calculations and data collections, calculation of energy consumptions, energy bill calculations, analysis, recommendations, payback calculations and conclusion. Recommendations like capacity addition in solar water heater system, replacement of water cooler with new energy efficient one need to be addressed with immediate effect.

**Objectives**

Following are the objectives of our energy audit for energy conserving program:

1. To minimize the energy wastage so that the energy bill will be reduced.
2. To overcome the energy wastage without affecting facilities and need of students.

3. Highlight the areas of energy wastage and estimation of energy saving scheme.

4. To achieve positive environmental effects.

**Energy Audit**

An energy audit is recommended to determine the energy consumption associated with a facility and the potential savings associated with that energy consumption [1]. From a general point of view, an energy audit provides enormous benefits in different areas:

1. It reduces energy costs in your target place.
2. It reduces the dependency on external energy sources.
3. It makes the place environment friendly and reduces pollution.
4. Consumption of natural resources can be reduced.
5. It helps reduce the impact of greenhouse gas emissions.
6. It helps you to lower energy bills.
7. It enables you to increase the comfort of those in the facility.
8. It helps in enhancing the life span of the equipment in your facility.
9. It throws light on any unaccounted consumption that may exist at the facility [2].

Thus, an energy audit can identify energy consumption and energy costs of the building/facility and it can improve to develop measures to eliminate waste, maximize efficiency and optimize supply energy. Three



key factors are improved through the energy audit: Profitability, Productivity and Performance [3]. Energy audits are of two types,

**Walk through audit**

The walkthrough audit is also called as simple audit. It is quickest type of audit. In walk through audit first collect the information about the building, means it layout or blue prints. In this audit get the interview of site person, collect bill and utilised this properly. In this type of audit only major areas are uncovered. Above type of audit is not sufficient to take the final decision on implementing a proposed measure [2].

**Detail Audit**

The Detail audit is also called as comprehensive audit. This detailed audit method is an accurate method for energy saving. This energy audit consists of a detailed walkover to identify the energy profile of the building by a detailed survey and technical visit. Detailed audit provides the most precise estimate of energy saving and cost. Collect the all data of the building and taking the detailed audit analysis of action plan and scheduling the implementation process [4,5].



**Fig. 1 Outer view of B1 hostel building**

Fig. 1 is the photograph of the hostel B1. Here we can see the area covered by the hostel. This is a three-storey building having total 20 rooms

on one floor, in all 60 rooms are there. It has common wash room block per floor. It consists of one office for attendant, one TV/Indoor Game facility centre at ground floor. There is a laundry facility on top floor with washing machine and ironing facility.

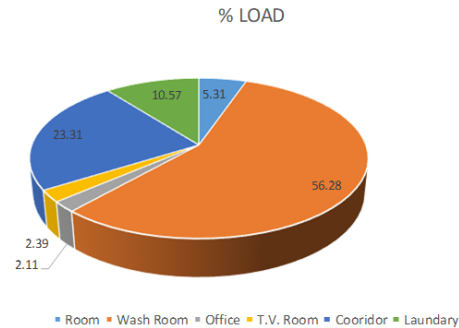
**Load Calculations**

Table 1. represents the total load calculations for hostel block B1, here the equipment are separated and the calculations are presented for the all equipment taken together. Few types of equipment have different ratings as we have policy such that, we replace the damaged or fused equipment with new energy efficient equipment to conserve the energy. TV hall is having a one flat television with power ratings of 180 watts and to maintain sufficient natural lighting conditions two tube lights and two fans are fixed in this room. Table1. Shows the detailed calculations of load connected and load calculations. It also gives total energy consumption for the hostel block B-1.

**TABLE 1: Total Load Calculation For B1 Block**

Items	Equip ment Used	Pow -er rati ngs	Dail y Usa ge Tim e in Hrs	Powe r Cons u- med Per Day in Watt	Powe r Cons u- med Per Mont h in Watts
Total No. of Room s =60	Fan	60W	12	720	21600
	Fluores cent light	20W	8	160	4800
	Fluores cent light	10W	3	30	900
	Mobile chargin g	15W	3	45	1350
	Laptop	65W	2	130	3900
	Night lamp	10W	7	70	2100
Total no.	Water heater	3000 W	4	1200 0	36000 0

of wash room =3	Fluorescent light	20W	12	240	7200
Office	Fan	60W	5	300	9000
	Fluorescent light	20W	8	160	4800
Television Hall	Fan	60W	2	120	3600
	T.V.	180W	2	360	10800
	Fluorescent light	20W	2	40	1200
Corridor	Fluorescent light	20W	12	240	7200
	Water Cooler	1550W	3	4650	139500
	CFL	15W	12	180	5400
Laundry	Washing machine	1300W	1	1300	39000
	Iron	1000W	1	1000	30000
	Fluorescent light	20W	2	40	1200



**Fig 2. Comparative consumption chart of Hostel B-1.**

**Energy Bill Calculations**

We have tabulated energy consumption calculations by each load from the data collected from site actually in Table 2. The hostel load is considered as residential load due that that the rate for per unit consumption is Rs5.60. This helps to get an actual energy consumption cost of equipment. At the end of the table we get actual amount of electric we get actual amount of electric energy consumption. Using the tariff declared by MAHADISCOM, the electricity charges are calculated [6-8].

Fig.2 represents the comparative energy consumption. Here we can understand that the energy consumption for the wash room area is very high that is about 56.28% and the very less that is 2.11 % for the office room for the block B-1. As per observations, all the wash rooms has in all six electric geysers, with 3000watts each. The utilisation of the hot water is more and the geysers used are of higher wattages hence the consumption observed under the head of common room is more. Laundry room has also both types of load, washing machine and Ironing, its wattage is 1300 watts and 1000 watts respectively. As per the regulations the washing machine is used only for 1 hour per day and ironing is also done only for an hour.

**TABLE- II. TOTAL Energy Cost Calculation For B1 Block**

Items	Equipment Used	Energy Consumed by an equipment (Units)	Total Energy cost of equipment per month	No. of equipments (QTY)	Total Energy cost per month (Rs)
Total No. of Rooms =60	Fan	216	1209.6	60	72576
	Fluorescent light	4.8	26.88	120	3225.6
	Fluorescent	0.9	5.04	90	453.6

	light				
	Mobile charging	13.5	75.6	180	13608
	Laptop	39	218.4	40	8736
	Night lamp	21	117.6	60	7056
Total no. of wash room =3	Water heater	360	2016	6	12096
	Fluorescent light	7.2	40.32	15	604.8
Office	Fan	9	50.4	1	50.4
	Fluorescent light	4.8	26.88	3	80.64
Television Hall	Fan	3.6	20.16	1	20.16
	T.V.	108	604.8	1	604.8
	Fluorescent light	1.2	6.72	3	20.16
Corridor	Fluorescent light	7.2	40.32	12	483.84
	Water Cooler	139.5	781.2	3	2343.6
	CFL	5.4	30.24	75	2268
Laundry	Washing machine	39	218.4	1	218.4
	Iron	30	168	1	168
	Fluorescent light	1.2	6.72	2	13.44
<b>Total energy cost per month =Rs.1,24,627.44/-</b>					

**Recommendations**

**Ceiling Fan**

The total no. of ceiling fan = 63 nos. Here initially we recommend replacing of only 10 ceiling fans in hostel, which are old and not giving proper output, to reduce the initial cost on new energy efficient fan.  
Old ceiling fan calculation

$60w * 10nos * 12hrs * 30 / 1000 = 216$  unit per month  
 $216 \text{ unit} * 5.6Rs = Rs. 1209.6/-$   
 Energy efficient fan calculation:  
 $28w * 10nos * 12hrs * 30days / 1000 = 100.8$  unit per month  
 $100.8 \text{ unit} * 5.6rs = Rs. 564.48/-$   
 Monthly Saving =  $1209.6 - 564.48 = Rs. 645.12/-$

**Tube light T1**

the total no. of tube lights =153nos. here initially we recommend to replace only 10 tube lights in hostel. Old tube light calculation:  
 $20w * 10nos * 8hrs * 30 \text{ days} / 1000 = 48$  units  
 $48 \text{ units} * 5.6rs = Rs. 268.8/-$   
 Energy efficient T bulb calculation  
 $12w * 10nos * 8hrs * 30days / 1000 = 28.8$  units  
 $28.8 \text{ units} * 5.6rs = Rs.161.28/-$   
 Monthly saving =  $Rs.107.52/-$

**Fluorescent Tube T2**

The total no. of fluorescent tube for study table = 180nos  
 Old fluorescent tube calculation  
 $10W * 10nos. * 3hrs * 30days / 1000 = 9$  units  
 $9 \text{ units} * 5.6rs = Rs.50.4/-$

**Geyser**

Total no of geyser= 6nos.  
 Old geyser calculation  
 $3000w * 2nos * 3hrs * 30days / 1000 = 540$  units  
 $540 \text{ unit} * 5.6rs = Rs. 3024/-$   
 Energy efficient geyser calculation  
 $2000w * 2nos * 3hrs * 30days / 1000 = 360$  units  
 $360 \text{ units} * 5.6rs = Rs. 2016/-$   
 Monthly saving =  $3024 - 2016 = Rs. 1008/-$

**Water Cooler**

During data collection we observe water cooler which is used, is not in good operational condition. Due to that we recommend to replace it, with new energy efficient water cooler. Model of NST80120B brand Blue star which consumes only 3.8A current and wattage is 820 wattage 120 litre of capacity.  
 Old Water cooler calculations.  
 $1550W * 1nos. * 4hrs * 30days / 1000 = 186$  units  
 $186 \text{ units} * 5.6 Rs = Rs 1041.6/-$   
 New water cooler calculations:

820W\*1nos.\*4hrs.\*30/1000=98.4 units  
 98.4 units\*5.6Rs=Rs 551.04/-  
 Saving of cost  
 1041.6-551.04=Rs 490.56/-  
 Cost of new one =30000/-

### Pay Back Period

#### 1. Ceiling Fan:

Monthly Saving = 1209.6 – 564.48 = Rs. 645.12/-  
 Investment on 10nos energy efficient ceiling fan = 3046\*10 = Rs. 30460/-  
 Payback period = 30460/645.12 =47.21 months = 4 year approximately

#### 2. Tube Light:

Monthly saving = Rs.107.52/-  
 Investment on 10nos energy efficient T bulb = 220\*10 = Rs.2200/-  
 Payback period = 2200/107.52 = 20 months  
 Investment on 10nos Solar study lamp = 400\*10 = Rs. 4000/-  
 Annual saving = Rs.604.8/-

#### 3. Geyser:

Monthly saving = 3024 – 2016 = Rs. 1008/-  
 Investment on two geysers = Rs.6400\*2= Rs.12800/-  
 Payback period = 12800/1008 = 13 months.

#### 4. Water cooler:

Saving of cost =1041.6-551.04=Rs 490.56/-  
 Cost of new one =Rs.30,000/-  
 Energy and Payback Calculations:  
 Total Investment in Rs.

Ceiling fan = 30460  
 T bulb = 2200  
 Solar lamp = 4000  
 Geyser = 12800  
 Water cooler = 30000  
 Total = Rs. 79460  
 Total Savings in Rs per month  
 Ceiling fan = 645.12  
 T bulb = 107.52  
 Solar lamp = 50.4  
 Geyser = 1008  
 Water cooler = 490.56  
 Total = Rs. 2301.6

**Overall payback period = 34.52 months**

### Conclusion

Day by day the electric energy consumption is increasing and the economy of the Industrial sector is hampered. Wastage of energy is also a concern and every stakeholder must try to reduce or stop the energy wastage. In the above work, energy calculations for B1 hostel of Sandip foundation are considered. The recommendations for every appliance used are expressed. The suggestion for water cooler is that, it must be replaced by new Energy Efficient water cooler. If the recommendations are followed then total energy bill for the hostel B1 of Sandip foundation may reduce about 41.14%. The overall payback period for the hostel B1, is approximately 35 months if all the recommendations are implemented as it is.

### Acknowledgement

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**IOT Based Women Safety Device****Prof. Patel Jagdish A<sup>1</sup>, Srushti Dusane<sup>2</sup>, Saloni Thorat<sup>3</sup>, Mayuri Pawar<sup>4</sup>**<sup>1</sup> Assistant Professor, E&TC Engineering Department, SITRC, Nashik, Maharashtra, India<sup>2,3,4</sup> Students, E&TC Engineering Department, SITRC, Nashik, Maharashtra, India**ABSTRACT**

Nowadays women are facing many security problems in the society. In such cases, they feel handicap and need help to protect them. Even though many technologies have been introduced for women still kidnapping, eve teasing and sexual harassment are taking place in our country. When the women face into unsecured situations, to ensure the safety, automatic detection system needs to establish which send an alert message which includes the location. This can be done by sensing various factors such as abnormal sounds, body reaction like trembling, dreading and heartbeat which can be sensed using sensor and to provide the alert message, with the help of Internet of Things (IoT). In this paper, we surveyed the existing mechanism for detecting locations, for sending communications and collecting physical parameters of the human body using sensors.

**Keywords:** Automatic detection system, Internet of Things (IoT), sensors.

**INTRODUCTION**

Internet of things (IoT) is influenced with human life in both knowingly as well as unknowingly. With a help of internet every machine is controlled, which makes the people life easier. Women are the backbone of any economy primarily shaping future of the country. She who earlier stayed at home to attend her domestic duties is now maintaining work and home simultaneously, participating in the process of economic development on an equal footing with men. Security is the condition of being protected against danger or loss. In the general sense, security is a concept similar to safety. Individuals or actions that encroach upon the condition of protection are responsible for the breach of security. There is no denying the fact that women in India have made a considerable progress in almost seven decades of Independence, but they still have to struggle against many handicaps and social evils in the male-dominated society. Women safety is one of the major issues in today's world. The world is becoming so much unsafe for women. Even though many technologies have been introduced for women still kidnapping, eve teasing and sexual harassment are taking place in our country. With the onset of IT&BT industry, women work in night shifts. It is the responsibility of the firm to provide office transportation to such employees. Now a days even though the companies provide the facilities for

transportation, but the security of the women is not fully ensured as one of the incidents occurred in the year 2007 at Pune where a girl working in the Call Center was brutally raped by two of her cab drivers assigned by the company, not only this we have come across many of the same incidents in the recent times where the safety of the women cannot be fully ensured with the cab facilities provided by the companies.

The only solution to the problem can be taken in a such a way that, women should be assigned with a safety gadget that is portable and ensures her safety. Our project focuses on providing a Smart gadget based on IoT solutions that not only helps to woman escape the critical situations but also ensures to provide justice to the women by capturing the image of the culprit if in case any harassment occurs.

The main contributions of this review paper are as follows:

- Highlighting the problems related to security of women.
- Discussing the role of IoT in transforming the lifestyles of people.
- Providing survey and technical assessment using electronics and IoT.
- Providing insight into Automatic detection system.

## WOMEN SAFETY RELATED FACTORS

There are several techniques that used in women safety device:

- Location tracking
- Notification
- Sensors
- Image Capturing

### A. Location tracking

GSM stands for Global System for Mobile Communication. It is a digital mobile cellular network which has been used for transmitting the voice and data SIM 800C is a complete Quad-band GSM solution. It operates in low power consumption with a voltage range of 3.4v~4.4v. It gives an efficient transmission when compared to other types. GPS is a technique which is used to find out the actual position of the person. It communicates directly to the satellite by using the GNSS network.

### B. Notification

With the help of GPS and GSM the location is identified. And thus, the identified location is shared to the people through SMS, Email ID, calls Etc. With the help of buzzer an alarm sound is generated, through this sound the people who are in minimum distance can help them.

### C. Sensors

Sensor is a device which calculates or discovers a physical property that indicates, or otherwise it responds to the specific devices. There are several types of sensors which are used to measure several conditions; some of the sensors are detected by using various physiological sensors namely: Heartbeat sensor, Temperature sensor, Ultrasonic sensor-

- a. Heartbeat sensor- Heart beat sensor finds the pulse rate. It has infrared light emitter diode and detector arranged side by side in a leaded package which blocks the surrounding ambient light which may affect the sensor performance. Working on the principle of IR reflection by blood, this sensor keeps a count of woman's heartbeat. It is used to measure the speed of

heartbeat; this sensor can be placed in any nerves of human body. Usually, the output is in analogue format. Hence it can record the change in the heartbeat.

- b. Temperature sensor- Temperature Sensors calculate the amount of heat energy or even coldness which is generated by an object or system, for to "sense" or detect any physical change to the temperature producing an analog or digital output. This sensor keeps a track of woman's body temperature and sends the generated analog data to controller. It used to measure the amount of heat energy produced by an object or human body, it produces an output in analogue format, a formula is used to convert the analogue signal into the temperature of human body.
- c. Ultrasonic sensor- An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e., the sound that humans can hear).

### D. Image Capturing

The video camera is used to capture the image or video in order to send the photos or videos to the registered contact for the later Investigation. It is done by using Raspberry Pi Camera Module.

## LITERATURE SURVEY

In a country, Sexual offense happens against to the women and children. According to National Crime Records Bureau, New Delhi;

1. In 2011, over 42968 the criminal assault to women has

Reference Paper	Contributions	Limitations
Design and Development of – Suraksha[7]	The nearest police station gets a location alert when distress happens to a Woman.	Even though the location alert is sent to the nearest police station they might take some time to reach the spot.
Smart Foot Device for Women Safety [8]	A small foot wearable device is developed. It consists of a light blue bean microcontroller, when the tapping sound occurs four times it sends an alert message to the emergency connects through the Bluetooth.	The speed of the light blue bean microcontroller is minimum.
Women Safety Device and Application [9]	A button pressing device is developed for the emergency people with a single, double and a long press	If the network is not available then the message is not sent to the preset contact.
A Mobile Application for Women’s Safety: WoSApp [10]	A notification is sent to the enlisted contact when the person shakes their phone for about 8 second or pressing the panic button.	This application is not supported to windows, iOS mobile phones.
Research and development of a mobile based women safety application with real-time database and data-stream network [11]	An application is developed with unique feature for security purpose. Initially it requires a login details for authentication purpose. Only if the person is authenticated can use this app. It provides security from third parties.	Even though it is a security application at the time of emergency they can’t login and provide their information.

increased to 84746 cases in 2016.

2. Around 309 acid attack cases are produced in the year 2014.

3. In 2011, 24206 rape cases have been enlarged to 38947 cases in 2016

4. According to these statistics, around 92 women are raped every day in India.

Suraksha[1] is a stand-alone device which can be triggered in three ways either voice, switch, and shock/ force. Voice is the voice of victim. The device will recognize it and automatically send distress messages. Switch is a simple on/off trigger, and shock/force- whenever this device is thrown it will use force sensor to start functioning by giving the information of the location of the victim to her members of family and friends.

A self-defense women safety system [2] is proposed which when triggered by a switch, automatically sends the location of the victim to their concerned one. In addition, the device will also play a prerecorded message using speech circuit to alert the surroundings.

SMARISA [3] is a portable device for women safety. It comprises of hardware components

such as Raspberry Pi Zero, Raspberry Pi camera, buzzer and button to activate the services. It is activated by the victim by clicking the button. Upon clicking, the current location of the victim is fetched and the camera captures the image of the attacker which are then sent to police or predefined emergency contact numbers via the victim’s smart phone. HearMe: An application that includes lock screen access and instant siren on the receiver device and can be accessed through hardware buttons to facilitate quick access to the woman [4].

Femme: It consists of a device and a smart phone that are synchronized using Bluetooth, which triggers the instant location to the registered contacts and includes audio recordings [5]. Abhaya app: It is an android app which was mainly developed for women safety that provides instant location to the registered contacts by pressing a single power button in the phone [6].

### CONCLUSION

The occurrence of threats to women leads to increase in number of security devices and applications. This research shows the various factors which have been used in applications



and smart devices developed for women safety. In this paper, the various techniques used so far for the sake of women safety against the fraudulent people have been discussed.

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## Public Garden Automation Based on Solar Panel

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### ABSTRACT

*Internal of things is a bridge between human & devices. In this paper automation of watering to cops & water tank has to be implemented. In this world automated technology takes place everywhere. For the aspect of making all system better, this system is designed for garden maintenance.*

*Nowadays misusage of electricity & water resources is a main problem. Sometimes due to carelessness of authorities, lamps are left ON which causes wastage electricity. Water wastage is another problem. To overcome this problem, our project helps to save electricity & water resources. Firstly microcontroller switches around 4:00pm, doing water supply to drinking water the gardens few hours before opening of garden for public. The garden gate is opened by running the motor unit which is driven by motor driver. Around 6:00pm, Lights are switches on depending on the output of LDR. Garden stay open for approximately 3 hours & by 8:40pm buzzer is sounded to point closing of garden & alert to visitors. The garden gate is closed at 9:00 & one of the two lamps is switches off. In morning all lamps are off depend on LDR result. Microcontroller is employed to control all actions of other devices.*

**Keywords:** Microcontroller ATMEGA32, soil moisture sensor, LDR, L293D motor

### I. INTRODUCTION

This paper aims into practice of the overall automation of general public garden using Microcontroller ATMEGA 32. The project will help to avoid the mistreatment of electricity and normal water in the public garden. Sometimes due to negligence of the authorities and the personal lights were left on which results in wastage of electricity. Water wastage is yet another problem which needs to deal with. Humidity sensor is employed to measure the humidity but it will surely give the voltage outputs which is applied to signal and health circuit and then applied to the microcontroller. All of us are using humidity sensor which will measure the water content in the soil and water resource time will be tweaked accordingly water content in the soil. This will avoid unnecessary hydrant during the rainy season. The gates of the garden are also opened and closed according to preened timings. The gate will be opened by motor unit which is manipulated by the microcontroller. Lights will be switched on depending after the intensity of the natural light and the lights remain functionally right up until your garden remains wide open. The garden will be closed at around on the lookout for 09:00 p.m. For around 08:50 p.m private message at buzzer will show closure of your garden and alert the site

visitors. The gate will be then closed on the lookout for 09:00 p.m and lamp will be switched except a few. Microcontroller can be used to control entire functionality.

### II. RELATED WOTK

Automation is done for convenience of authors. When developing a garden automation it is significant to give automatic switches on and off lamps.

A public garden automation can be constructed from different approaches including modifying irrigation or adding some more sensors such as humidity sensors, fire sensors results in smart automation. Making a garden automation with the help of motor driver results in opening and closing of garden gate. Some smart automation garden designs favor sensor placement of understanding sensor used in automation system. Newer development in sensor technology can help to neglect sensor placement on platform. Many automation systems use a solar panel, real time clock, fire sensor for more convenience.

### III.METHODOLOGY

A. HUMIDITY SENSOR: This sensor is used to measure the humidity and it will give the voltage outputs which will be applied to signal

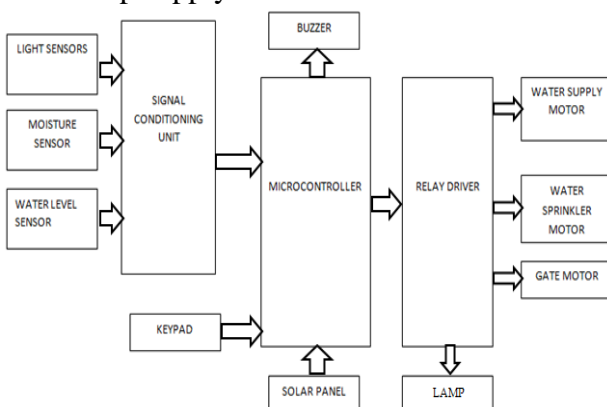
conditioning circuit and then applied to the microcontroller.

**B. LIGHT SENSOR:** This is second sensor which is use to sense light. This can be LDR. Output of sensor given to signal conditioning circuit which will raise signal to required level of microcontroller.

**C. MOTOR DRIVER:** We need to drive the DC Motors. For this purpose we need to provide 12volt supply to motor. Motor driver is also used for this purpose.

**D. MICRO-CONTROLLER ATMEGA32:** This is the main segment of the paper. The microcontroller is in charge of detection and polling of the peripherals position. It is making. It is in charge of putting first all the devices fastened to it. We have used the P89V51RD2.

**E. RTC:** The serial real-time clock (RTC) is a low-power, full binary-code decimal (BCD) clock/calendar plus 56 bytes of NVSRAM. Address and data are transferred serially through an IC, bidirectional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and season information. The end of the month date is automatically adjusted with fewer than thirty - one days, including corrections for leap year. The time operates in either the 24-hour or 12-hour format with AM/PM indicator RTC has a built-in power-sense circuit that detects electricity failures and automatically changes to the backup resource. Time keeping procedure continues event through the part operates from the backup supply.



#### IV. LITERATURE SURVEY

1. Goran Kitić and Vesna Crnojević-Bengin, "A Sensor for the Measurement of the Moisture of Undisturbed Soil Samples," *Sensors* 2013 et al. The main aim of this paper is to illustrate the technology that can be used for automation of gardens. The most important problems faced are the misuse of electricity and its wastage. Sometimes due to carelessness of the authorities and the workers lamps are left ON which results in wastage of electricity. Water wastage is another problem which needs to be dealt with. Our project helps to overcome all these problems.

2. P. Parwekar (2011). From Internet of Things towards cloud of things. In *Computer and Communication Technology (ICCT)*, 2011 2nd International Conference on, pages 329–333. IEEE, 2011 et al. The Garden Sensors gather and analyze data about changing weather and soil moisture conditions and then connects to the user's Android phone with timely alerts. Also, the system includes a .Net Application which runs on a Microsoft Windows Computer which can be used to monitor the plant's conditions at user's workplace.

3. Rajeev Piyare Internet of Things: Ubiquitous Home Control and Monitoring System using Android based Smart Phone, *International Journal of Internet of Things* 2013, 2(1): 5-11. Et at The system used Android application is used to control and monitor the appliances and Wi-Fi technology as a communication protocol to connect system components. Depending upon the moisture level of garden land and daylight intensity, the system can detect the appropriate time of water supply to the plants and trees in the garden.

4. Deepak Mehetre Deepak Mehetre "An Automatic Irrigation System using ZigBee in Wireless Sensor Network," 2015 International Conference on Pervasive Computing (ICPC) .et al the Water Valve automatically controls the existing water system based on data

collected by the Garden Sensor and adapts to every change in the plant's requirements. This saves water, lowers utility bills, and the user needs never to worry about thirsty plants again.

### V. CONCLUSION

This project elaborates the design of public garden automation based on solar power with

microcontroller ATMEGA .The circuit works properly as the command given by user.After designing the circuit , automatically water supply given to plants , and lamps are switched on off based on light intensity as well as opening and closure of garden gate.

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## Solar Window (BIPV)

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### ABSTRACT

Well, solar energy has become a potential source for human nature and power our daily lives. The importance of solar energy is vivid and quite abundant. It can be broadly defined but some of the basic definition is: Solar energy-power from the sun-is a vast, inexhaustible, and clean resource. In short Sunlight, or solar energy, can be used directly for heating and lighting homes and businesses, for generating electricity, and for hot water heating, solar cooling, and a variety of other commercial and industrial uses.

It is cost efficient as well as environment friendly and hence it can be considered as one of the best renewable technology energy. In solar plant there are many solar panels connected and in panels there are many cell units which apparently become into a whole lot of panels. In this project we are going to discuss the effect of direct sunlight on solar panels fixed on "a non-tilting" surface generally fixed to windows of homes or buildings. We are going to take a lot more parameters into consideration before coming to the final conclusion. The important parameters are continued further. Photovoltaic (PV) has a fast going annual rate and is quickly becoming an important part of the energy balance in most region.

**Keywords:** Transparent photovoltaic, Renewable energy, Transparent semiconductors

### 1. Introduction

As we have now known the importance of renewable sources of energy we now need to utilize these resources effectively. Sunlight is one of the most conventional source of renewable energy. Many developments have been made for generation of electricity using sunlight in recent years. Solar panels are used for generation of electricity through sunlight which are widely used in industrial and residential buildings now-a-days. Flexible solar panels are the latest type of panels available for use. But solar panels also are costly and most of the people cannot afford it. Also with the increasing need and demand of electricity are the solar panels enough? The answer is no because with such a huge demand of electricity in the metro cities it's not possible to reach out the electricity needs of the people living in villages and

Other rural areas. So to meet these huge demand after a lot of research now a concept of solar windows is introduced. Many countries are still trying to make solar windows efficient to use. In recent years there have been many developments made in study of solar windows technology.

### 2. Benefits of solar windows

Installation of PV sunscreens help reduce the cooling costs as much as up to 30%, also they can keep your home a comfortable 15 degrees cooler during summer days. As solar energy is a renewable source once it is installed, solar energy can almost be produced free of cost. Also causes no pollution. In short if you are thinking for long term, there is an absolute chance of high return on investment, as it produces free amount of energy.

- Cost efficient
- Better option for long term investment.
- The cost of maintenance is low
- Solar windows also block a good amount of UV (ultraviolet radiation) that causes some of the fading and damage to textiles when exposed to major sunlight.
- Similarly can also decrease cooling cost in winters.
- Future demand
- Clean renewable energy
- Easy installation
- Glare reduction
- Provides extra privacy during daylight hours

- Provides ventilation in such a way that helps to reduce the dust and insects which enter the home.
- ‘Improve net’ solar screens have to reduce electric costs up to 33%.
- Who doesn’t want their windows to look beautiful? Solar windows give a good aesthetic appearance and curb appeal to eyes.
- Best alternative to costly window tinting options.

made up of compounds such as GaAs or CdTe. This electricity generation is ecofriendly in nature

**3. Indian scenario of PV solar windows**

India’s climate in various parts of the country is the main reason for the production of abundant solar energy. This abundant clean solar energy is a perfect replacement for the extremely harmful, polluting and rapidly depleting conventional sources of energy.

- Historical background: In the 18<sup>th</sup> century the total energy need was fulfilled by coal. After that the global industrialization took place by extracting energy from coal, oil, natural gas and nuclear resources such as uranium. Such resources took millions of years to accumulate and depletion of such resources is taking place at the rate of 100,000 times than they are being replenished. The emission obtained from these resources and due to human activities has given rise to the greenhouse effect and hence the global warming.
- The photovoltaic system (PV): A photovoltaic system, also PV system or solar power system, is a power system designed to supply usable solar power by means of photovoltaic. It consists of an arrangement of several components, including solar panels to absorb and convert into electricity, a solar inverter to convert the output from direct to alternating current, as well as mounting, cabling, and other electrical accessories to set up a working system .PV systems are also referred to as the solar cell which basically comprises of semi-conducting materials (P and N type extrinsic) made up of silicon and also

Sr. no	State/ UT	Total cumulative capacity till 31.03.2017(MW)	Capacity Commissioned till 31.10.17 (MW)	Total cumulative capacity till 31.10.17 (MW)	%
1	Andaman and Nicobar	6.56	0.00	6.56	0.04
2	Andhra Pradesh	1867.23	271.60	2138.82	13.70
3	Arunachal Pradesh	0.27	4.12	4.39	0.02
4	Assam	11.78	0.00	11.78	0.02

**4. Installation of solar window**

At first, we did survey of the college campus to get the knowledge of amount of sunlight arriving at different spots in the campus, so that we could decide the position of placement of solar panels. During this survey we continuously observed that which part of the campus was receiving sunlight throughout the day time, and also during the evening hours.



**Survey of campus**

And after a survey of 2 to 3 days we observed that the area near the laboratory of mechanical department were receiving a sound amount of sunlight throughout the day time. So, we decided to place the solar panels near the laboratory of mechanical department. In the beginning our aim was to observe the readings of the solar panels placing it on the ground surface so that we can know the amount of voltage obtained at different times throughout the day at different angles. We took the readings for next 6 days at different time during day time and at different angles.



**Reading at different location**

Now we decided to paste the solar panels on the windows to observe the readings. For that we measured the dimension of windows and solar panels so that we could know the number of solar panels that can cover a single window. But there was a problem that how could we stick the solar panels to the windows, after a long discussion it was decided that we will

stick the solar panels to the windows with the help of silicon sealant.

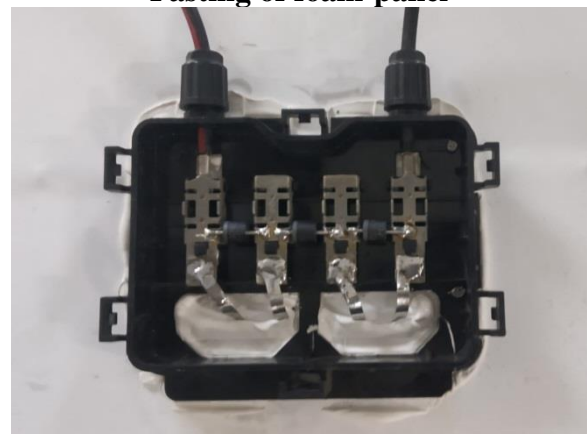


**Silicone sealant**

But it was not possible to stick the solar panels directly to the windows because of the junction box thickness. So, we increased the thickness of solar panels by sticking it with foam and bringing it to one level. Then we applied silicon sealant to the foam and placed it on the windows and held it there for one hour so that the panels could stick there properly and would not fall.



**Pasting of foam-panel**



**Junction box**

Now we started to note down the amount of voltage produced by the solar panel after sticking it to the window at an angle of 90 degrees. We used multi- meter to note down the voltage and current in the solar panel.



**Multimeter**

**Following are the observations during different time intervals at an angle of 90 degrees for 28 days: -**

DATE	TIME	VOLTAGE (Volts)	CURRENT (Watt)
27 Feb	11:00	38.9	0.87
	1:00	37.8	0.58
	3:00	37.4	0.35
1 March	11:00	38.7	0.98
	1:00	38.4	0.68
	3:00	37.5	0.71
2 March	11:00	37.7	0.91
	1:00	38.8	0.89
	3:00	37.8	0.74
3 Marh	11:00	39.7	0.90
4 March	1:00	38.7	0.89
	3:00	38.1	0.86
	11:00	39.1	0.95
5 March	1:00	39.5	0.86
	3:00	38.8	0.84
	11:00	40	0.89
9 March	1:00	41.2	0.91
	3:00	39.9	0.88
	11:00	39.4	0.90
10 March	1:00	38.5	0.89
	3:00	38.1	0.88
	11:00	40.2	0.89
11 March	1:00	39.4	0.87
	3:00	38.3	0.84
	11:00	40.2	0.91
12 March	1:00	40.0	0.89
	3:00	39.3	0.86
	11:00	40.2	0.91
13 March	1:00	40.0	0.89
	3:00	39.3	0.86
	11:00	41.2	0.90
15 March	1:00	39.4	0.88
	3:00	39.3	0.87
	11:00	39.5	0.89
16 March	1:00	39.0	0.88



	3:00	38.4	0.86	27 March	11:00	39.0	0.90
17 March	11:00	39.2	0.88		1:00	38.6	0.88
	1:00	38.4	0.86		3:00	37.8	0.87
	3:00	37.7	0.85	29 March	11:00	39.8	0.89
18 March	11:00	39.8	0.89		1:00	38.6	0.89
	1:00	39.2	0.87		3:00	37.2	0.87
	3:00	38.6	0.86	30 March	11:00	39.5	0.92
19 March	11:00	40.1	0.90		1:00	38.6	0.90
	1:00	39.8	0.88		3:00	38.1	0.89
	3:00	38.6	0.87	01 April	11:00	38.4	0.87
20 March	11:00	39.8	0.89		1:00	37.9	0.86
	1:00	39.0	0.88		3:00	37.1	0.86
	3:00	38.4	0.86	02 April	11:00	38.6	0.87
22 March	11:00	40.3	0.91		1:00	38.1	0.86
	1:00	39.7	0.89		3:00	37.8	0.85
	3:00	38.8	0.88	03 April	11:00	39.6	0.90
23 March	11:00	39.8	0.89		1:00	39.0	0.88
	1:00	38.6	0.87		3:00	38.6	0.86
	3:00	37.4	0.86				
24 March	11:00	38.9	0.88				
	1:00	38.1	0.87				
	3:00	37.6	0.87				
25 March	11:00	38.4	0.87				
	1:00	38.1	0.86				
	3:00	37.6	0.84				
26 March	11:00	39.4	0.89				
	1:00	38.8	0.86				
	3:00	38.2	0.87				

### Conclusion

By doing this project we can conclude that solar panels stucked at the windows making them solar windows and when placed at an angle of 90 degrees give appropriate results compared to windows placed at different angles. Also, we came to know from the calculation that the initial cost of placing the solar windows will be very much high but by the passing time it will be very much beneficial for the owners.

We at SIEM Civil Department can place these solar windows and also can produce the electricity need of the whole department at the beginning and also during summer seasons when there is ample amount of solar energy available there will be more amount of

electricity produced and we could supply the extra amount of electricity to other departments. Also the excess amount of energy can be stored in the batteries for later use or could be sold to the electricity board which in return will provide us the same amount of energy when the solar panels are not able to produce sufficient amount of energy or when there is rainy season. From this experiment we can also conclude that these solar windows are of great advantage for ones use as they can be self-dependent for their electricity production and also can use according to their convince and also is a great way to make electricity by means of natural resource available.

### Acknowledgement

I would like to take this opportunity to express my profound gratitude and deep regard to HOD Prof. K.L Bidker Sir, for his exemplary help, valuable feedback and constant encouragement throughout the duration of the project. His valuable suggestions were of immense help throughout my project work. His perceptive criticism kept me working to make this project in a much better way. Working under him was an extremely knowledgeable experience for me. I would also like to thank Mr. Akshay Gangurde sir to provide us materials for the project.

I would also like to give my sincere gratitude to all the friends and colleagues who filled in the survey, without which this research would be incomplete.

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## Solution of 2 dimensional steady and unsteady heat conduction equations by using Finite Difference method

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### ABSTRACT

Conduction is mode of heat transfer in which there is a transfer of heat energy from high energetic particle to low energetic particle. Computational fluid dynamics (CFD) is a tool which is used to solve any problem numerically, which involves fluid flow and heat transfer. In the current work, 2 dimensional steady and unsteady heat conduction equations are solved by CFD. Governing equation is discretized using finite difference method (FDM). Resulting discretized equations got by FDM are solved by applying suitable boundary conditions and initial conditions by using suitable software. Jacobi method, Gauss-Seidel method and successive-over relaxation method is used for solution. Again for unsteady heat conduction equation solution, both explicit and implicit approaches are used. It is found that, unsteady heat conduction solution is taking more time to get converged solution as compared to steady solution because unsteady heat conduction solution involves more computation compared to steady state. Also in unsteady heat solution, implicit approach is takes more time to get converged solution compared to explicit approach. Solution achieved numerically using CFD is compared with theoretical problem for validation.

**Keywords:** Heat conduction, Computational Fluid Dynamics (CFD), Finite difference method (FDM), explicit method, implicit method, heat conduction equation.

### INTRODUCTION

Analytically it is not possible to solve heat conduction equation either 1, 2 or 3

dimensional if computational domain involves no of grid points. Even if number of grid points is lesser, it takes very long time to get converged solution by manual calculation. In this work a square domain is consider whose 4 sides are maintained at different temperatures. Temperature at inner nodes/grid points are calculated by solving 2D steady and unsteady heat conduction equation using iterative solver like Jacobi method, Gauss-Seidel method and successive-over relaxation (SOR) method. Iterative calculations are done by writing a code in suitable software. For unsteady heat conduction solution both explicit and implicit approaches are used.

**GOVERNING EQUATIONS**

Following are the governing differential equations.

2D steady heat conduction equation

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$$

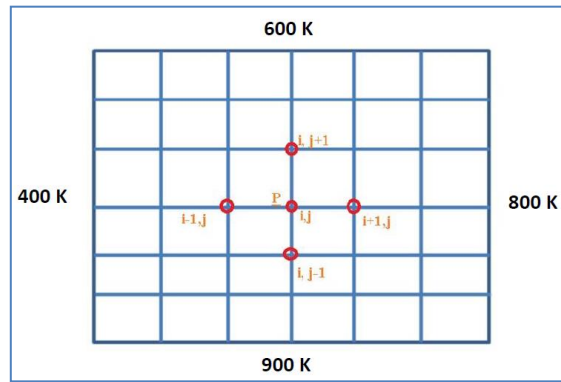
2D unsteady heat conduction equation

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = \frac{1}{\alpha} \frac{\partial T}{\partial t}$$

Where, T is temperature, t is time,  $\alpha$  is thermal diffusivity and x and y are spatial coordinates.

**COMPUTATIONAL DOMAIN**

Computational domain with certain length along x and y directions is assumed. Accordingly it can be square or rectangular in shape. Four faces of domain are maintained at 4 different temperatures. For analysis purpose the length of domain along x and y directions are assumed to be 1 unit. Computational domain is divided into number smaller control volumes as shown In figure. Solution is calculated at 4 corners of control volumes. For understanding purpose 5 points are mentioned if a figure. P is a point at which solutions needs to be calculated. To the left, right, bottom and top are the four neighbouring points of point P. in the diagram shown below, i and j is the index along x and y direction respectively.



**DISCRETISATION**

Discretisation scheme used is forward in time and central in space. Accordingly for 2D steady heat conduction equation we have discretised from of equation as,

$$T_p = \frac{1}{k} \left[ \frac{T_L + T_R}{(\Delta x)^2} + \frac{T_T + T_B}{(\Delta y)^2} \right]$$

Where,

P is any point inside the domain at which temperatures needs to be calculated.

$T_p$  = Temperature at any point inside the domain,

$T_L, T_R, T_T, T_B$  = Temperature at a point which is to the left, right, top and bottom side of the point P respectively.

$\Delta x$  and  $\Delta y$  are grid spacing along x and y directions respectively. And

$$k = 2 \left( \frac{(\Delta x)^2 + (\Delta y)^2}{(\Delta x)^2 (\Delta y)^2} \right)$$

Similarly for 2D unsteady heat conduction equation, we have discretised from of equation as,

$$T_p^{n+1} = T_p^n + k_1(T_L - 2T_p + T_R) + k_2(T_B - 2T_p + T_T)$$

Where,

n+1 = Current time step

n = Previous time step

$$k_1 = \frac{\alpha \Delta t}{(\Delta x)^2} \text{ And } k_2 = \frac{\alpha \Delta t}{(\Delta y)^2}$$

$k_1$  and  $k_2$  are known as Courant–Friedrichs–Lewy (CFL) no in x and y direction.

**INPUTS/VALUES USED IN CODE**

In the program which is prepared to solve the heat conduction equation (Steady and unsteady), following inputs are taken.

Number of grid points along x and y directions = 100. Accordingly grid spacing/grid size along x and y directions is 0.0101 unit

Length of domain along x and y directions = 1 unit

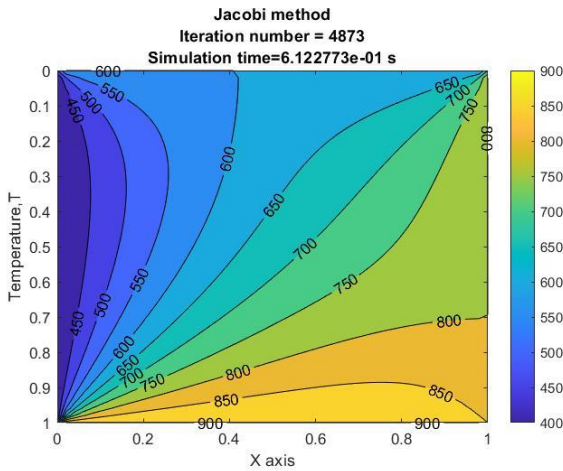
For unsteady solution, time step size =  $1.63 \times 10^{-5}$  and thermal diffusivity = 1.4

For SOR method, relaxation factor = 1.4

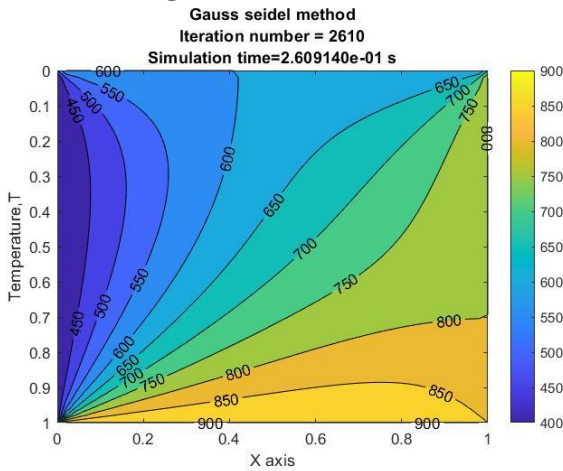
To initialise the solution, initial value of temperature used is 300 K.

**RESULTS**

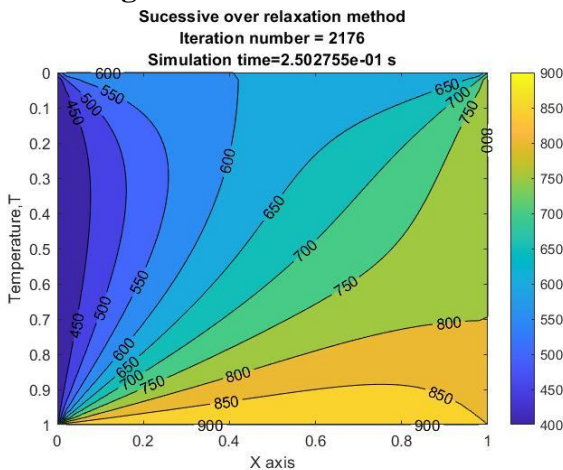
**a) Steady state heat conduction**



**Figure: Jacobi method**



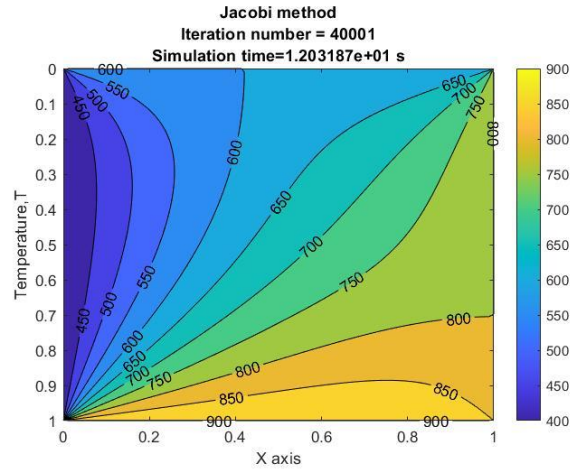
**Figure: Gauss-Seidel method**



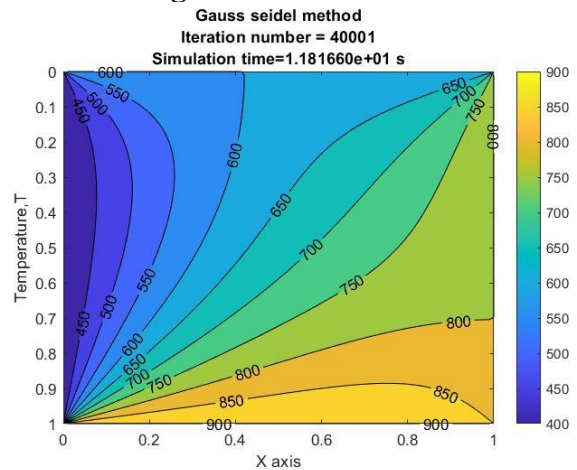
**Figure: SOR method**

**b) Unsteady state heat conduction**

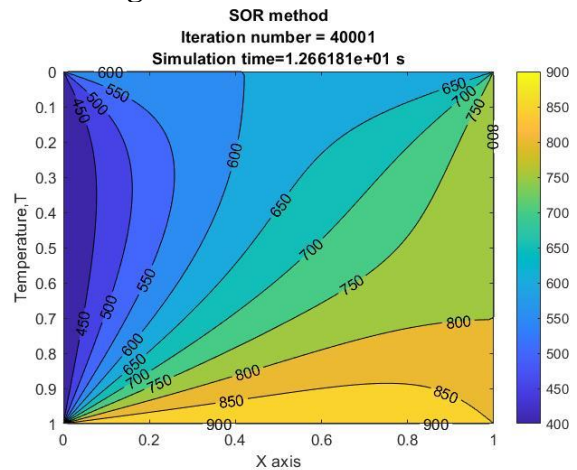
**1) Explicit method**



**Figure: Jacobi method**



**Figure: Gauss-Seidel method**



**Figure: SOR method**

2) Implicit method

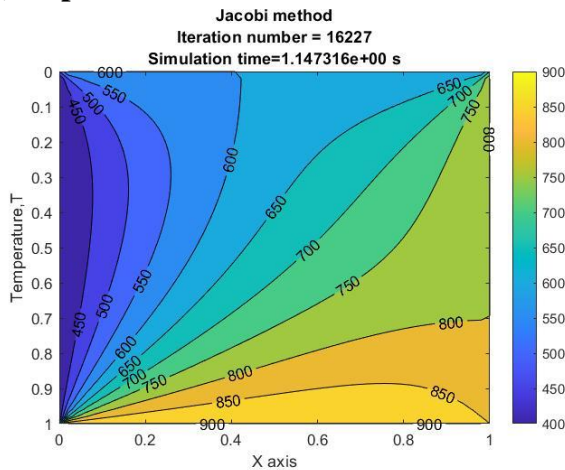


Figure: Jacobi method

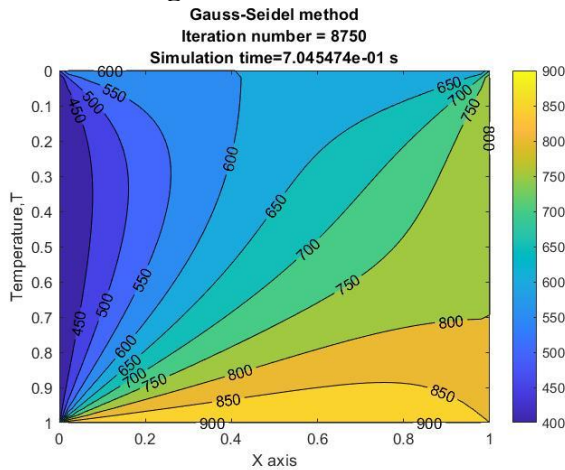


Figure: Gauss-Seidel method

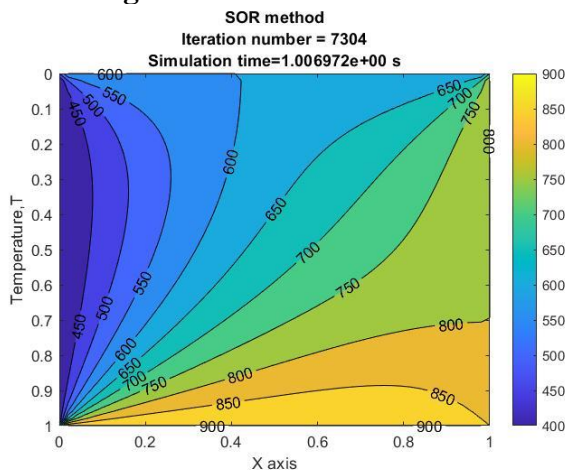


Figure: SOR method

VALIDATION OF SOLUTION OBTAINED

For validation purpose a square domain is considered having dimensions 750 mm x 750 mm. Left and top face is maintained at 100°C while right and bottom face is maintained at 0°C. Four grid points assumed along x and y directions. After applying finite difference method to interior four grid points, it results into four equations. After solving it temperatures at four interior nodes are comes out to be 50°C, 25°C, 50°C and 75°C.

This problem is also solved by a code which is developed to solve the problem in the current work. After solving it is found that theoretical results achieved above and results achieved by iterative solutions using code are exactly same. This proves that whatever code is developed, it is giving correct solution.

CONCLUSION

1) Steady state calculations and in unsteady state calculations, it is found that computation time of Jacobi method is highest and that for SOR method is lowest. For Gauss-Seidel method computation time is in between Jacobi method and SOR method. This is good agreement with literature available.

2) If we compare the steady state and unsteady state computation time, in case of unsteady state computation time is much higher as compared to steady state for same type of solver. This is because in unsteady state convergence needs to be achieved for each and every time step.

3) If we compare the computation time of explicit and implicit solver, explicit solver takes more time for computation for same type solver. This is due to in implicit solver recent values are also used from current time step in addition to value from previous time step for calculation of temperature in current time step. On the other hand in explicit solver values from previous time step only used to calculate temperature in current time step.

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## Land Shaping for Irrigation

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### ABSTRACT

The mainly practical and environmentally way of creating irrigation assets in the coastal area is through harvesting of excess rain water that goes waste as runoff into the sea. It can be done effectively through suitable shaping of the farm land, which involves in modifying the surface of the farm land for harvesting of excess rain water as well as making the land surface suitably shaped for adoption of improved cultivation of diversified crops. The most important intention of these land shaping are for creating irrigation resources through harvesting excess rain water, diversification and multiple crop cultivation encompassing the year. Employing innovative land management practices will not only serve the land degradation concerns but also enable to harvest rainwater and diversification of agriculture. A comprehensive study conducted on fertility indicated that the cutting in slope group of 1.5 to 3 % reduced nitrogen content appreciably. It is also seen that in the first two years removal of surface soil created a problem in zinc deficiency. It is therefore, necessary to augment fertility with a higher dose to tune of 1.25 times greater than usual dose.

**Keywords:** Land shaping, land grading, Cropping Pattern, depth of cut-fill, Water Retention Capacity

### INTRODUCTION

Most of the natural lands, barring few exceptions, have uneven surfaces having grades in different directions. If water application is made to this land, it travels to the low-lying areas easily, by passing the high spots. The distribution is not therefore even resulting in pondage of water depressions and dry areas on elevated portion. It also means interruption of drainage on one hand and acceleration of soil erosion on the other. The other effects are the non-uniformity of crop growth difficulties in farming operations. Land shaping is required to be done to overcome these hazards. It is an asset in dry farming and almost a prerequisite for modern irrigated farming. Land shaping is also known as land farming means reconstruction of land surface to a plane surface either level or with a predetermined grades longitudinal and cross slopes. The terms land shaping, land leveling, land grading, land smoothening are many a times used synonymously, though each term has a specific meaning.

### OBJECTIVES OF LAND SHAPING

The basic objective is to enable the farmer to have a better control on distribution and application of available water over his field. It helps farmers in

- The uniform distribution of water over the field.
- Economic use of water
- Draining of excess water, either from rains or from excess irrigation without damage to the crops or soils.
- uniform distribution of fertilizers along with irrigation water if necessary
- Increasing the yields and quality of crops incidentally
- Bringing some un-commanded portion under irrigation by moving soil to the lower elevations.
- Effective saving of labors in all farming operations.

### DATA COLLECTION

3.1 Soil Depth: It is necessary to ensure during planning that the soil strata remaining after the land shaping is adequate and suitable for crop cultivation. The trial pits shall be at the four

corners of the field and one at the center, to cause minimum disturbance. The samples from each 50 cm depth should be collected.

3.2 Nature of Soil: For land shaping purposes it is enough to know the textural classification of the soil. It should be done for each 50 cm depth of soil. The classification is usually done by the mechanical analysis of the soil sample or it can be done by field method.

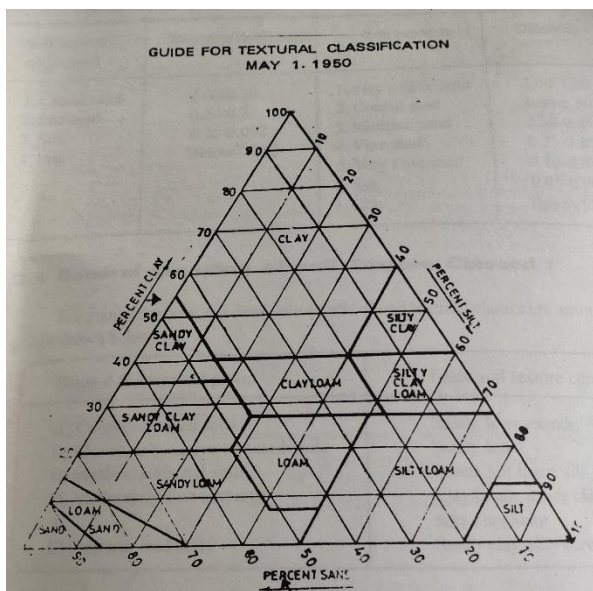
3.3: Soil Texture: It refers to the relative proportion and the various size below 2 mm in dia. The widely used distribution systems are

- (a) International Soil Science Society (ISSS)
- (b) U.S. Department of Agriculture (USDA)-

Figure 1  
Here ISSS Method is used and the soil texture is given in table 1

**Table 1: Soil Texture by ISSS Method**

Sr. No.	Soil Range(mm)	Separate Diameter Range (mm)
1	Coarse Sand	2.0-0.20
2	Fine Sand	0.2-0.02
3	Silt	0.02-0.002
4	Clay	Less than 0.002



**Figure 1: Textural Classification Guide, USDA, Bureau of Plant Industry, Soils And Agricultural Engineering, 1950**

**DESIGN CONSIDERATIONS FOR LAND SHAPING**

**4.1 Soil Profile:** For good cultivation, about 1.0 m of soil depth is desirable. If the depth of soil strata is limited, this limits the depth of cut of soil that can be removed. For these cases, contour benching or terracing is practiced, and grading is done within the benches or terraces. The depth of cutting is limited so that after shaping, enough soil layer is left in position. The soil texture along with the irrigation methods to be used, is usually govern the maximum gradients.

**4.2 Minimum Soil Cover:** The soil cover should satisfy

- (a) It should be able to accommodate the root system of the contemplated crop
- (b) It should be able to hold the irrigation water supplied for the rotation

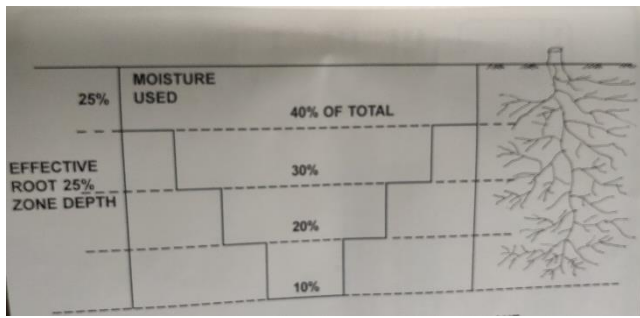
**4.3 Root Zone Depth:** It varies according to crops, which is tabulated in table 2

**Table 2: Root Zone Depths of Different Crops**

Sr. No	Name of Crop	Root Zone Depth in cm
1	Cotton, Grapes, Maize, Wheat, Sunflower	100 to 120
2	Banana, Groundnut, Gram, Beet	50 to 100
3	Potato, Leafy Vegetables, Onion, Cabbages	25 to 50

For commonly grown crops in Maharashtra, the root zone depth is about 1m. It would appear that the minimum soil cover should be 1m. Figure 2 shows the moisture extraction pattern of the crops. This shows that about 70% of the moisture used in extracted from 50 % of the root zone depth and 90% is extracted from 75% of the root zone depth. From above it can be concluded that the maximum necessary soil cover is 100cm, desirable 70cm and the minimum necessary is 50cm.





**Figure 2: Moisture Extraction Pattern in Root Zone**

**4.4 Water Retention Capacity of Soil:** The second consideration for the minimum soil cover will be water retention capacity of the soil. The minimum soil cover should be able to hold the irrigation water necessary during the rotation period. Table 3 gives the depth of soil required to hold 160 mm of water.

For all soils except loamy sand, silt and sand the desired soil cover after land shaping may be 75cm, while the minimum soil cover shall not be less than 50cm. In Maharashtra state most of the soil are covered by the above 9 groups. The soils under classification of loamy sand, silt and sand are rarely encountered are not very suitable for irrigation purpose.

**Table 3: Values of Available Water Capacity for Different Soil Texture Classes and Soil Depth required to hold 160 mm of Water**

Sr.No	Soil Class	Awc Mm/M Depth	In	Depth of Soil Cover Required in Cm
1	Clay	190		84
2	Silt Clay	210		75
3	Sandy Clay	180		88
4	Clay Loam	220		73
5	Silt Clay Loam	240		67
6	Sandy Clay Loam	200		80
7	Loam	200		80
8	Silty Loam	235		68
9	Sandy Loam	85		86

10	Loamy Sand	120	130
11	Silt	80	200
12	Sand	60	270

**4.5 Irrigation Method Adopted:** The irrigation method likely to be used has a great influence on land shaping. Basin irrigation, border irrigation, furrow irrigation are the different gravity methods of irrigation. Each method has its own demands on planning for land shaping. Hence the nature, adaptability and limitations of each method are very important.

**4.6 Natural Topography of the Land:** The final requirement of the land shaping is to have a uniform acceptable grade in the direction of irrigation and a minimum (or nil in case of basin) slope in the cross direction. As a general rule, the irrigation would be preferable along the gentler slope and the compartments along the steeper slope.

**4.7 Cropping Pattern:** The land shaping must be suitable for the irrigation method to be adopted in the particular piece of land. This in turn depends upon the crops likely to be grown, the value of the crops and cropping intensity e.g., for paddy, vegetables or orchards basin irrigation is necessary and the investment required for zero slope land shaping can be investment. Most of the land, where no specific crop is contemplated, can be shaped to the requirement of border irrigation which is the most popular method in Maharashtra state.

**4.8 Climate and Rainfall Pattern:** In the regions of high rainfall intensity maximum nonerodable gradient should be provided. The gradient can be gentler as the maximum intensity of rainfall decreases.

**4.9 Un-commanded Patches:** The patches near the turnout are sometimes un-commanded by the water level in the field channel. Special attention may be paid to see if these patches can be brought under command by having some extra excavations in these patches.

**4.10 Maximum Cut:** It can be decided by (a) The depth of soil (b) Nature of soil (c) Economy in the movement of earth

### 5.0 LAND SHAPING DESIGN

Methods: (a) Plane or centroid method (b) Profile method (c) Plane inspection method (d) Contour adjustment method

**5.1 Topographical Survey:** Land shaping (Figure 5) is to be planned in consonance with the overall layout of the chak alignment and levels of the field channels and field drains. From the contour map for the chak, the individual land holding for which land shaping is separated out and blown up if necessary. It is convenient to take scale of 1:1000 for the map. The position of the water source i.e., the turnout is marked on this map along with the bed level of the turnout and water depth. The irrigation direction and the alignments of field drains are also indicated on this map.

The actual survey to be carried out, in addition to the above map consists of grid levelling of the holding on a 10m\*10m grid. The benchmark uses for chak survey should be used for this levelling. This grid map shall be to the scale of 1:500. The ground levels are marked in the left-hand bottom space at each point as indicated.

**5.2 Execution of Land Grading Work:** The field procedure adopted during execution of land grading work

- 1) Locate the compartment and verify its dimension.
- 2) Transfer alignment of null line from the compartment sheet to the field by line marking or burrowing.
- 3) Fix wooden pegs (5cm\*5cm\*100cm) at each grid points of the compartment.
- 4) Find out maximum depth of cut for compartment and prepare one reference stick of a length little longer than the maximum depth of cut e.g., if maximum depth of cut in a given compartment is 24 cm, prepare reference stick of say 30cm.
- 5) To fix the depth of cut at the cut grid point, deduct the depth of cut at the given grid point from the reference stick height and tie a red ribbon at the resultant height. If the depth of cut is 14 cm, then measure 16cm up (30cm-14cm) from the ground level and tie red ribbon at that point of peg. (Figure 3 and 4)

- 6) At null point the height of the red ribbon will be equal to the height of the reference stick i.e., in this case it is 30cm.
- 7) To fix the height of fill at the fill grid point is quite simple, simply measure the height of fill from the ground level and tie a blue ribbon at that level.
- 8) When using machine for land grading works, start cutting in layers in between two grid pegs and carry the excavated soil stuff towards null line. To check the adequacy of depth of cut at each cut peg and also the desired grade in between pegs, tie a nylon rope along the cut peg at the ribbon height and try to move vertically the reference stick between the rope and the formation level (Figure 5.2). The cutting should be continued till the reference stick fits exactly at any point between the rope and the finished ground profile. By this method, it is possible to control grades in both, cross and irrigation direction when execution work still going on.

Formation level	Fill
Ground level	Cut

Thus, irregularities if any can be corrected at the site itself.

- 9) The cut soil can conveniently and rather quickly be spread by using wheel tractor.
- 10) In case of fill pegs, the excavated soil should be filled up to the ribbon heights. Here to the desired ground profile between two fill pegs can be achieved by simply tying a nylon rope at the ribbon height along the fill pegs. (Tie one end of the rope at the bottom of the null point peg and another end at the last fill peg.) And see that the full plane of formation touches the rope. This will be achieved only when the soil is filled to the desired formation level in the fill zone.
- 11) Care should be taken not to disturb the grid point pegs till the major land grading operation is completed.
- 12) Compartment bund of the desired cross section (0.18 m<sup>2</sup> of 0.45 m<sup>2</sup>) is also prepared by using the cut soil staff. The

provision of the extra soil needed for bund construction should be already made available during the design of the compartment itself.

- 13) Pegs should be removed and land smoothing should be subsequently carried out to remove mounds around the pegs and other irregular surface relief created by machine movements or labour during major match-line operation. Use either bullock drawn or tractor drawn float /leveler for smoothing purpose.

The above procedure can be explained by the following example;

Data given

- (1) Soil: Medium Textured
- (2) Cut/Fill ratio: 1.1 to 1.25
- (3) Crops to be grown: Wheat, Sugarcane, Cotton, Groundnut
- (4) Soil Depth: 0.6m
- (5) Water Source: Canal water with discharge 30 lps
- (6) Method of irrigation: Border and furrow

Steps

- I. Locate the field in the chak plan (Figure 6). Fix the turnout position and the field channel alignment.
- II. Determine the land slope along the field channel/ equalizer and slope perpendicular to the field channel (Figure 7)
 

Average elevation at the centroid = 8.27m  
 Compartment Number 1 (Area = 0.27 ha)  
 First trial Cut/Fill =  $77/78 = 0.987$   
 Lower the plane at the centroid by 1cm  
 Cut/fill =  $(77+6)/(78-6) = 83/72 = 1.15$   
 Cut/fill ratio on volumetric basis Average depth of cutting =  $83/6 = 0.138$   
 Average depth of filling =  $72/6 = 0.12$   
 Cutting area =  $57 * 25 = 1425m^2$   
 Filling area =  $51 * 25 = 1275m^2$   
 Cut of ratio Volume of cutting / volume of filling  
 =  $(1425 * 0.138) / (1275 * 0.12) = 1.28$
- III. Fix the direction of irrigation and fix the alignment of equalizer
- IV. Sub-divide the field using the criterion under consideration
- V. Consider sub-field compartment as an independent field for the purpose of

land leveling and determine the centroid of the field.

- VI. Add all the elevations and divide the sum by number of elevations in the field

Design elevation at the centroid = All elevation / Number of elevation in the field =  $99.24 / 12 = 8.27m$

Calculate the designed elevation at each grid point according to the slope designed for irrigation and the cross slope.

Elevation difference per m length

Opposite the direction of irrigation =  $(0.4/100) * 100 = 0.4cm$

Add 0.4cm for each m length if we run opposite the irrigation slope

For 15 m the elevation difference =  $15 * 0.4 = 6.0cm$

The designated elevation at centroid = 8.27m

If we run perpendicular to the irrigation slope, the designed cross slope should be used for determining the elevation. Add 0.2 cm for each m length if we run opposite the cross slope. For 15m the elevation at the grid points are calculated.

- VII. The elevation difference between the designed and the ground elevation will give the depth of cutting or filling.

Designed elevation – Ground elevation = Cutting or filling

If the elevation difference in the above equation is negative then it is cutting depth.

- VIII. Calculate the cut fill ratios

Cut/Fill =  $77/78 = 0.987 < 1.15$

If this is within the specified limit, then it is ok., otherwise, raise or lower the plane at the centroid to achieve the designed cut/ fill ratio.

The ratio is not within the limit. Therefore, lower the plane by 1cm

Cut = 73

Fill = 72

$c/f = 83/72 = 1.15$  which lies in between 1.1 to 1.25

- IX. Correct the designed elevations accordingly.

- X. Draw the zero cut-fill contour and calculate

Volume of cutting/ Volume of filling = cut/fill ratio

Volume of cutting = Cutting area \* average depth of cutting

Volume of filling = Filling area \* average depth of filling

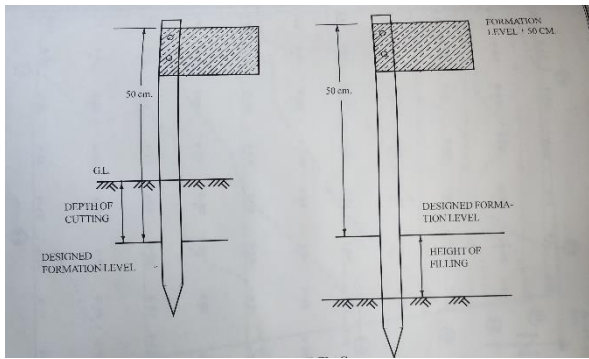


Figure 3: Typical Stake and Flag

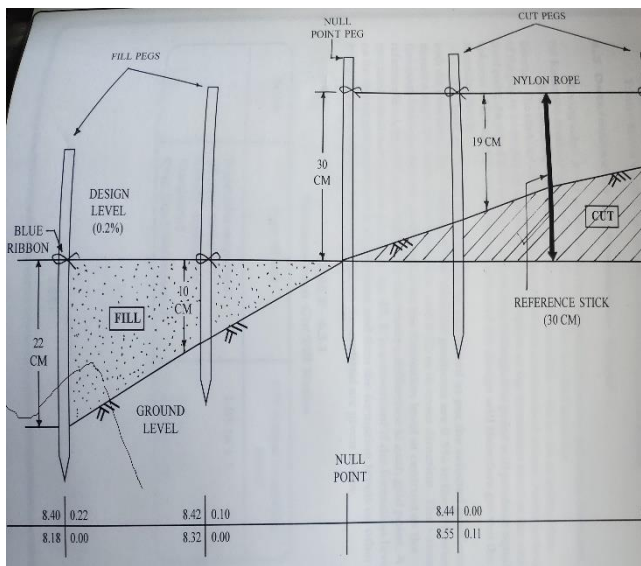


Figure 4: Fixing Depth of Cut and Height of Fill by Tying Ribbons Using Reference Stick Method

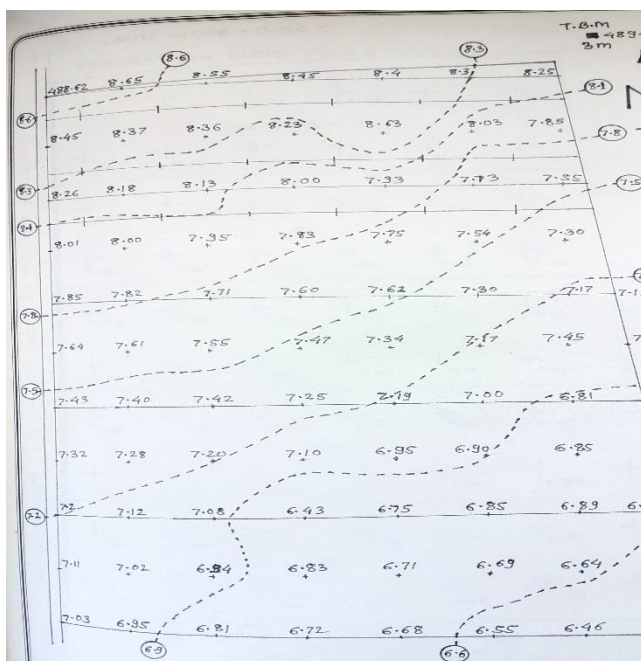


Figure 5: Plan of the Field showing Contours

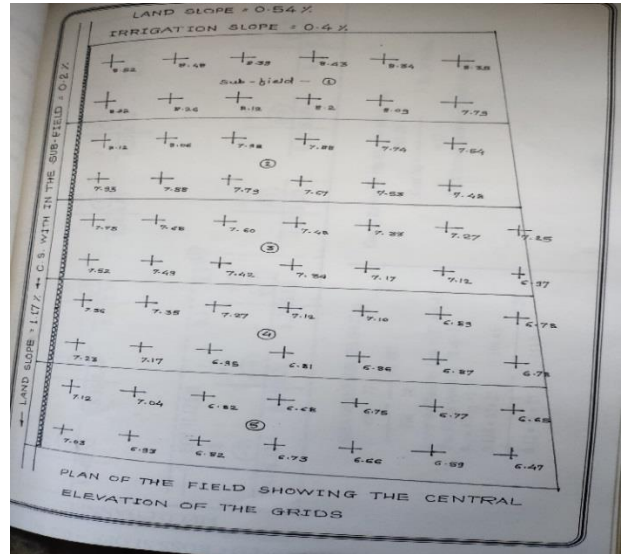


Figure 6: Plan of the Field Showing the Central Elevation of the Grids

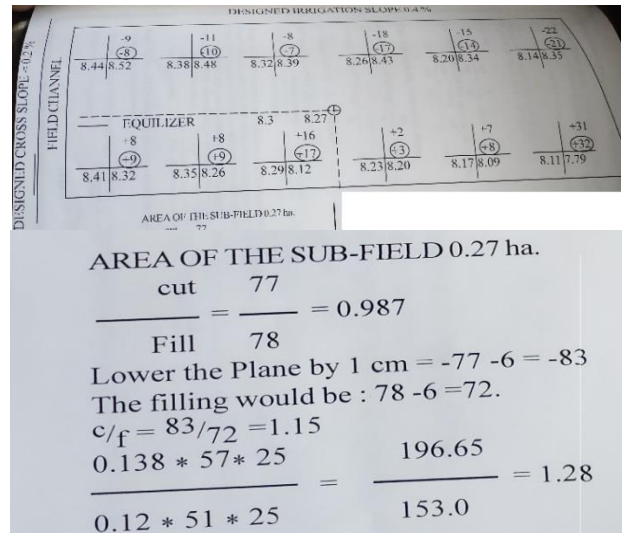


Figure 7: Determination of cut-fill ratio

Conclusion and Remarks

A comprehensive study conducted on fertility indicated that the cutting in slope group of 1.5 to 3 % reduced nitrogen content appreciably, there being not so much changes in phosphorous. It is also seen that in the first two years removal of surface soil created a problem in zinc deficiency. It is therefore, necessary to augment fertility with a higher dose to tune of 1.25 times greater than usual dose. Experiments on wheat, gram as influenced by cutting and filling indicated that the yields of these crops decreased in cut portion as compared to fill area.

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## Center Pivot System of Irrigation

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### ABSTRACT

The center pivot method of irrigation is widely used in the developed countries. Sprinkler irrigation system provided grater control than is possible with many irrigation systems. It is also having advantages of being automated more easily. The objective of an irrigation system is to efficiently and economically apply sufficient water to crop production. Efficiency is important to conserve water, energy and labour. Maharashtra state has the second largest total cultivable area but lowest percentage of the irrigated area amount all the states of the country. It is highly imperative to extend the irrigation facilities on as much larger area and to a larger society as possible. One of the practical approach to resolve the problem besides several other is adoption of water are sufficient irrigation methods, sprinkler and drip

**Keywords:** Centre pivot, sprinkler, drip, cultivable area, irrigation methods.

### Introduction to CPS Technology

Under USAID assisted resources management and trainee project it was proposed by the program coordinator to undertake an adoptive research project on "Evaluation of adoptability of water pivot/ linear move systems".

System supplier: It is supplied by Valmont Industries INC, USA who has opened his office near New Delhi. Kolkata has a collaborative venture with Valmont Company to introduce and eventually indigenize the mechanized sprinkler system in India.

Crops grown under CPS: The CPS is self-propelled fully mechanized sprinkler system, which irrigates an area of 25 to 52 ha within 10 to 72hrs. The traditional and special crops irrigated by CPS and linear includes-

**Table 1: Crops grown under CPS**

Field Crops	Vegetables	Special Crops
Cotton	Onion	Orchard
Rice	Peas	Grapes
Peanut	Potatoes	Flowers
Sugarcane	Tomatoes	
Wheat Sunflower	Watermelon	

India's need for CPS: In addition to the importance of food sufficiently the importance of agriculture in the Indian economy cannot be over emphasized. Agriculture Is the dominant sector of Indian economy contributes 35% at

the GNP to maintain its strong expert orientation agriculture in India' must continue to modernize? Irrigated areas are almost four times as productive as rain fed areas and they account for about 60% of all agricultural output in India. Hence India must be using the best and most efficient irrigation system available.

Energy Conservation: India is currently struggling to meet the energy demands of its Ever-expanding population agriculture and industry. By using a high efficiency CPS or linear systems farmers can irrigate more land using less water and horsepower and therefore less efficiency. In Uttar Pradesh, the 100ha, tube well requires 833hrs of operation to fully irrigate 109ha command area. The following table 1 compares the energy consumption of future tube well flood irrigation with a CPS to irrigate the same area. Table 2 provides power consumption flood vs. CPS

**Table 2: Power Consumption Flood vs CPS**

	Flood	CPS
Flow rate	500 GPM	500 GPM
Area	100ha	100ha
Pump hp	25hp	25hp
ha/hr	0.12	1.78
Hrs operation for complete irrigation	833hrs	56hrs
Powers consumed	20825 hp hrs	1400 hrs

Power saved using CPS rupees/kw	-	Rs. 2.4
Saving complete irrigation of CP	-	Rs 34779
Completely irrigation /year	-	3cycles
Annual saving using CPS	-	Rs. 104338

Watershed development: CPS can offer much to India in terms of watershed development. Being able to tolerate slopes up to 30° CPS completely eliminate the need for costly land leveling.

Farm size: The average size of farm in India ranges from less than 1ha to slight more than 1ha. This has forced to India to be one of the few countries more voluntarily cooperatives has been highly successful. Farmers have banded together to form cooperation to purchase inputs such as seeds, fertilizers and market their produce more profitably. In many states the farmers are on a common tube well program.

Project Proposal: The CPS would be located on a small piece of state own land. It would therefore remain in the control of the state and farmers would not be susceptible to complete among themselves. In addition a pivot delivers the exact amount of water to each farmer, thereby guarantying equitable irrigation, fertilizers and pesticides.

Objectives of Project: The objectives of the project was to determine:-

1. Water consumption, relative water efficiency and water consumption of CPS
2. Energy and conservation, relative energy efficiency and energy conservation of CPS
3. Labour requirements and labour saving of CPS
4. Determine saving in land leveling coat.
5. Determine yield increase under CPS
6. Determine the production economics of CPS
7. Determine the effectiveness of CPS in rehabilitating partially waterlogged soil.

Water requirement: Some of water could be either underground aquifers which could be tapped by drilling and brought to surface by using vertical turbine pumps or using existing canals or other available ground water.

Irrigation.: It is achieved by using CPS each about 442m long and covering an area of 52ha. Water application amounts are reduced by 30 to 70 % , energy consumption is reduced by 30%, yield can be increased by 100 to 300%, labour reduced by 75% and chemicals can be applied directly utilizing 5 to 40% less chemicals. Each 104ha project requires 2CPS.

Basics of Sprinkler System: The basics of sprinkler system are explained as below.

Soil Consideration: With the CPS the objective is to apply water at a rate that is less than the intake rates to achieve a uniform application of water and eliminate run-off. Any tillage after the formation of crusts can significantly increase the intake rate.

Climatic Conditions: The variation of precipitation and ET is generally higher for seasonal precipitation than for seasonal ET. The expected rain and ET for these areas is important when designing and operating CPS.

System Capacity: The NIR for the crops to be irrigated will establish the lower limit for the system capacity. The allowable depletion is less for sandy soil or shallow root zones and system must have higher capacity.

Uniformity: A CPS has distinct advantage of high uniformity if properly designed. Stationary systems will generally have lower uniformity since they typically do not have the same overlap and do not move to remove some of the uniformity.

Site Details: Trial Cum Demonstration (TCD) farm at Vihamandwa, Taluka Paithan, District Aurangabad was proposed for the CPS installation.

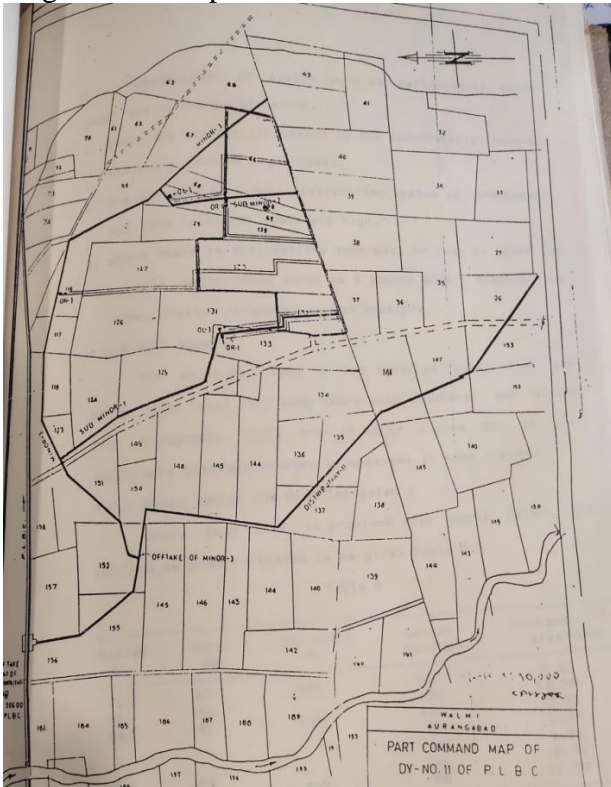
The TCD farm Vihamandwa is located in the command of distributors number 1, Paithan left bank canal of Jayakwadi irrigation project, (fig1) out of 39 ha of farm area 32 ha are available for cultivation purpose. The farm is used for conducting trials of improved crop varieties, cultivation practices, various irrigation layouts etc. for demonstration to farmers from Jayakwadi command.

Introduction of system could be particularly useful under the following situations.

1. where the surface irrigation not economically possible and might involve high losses
2. where layout of proper distribution system is problematic and land levelling costs are higher.



3. where there is availability of tube well or nearby minor or dug well which could serve as a source power, pumping out water, gravity irrigation is not possible.



**Fig.1: Site Details of Trial Cum Demonstration (TCD) farm at Vihamandwa, Taluka Paithan, District Aurangabad, proposed for the CPS installation**

Crops grown on the farm:

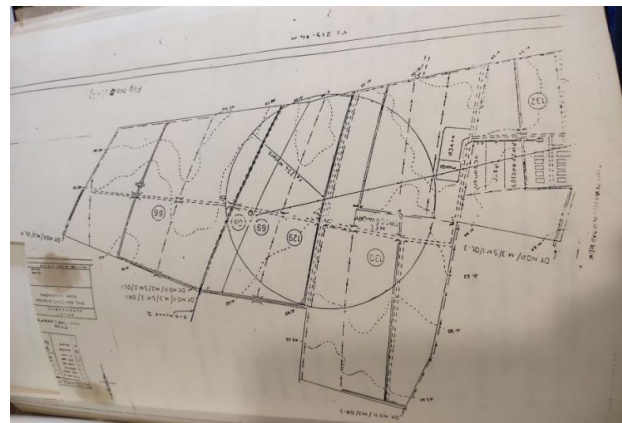
Kharif-Green gram (mung), sunflower, groundnut, paddy, bajara etc. Season period - June to October

Rabi - Wheat, Sunflower, cotton Season period - October to February

Hot weather season - Sunflower, groundnut, green gram Season period - February to June

Energy source: It consists of 20-25 hp pumps.

4.0 FIELD LAYOUT OF CPS: Out of 32ha available cultivable area, the CPS can be adopted for maximum of 15 ha owing to shape of farm ( fig 2). If it is desired to irrigate a square area using end gun system an area of 21ha can be irrigated.



**Fig.2: Field Layout of CPS**

Limitations for CPS

1) The textured soil may create serious problem of the wheel movement and also of excess runoff.

2) Adoption of mixed cropping pattern.

3) Maintenance of the system, availability of spare parts, repair facility and related cost.

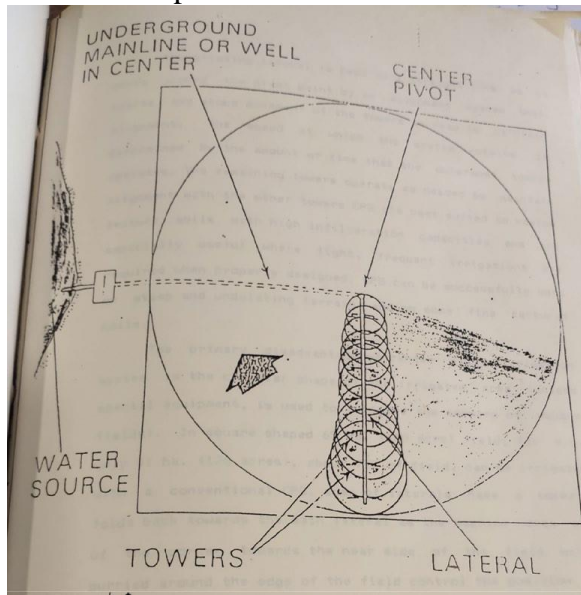
4) The specific cost should be justified.

System layout and components of CPS: CPS includes one or more center pivot units. System design involves locating individual center pivot units and laying out mainline and sub main.

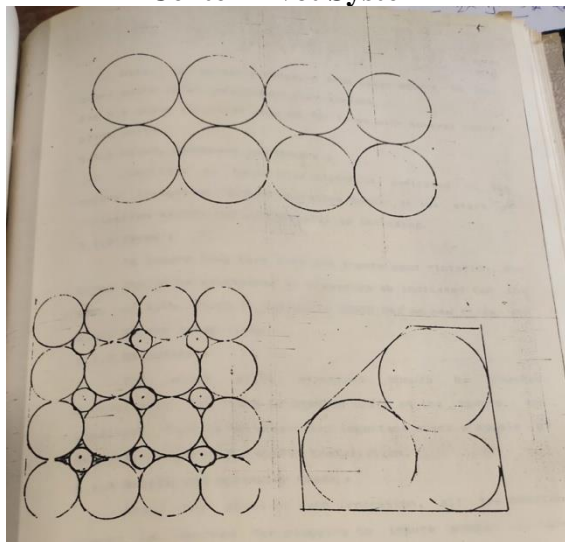
It also includes specifying lateral diameters, selecting sprinkler and recommending speeds of rotation for each unit. The final step in the design process is the sizing of sub mains and mainlines.

A typical field layout for center pivot unit is diagrammed in fig. 3. The lateral rotates continuously in either direction around the field. A CPS consists of a sprinkler lateral that rotates in a circle around a fixed point structure. Water is supplied to the lateral at the pivot point. The lateral is supported by towers spaced each 24 to 76 m, along the laterals and trusses or cables. Towers are mounted on wheels and driven by 0.4, 0.75, 1.1 kW (1/2 hp, 1 1/2 hp) electric motors. They can also be driven by hydraulic oil or water drive motors. Laterals are generally about 365 to 400m long as 790m. Sprinklers operate at pressure ranging from 140 kPa to more than 790 kPa. The primary disadvantage of CPS is the circular shape of the irrigated area. (unless special equipment, is used to irrigate the corners of the square fields.) In square shaped 65 ha field, for e.g. Only 51 ha, about 79 % of field, can be irrigated with a conventional CPS. Water is normally conveyed from water source to the

pivot point in an underground pipe surface. Fig4, shows alternate layouts for farms with several center pivot units.

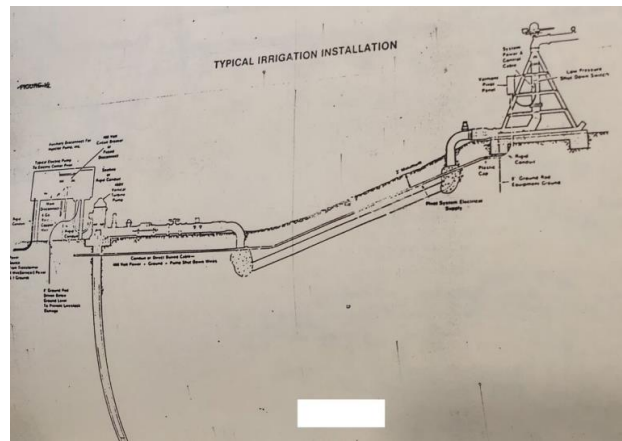


**Fig .3: Field Layout for Self-Propelled, Center Pivot System**



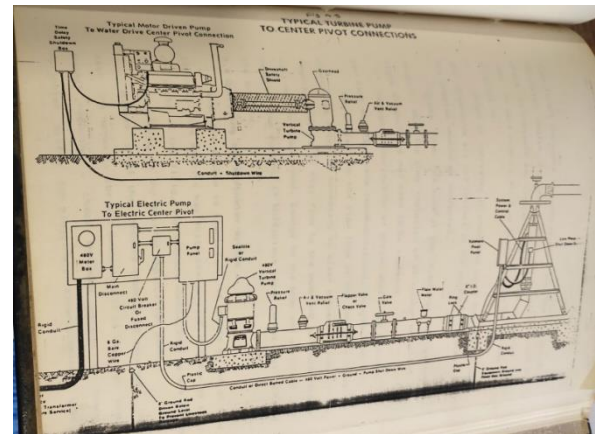
**Fig 4: Alternate Layout for Farms with Several CPS Units**

Structure: The whole pivot structure should be checked periodically for loose or missing bolts at the towers and pipeline. This is an especially important check a couple of irrigation after the system installation shown in Fig. 5. In fig. 6 a typical turbine pump is diagrammed.



**Fig 5: Typical Irrigation Installation**

Operating the sprinkler system: when the system is started up ,it should be set at 0 to 10% until the machine has fully pressurized in order to avoid dry spots in the field. The machine should then be set at the % corresponding to the desired application depth.

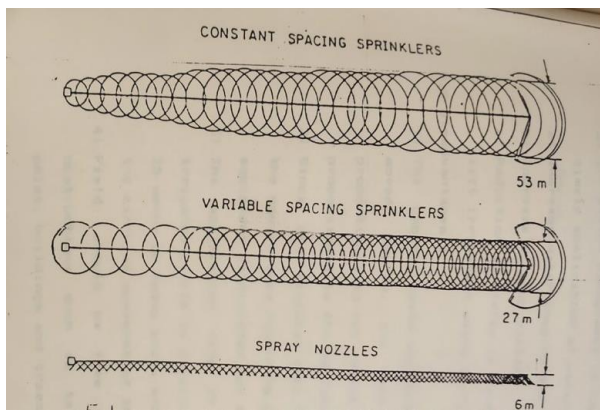


**Fig. 6 A typical turbine pump arrangement**

Moisture Monitoring: The soil moisture should be checked periodically to determine whether it is time to irrigate, or , whether irrigation should be postponed.

Types of Sprinklers: The arrangement of sprinklers on the lateral could be of 3 types as shown in fig 7.

- (1) Constant spacing Sprinklers
- (2) Variable spacing Sprinklers
- (3) Spray sprinklers



**Fig 7: Various Configurations of Nozzle Spacing and Wetted Area for CPS**

Design of CPS : The design consists of the following details .

Design considerations: The main factors to be considered in the design of CPS are

1. Peak water use rate of the crop
2. System capacity
3. Soil infiltration characteristics
4. Sprinkler nozzle configuration and
5. System hydraulics

At the end of the design ,the designer has to specify

1. The maximum required travel speed
2. Maximum lateral length and it's diameter.
3. System discharge
4. Sprinkler configuration desired
5. Available inlet pressure.

System capacity: it is given by the following equation  $Q = 2.70 \times A \times D / Tr$ .

where  $Q$ = discharge required at the pivot in lps.  
 $A$ = total area irrigated the system in ha ,  
 $D_{gross}$ = gross design application in mm,  
 $Tr$  = time per revolution of pivot arm in hrs fig .....

Rotation speed of lateral : The lateral is usually rotated every 10 to 722 hrs depending upon the soil infiltration characteristics ,the system capacity and management allowed deficit.

Time of application: It is given by the following equation –  $T_a = Dw \times Tr / 2\pi a \times r$ .  
 Where

$T_a$ = time of application at radial distance  $r$ , from the Pivot point (hrs),  
 $Dw$  = Wetted diameter of Sprinkler at a distance  $r$  from PP (m)  
 $r$ = radial distance from PP(m)

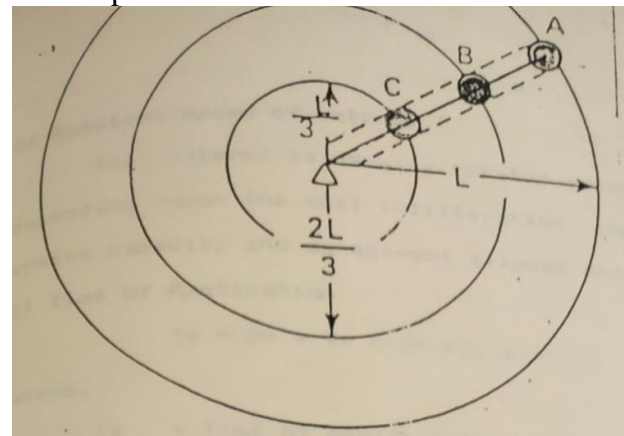
Application Intensity: The geometrical criteria of the CPS aatr such that the application rate must increase with the distance from the

stationary pivot point to obtain uniform depth of application rates, especially near the moving end of the lateral , after exceed the infiltration rate of moderate to heavy textures soils ( fig 8 and fig. 9) .The resulting The maximum application rate ( $d_{max}$ )

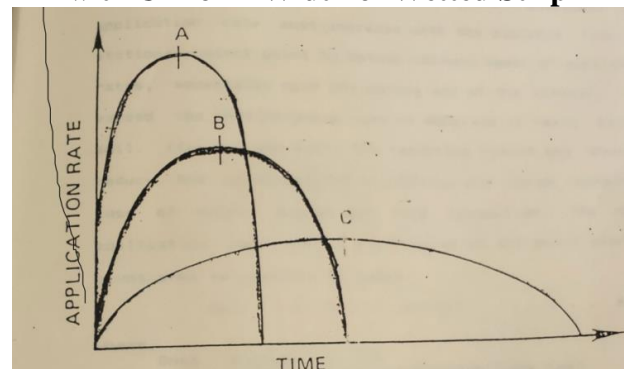
experiences at any point along the pivot arms is completed as below

$$d_{max} = (4/\pi a) ( D_{net}/T_a)$$

where  $D_{net} = D_{gross} ( 1-LS)$  and  $LS$ = wind drift and evaporation loss in mm.



**Fig 8: Aerial View of Center Pivot Field with Uniform Width of Wetted Strip**



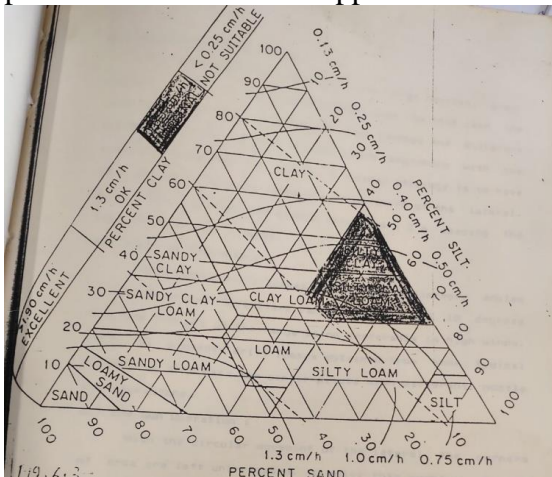
**Fig .9: Water Application Rate Profiles at Different Points Along Pivot Lateral**

Application Package	Sprinkler Type	Outlet Spacing	Normal Min Pressure	Relative Droplet Size	Application Rate	Uniformity (no-wind)
Single and Double Impact	Wale Constant	12 m (40 ft)	310-450 kPa (45-65 psi)	Large	Lowest	Very good
		Close Variable	205-345 kPa (30-50 psi)	Medium	Medium-low	Excellent
Diffuse-jet Impact	Variable	1.5-6.0 m (5-20 ft)	205-345 kPa (30-50 psi)	Medium	Medium	Very good
		Spray Nozzle on Top of Lateral	1.5-3.0 m (5-10 ft)	105-210 kPa (15-30 psi)	Fine	High
Spray Nozzle on Drop Tube	1.5-3.0 m (5-10 ft)	10-210 kPa (15-30 psi)	Fine	Very high*	Good	
		Small-medium	High	Good		
Spray Nozzles on Boom	Boom every 140-210 m (450-700 ft) with 3-7 spray nozzles per boom	45-175 kPa (13-25 psi)	Fine	Medium-high	Very good	
		Small-medium	Very high*	Good		

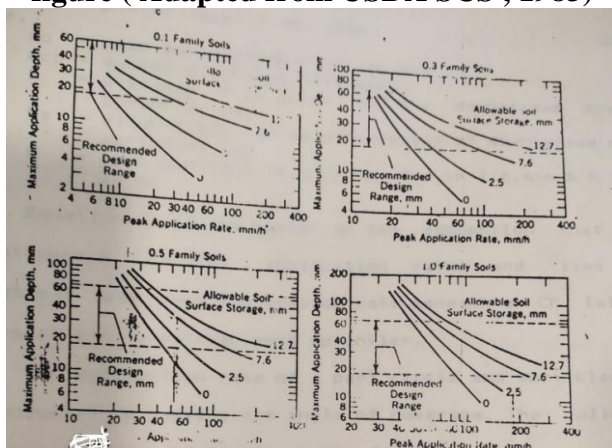
**Fig.10: Application rate can be reduced by extending drop tubes several meters alternately fore and aft of the lateral**

Infiltration Characteristics: Specific intake data are required for designed of CPS to limit run off. The curves given in fig.11, may be used for preliminary estimate of infiltration rate as a function of soil texture . Figure indicates general intake rates superimposed over USDA texture triangle. Thus, adoptability of different soil textures to irrigation by CPS is increased by the dashed lines which extend from left side of the figure .

It is known that soil infiltration capacity decreases with time, which allows CP to apply higher application rates( twice that of periodic move system) without runoff .It is to be noted that the information from fig 11, should only be used as a first approximation , since factors other than soil texture affect the infiltration rate Field test may me needed to determine intake rates of CPS . Fig 12 gives the curves for max depth of water that can be applied with CPS



**Fig.11: General infiltration rate contours superimposed on the USDA textural tri- adaptability of Soil type to irrigation by CPS indicated by dashed lines ex- from the left of figure ( Adapted from USDA SCS , 1983)**



**Fig 12 : Max depth of water that can be applied with CPS**

Sprinkler Discharge: The required discharge / sprinkler (qj) at any outlet along the lateral is given by the following equation.  
 $q_j = 2 \cdot r_j \cdot d_j \cdot WQ_b / (L^2)$

where qj= sprinkler discharge lps

rj= radial discharge from pivot to point under study (m)

sj= sprinkler spacing at rj (which is equal to the average distance to the adjacent up and down stream sprinkler (m)

L= radius irrigated in basic circle (m)

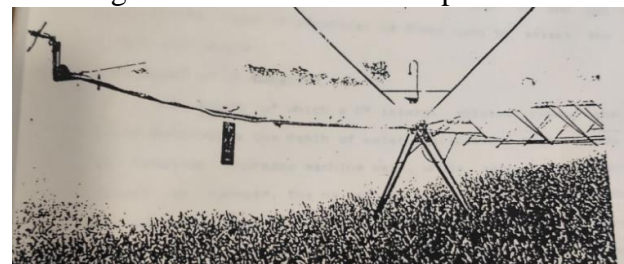
Sprinkler Selection: The selection of individual sprinklers begins after a water application package and lateral diagram haven been chosen. From the required discharges and available pressure elect the appropriate sprinkler for each outlet. The following equation can be used to determine the discharge at each sprinkler.  $Q_s = K D a L S / (H - T_m) (E_a)$

Where Qs= sprinkler capacity lps Da = depth to be applied in mm, S=Spacing (distance) between spry on lateral (m), H=time interval between beginning of successive irrigations of given set (hr)

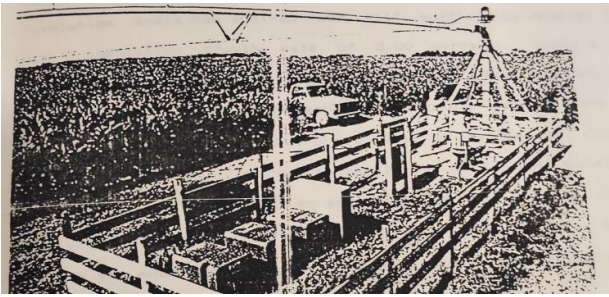
Tm = downtime for moving set move system and/or maintenance (hr)

Ea= application efficiency (present)

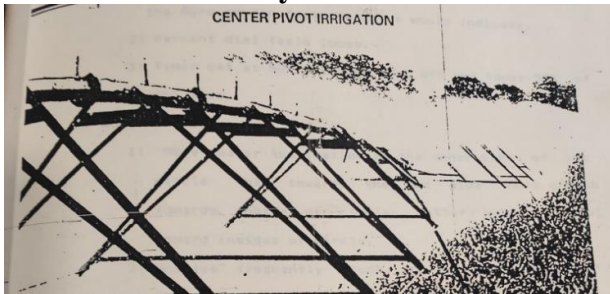
K= unit constant, (K=1.67 for Q- lpm, D in mm and L and S in m. Large gun type sprinkler are often located at the downstream end of CP laterals to extend the area irrigated by the CP unit. These are normally part circular sprinkler fig 13, that operate only the corners of the field. They may require a booster pump when their required pressure exceeds the pressure needed by the sprinkler upstream of gun sprinkler. Fig 14 shows a pivot point for a center pivot system, while fig. 15 indicates a CPS in operation.



**Fig.13: Center Pivot End Gun**



**Fig. 14: Pivot Point for a Center Pivot System**



**Fig.15: ACPS in Operation**

Design of gravity main: The following are the details in designing the gravity main.

Design discharge 30lps

Total length of PVC pipeline 1425m

FSL on main canal 448.25m

Outflow level on well 440.41

Total head available 7.845 m

Select 200mm PVC pipe (2kg/cm<sup>2</sup>)

From friction head loss graph linear diameter = 193.7m

Discharge = 30 lps , Velocity = 1.01m/s

Frictional loss = 4.57 m/ 1000m

Therefore, the total frictional loss

= 4.57+ 1325/ 1000= 6.05 m

Add frictional loss for bend, valves etc. (as 10%) =0.60

Total = 6.75m

Therefore, total frictional loss 6.75m and 7.845m head available. Hence ok.

Therefore, use 200mm PVC 22.5 kg/cm<sup>2</sup> pipe.

### Conclusions

CPS is a most efficient and modern irrigation practice. It has 75 to 85 % efficiency which is much higher than any other irrigation method available. It is superior in water conservation in addition to providing better yields. It prevents water logging and salinization. CPS can offer much to India in terms of watershed development. Being able to tolerate slopes up to 30% CPS completely eliminate the need for costly land leveling. Besides this CPS has many advantages as increased yields, increased income of farmers, reduce energy, reduce water requirement, reduce fertilizers, it has few disadvantages such as high capital cost and requires abstraction free land. Though farmers in India have very small holdings project can be predicted under group of farmers or co-operative.

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## Enhancement in Power Press Spacer Tool

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### ABSTRACT

*Presses are used in industries for a wide variety of uses including blanking, piercing and pressing. There are many different types of presses. The most popular are pneumatic presses and hydraulic presses. Pneumatic presses are 10 times faster than hydraulic presses and they can perform many jobs faster and more efficiently. Metal forming is one of the manufacturing processes which are almost chip less. These operations are mainly carried out by the help of presses and press tools. These operations include deformation of metal work pieces to the desired size by applying pressure or force. Press machine always works under impact load condition. Because of continuous impact the load, frame of press machine always experience continuous tensile stress.*

*Effect of the meshing methods on nodes and elements numbers during meshing of punching press operation has studied. FEA is a great way of studying the stresses, strains and deflection generated before going to real practices. Meshing serves significant role towards the correct solution from FEA. Effect of the meshing methods like patch independent, patch conforming and sweep have studied in the present paper. Modelling of the punching assembly which includes punch, sheet, blank holder and die has accompanied first then the meshing methods have applied to study the nodes and elements number. Three element sizes 10mm, 5mm and 1mm have been considered. Analysis of meshing methods dictates that the decrement in element size increases the nodes and elements number which provides fine meshing. Results also shows that sweep meshing method can be better with low element size. Patch independent method has found to give more number of nodes and element or fine meshing.*

*Press tools are used to produce a particular component in large quantity, out of sheet metals where particular component achieved depends upon press tool construction and its configuration. The different types of press tool constructions leads to different operations namely blanking, bending, piercing, forming, drawing, cutting off, parting off, embossing, coining, notching, shaving, lancing, dinking, perforating, trimming, curling etc. Generally metals having thickness less than 6mm is considered as strip. Metals having thickness greater than 6mm is considered as plate. In Piercing and notching the required shape periphery is cut in the work piece material. The press tool used is for Piercing operation is called as Piercing tool .The application of press operations are widely used in many industries like food processing, packing, defence, textile, automobile, aircraft and many apart from manufacturing industry.*

*In this connection an attempt is made on to learn the press tool design, materials, manufacturing used for press tool and calculations involved in it. In this work, a real time design of a simple piercing press tool and manufacturing of a prototype is made along with static analysis of punch where the output is a Pierce hole and notch hole. The press machine is of mechanical type of 200ton. Here the problem statement of project is two combine these two piercing and notching operation. Which is now manufacturing separately i.e. two piercing by one punch and two notching operation with another punch.*

### Introduction

A power press is a machine that supplies force to a die used to blank, form, or shape metal or non-metallic material. Thus, a press is a component of a manufacturing system that combines the press, die, material, and feeding method to produce a part. Presses are composed of frame, bed, or bolster plate and a reciprocating member called a ram or slide, which exerts force upon work material through special tools mounted on the ram and bed. Energy stored in the rotating flywheel of a mechanical press (or supplied by a hydraulic

system in a hydraulic press, or supplied by pneumatic cylinder in a pneumatic press) is transferred to the ram to provide linear movement. Metal forming is one of the manufacturing processes which are almost chip less.

These operations are mainly carried out by the help of presses and press tools. These operations include deformation of metal work pieces to the desired size by applying pressure or force. Presses and press tools facilitate mass production work. These are considered fastest and most efficient way to form a sheet metal into finished products. The software offers a

comprehensive range of stress analysis and other capabilities in an integrated package for such large-scale, complex problems. An integrated infrastructure, ANSYS Parametric Design Language customization capabilities and nonlinear simulation with contact plasticity work together to provide powerful simulation capabilities for this type of application.

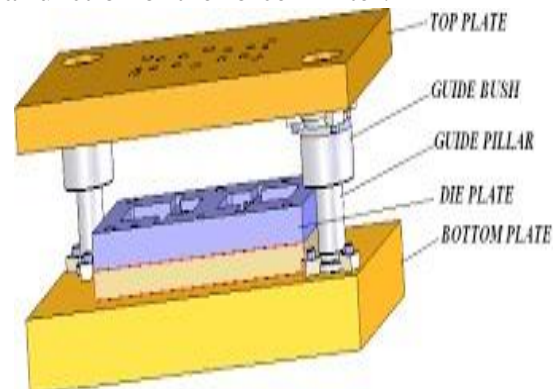
Key dimensions of the frame were modified using ANSYS Parametric Design Language (APDL) capabilities, with ANSYS Mechanical software analyzing the various combinations of parameters. They targeted their study towards reduction of bending stresses caused by bending of frame. Reduction of cost and Improvement in safety was another aim of their work. Software ANSYS was used for this work and found 13% reduction in frame.

Ever since the evolution of FEA, there has been a continuous and growing need for a powerful design analysis tool in the machine tools industry. Punch press can be defined as a machine used to make hole in metal sheet and creating the required work piece with the help of punching press tool. This machine may be smaller or larger or CNC type and produces one and more work piece in one time.



The force tool is used in this machine called punch as shown in figure 1 this punch tool generally made by hardened steel or tungsten carbide, it attached to the reciprocating arm of machine and other most part of this machine are die which attached or clamped onto the bed and anvil. For the analysis of the press frame strengthening, in order to ensure further operation of the press thought failures, the finite element method was used. The stress analysis by the FEM showed that rounding of the corner with a radius of 40 mm in locations of the

junction of steel sheets of the columns with the bottom crossbeams the maximum value of the equivalent stresses decreased from 273 MPa to 180 MPa, i.e. by approximately 35%. On the basis of the above-mentioned facts it was proposed to provide (after welding cracks) strengthening of the press frame by welding eight plates to all columns. Numerical analysis of the press frame showed that occurrence of sharp corners (without rounding) in the junction of the columns and bottom crossbeams caused (in the case of maximum allowable loading of ram 3500 KN equivalent stresses of 273 MPa. Crack initiation in the inner corners of the columns and also in other locations could be most probably caused by overloading during the operation which, however, was not caused by the technological process of pressing itself (cutting and forming), but as a result of inappropriate position of the semi-finished product and consequently arising of additional forces during the movement of the ram. However, in this case it appears to be due to malfunction of the force limiter.



When punch apply the force to work piece which is mounting in die, unwanted part of sheet metal starts shear out to make it in a blank as per the tool dimensions or required dimensions. Punching press machines known by its tonnage. Press machines currently utilizing in production industries have 30-ton capacity which may vary from 2000 to 2500 ton.

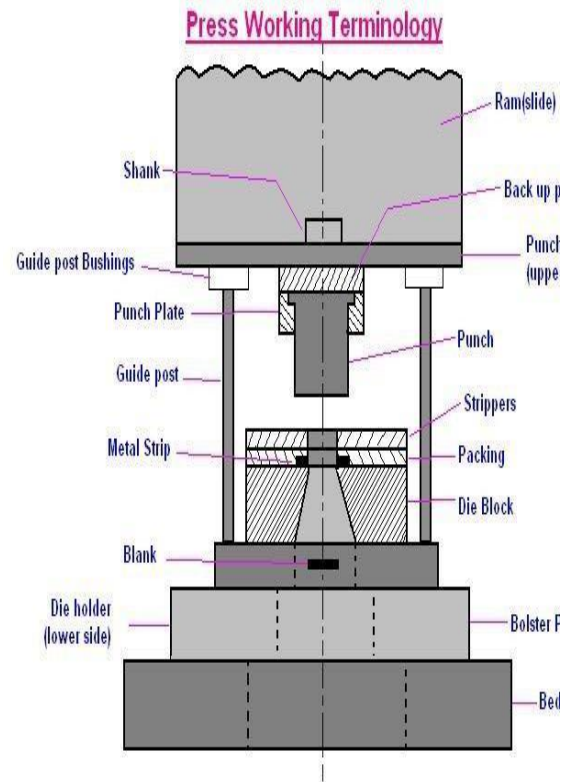
By this method one can get stresses in different sections, not only the maximum value. For a complete stress value and their distribution require a more complex calculation, furthermore allowing any dimensional optimization, such as FEM. Second, is presented a step-by-step method for modelling

the frame of mechanical press studied, using Pro/Engineer, in order to perform consequent static or dynamic analysis based on FEM, using COSMOS/M. So are presented the stages of defining the mesh, the environment bonds, the loads, and finally performing analysis and result interpretation. According to FEA results a continuous distribution of displacements and stresses that validate the model. At the end are presented considerations and comparison between the results of analytical method and FEM, regarding stress values and their distribution. Raut et al7 (2014) carried out the solution on designing of flywheel in different shape

i.e. web type flywheel, straight elliptical arm and tapered arm flywheel by using 4,6,8 arm and design it into the pro e after using ANSYS software for F.E.M. method and then find out the maximum deflection value . In 4, 6, 8 elliptical or taper arm flywheels. And final solutions in this analysis is It is observed that existing flywheel i.e. web construction is having maximum weight. It is observed that, all taper arm resp. 4, 6, 8 arm are having mass less than elliptical arm flywheel. It is observed that, stresses are greatest in 4 arm flywheel still it is less than its maximum stress value with minimum overall weight. Analysed a power press of 10 tonne capacity under static condition.

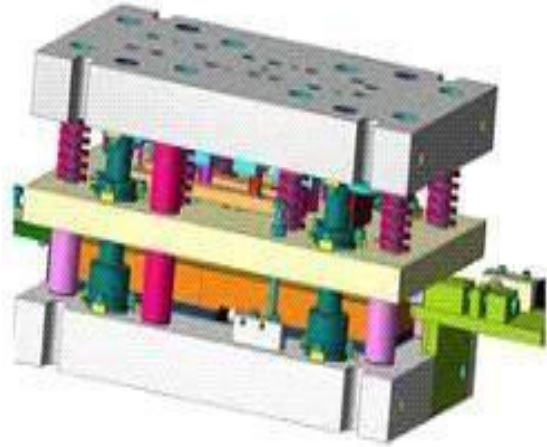
Implementing the booster system to increase the pressure of press by a desired ratio. For this no extra power input is needed. The pressurized air from the main compressor is taken as input to booster. It saves a lot of power consumption. Further no major modification is required in the circuit. Only small space is required for booster, reservoir and valves. The press is a try-out press. Now the press can be used for pressure higher than company pressure. Design of Air Booster for 1200 Ton Mechanical Thus various pressures can now be applied for pressing the sheet metal. Thus we can decide for which pressure the sheet gets pressed to desired shape to obtain good. Conducted design optimization and analysis of structure frame for heavy duty metal forming hydraulic press. More and Kulkarni11 (2015) analyse and optimize the 200 tone C type hydraulic press using ANSYS software. Ram et al12 (2015) studied

mechanical press machine setup process enhancement in metal-mechanic area for an elevators company. The work results from a master thesis project conducted during a period of five months.



Metal forming is one of the manufacturing processes which are almost chip less. These operations are mainly carried out by the help of presses and press tools. These operations include deformation of metal work pieces to the desired size and shape by applying pressure or force. Presses and press tools facilitate mass production work. These are considered fastest and most efficient way to form a sheet metal into Finished products. Here the problem statement of project is two combine these two piercing and notching operation. Which is now manufacturing separately i.e. two piercing by one punch and two notching operation with another punch.





Press tools are generally made using HCHCr, Steel alloys with high carbon. But before that based on many factors like cost, strength, hardness, strain and many parameters selection should be made. The materials used are generally selected are D2, EN31. Mild Steel is used as supporting plate. Apart from that materials like D3, high carbide materials, chromium steels and high speed steels are also used. D2 STEEL: This alloy is one of the Cold Work, high carbon, high chromium type tool steels. D2 is a deep hardening, highly wear resistant alloy. It hardens upon air cooling so as to have minimum distortion after heat treatment. Used for long run tooling applications where wear resistance is important, such as blanking or forming dies and thread rolling dies.

### Literature SURVEY

“Static Analysis Of Apress Ram- Linear Hydraulic Motor piston Assembly From Horizontal Hydraulic Press–2 Mn”- 2010 The aim of this paper is to analyses through the finite elements method (FEM)

the press ram-linear hydraulic motor piston assembly from horizontal Hydraulic Press – 2 MN. The analysis of ram-piston assembly was made for determination of stresses, displacements, deformations and the factor of safety distribution. A three dimensional model of the ram-piston assembly with a complex geometry was generated based on the designed data. The Finite Elements Analysis was performed using Solid Works 3D CAD Design and COSMOS Works software .The simulation results were evaluated and compared to the experimental data. Results show that the

established FEM model provides useful information for the ram-piston assembly optimal design.

M.Fulland “Analysis of Fatigue Crack Propagation in the Frame of A Hydraulic Press”-18 Jan 2007. Within this paper the fatigue crack growth in the frame of a hydraulic press will be discussed. The crack growth started at a shrink hole in a notch in the middle part of the frame. The state of stress of the crack is predominantly influenced by the notch, which induces a Mixed-Mode-loading during the crack growth. The propagation of the crack will be analyzed with the crack simulation program ADAPCRACK3D, which has been developed at the Institute of Applied Mechanics at University Paderborn. This program is able to calculate fully automatic the stress intensities along a 3D-crack front as well as the crack path and the lifetime of a structure.

Rakesh.A.Oza & S.P.Patel “Analysis and Optimization of Drive Shaft in Eccentric Mechanical Press” -2011 In current market, drive shaft is most important component to run the application, because of failure of shaft tends to stop the production line or manufacturing of the components. A Drive shaft is a rotating shaft that transmits power from the motor to the gear box. Drive shaft must operate in high and low power transmission of the fluctuating load as required in eccentric mechanical press.

Due to this type of fluctuating load drive shaft is fail. Thus it is important to make this shaft as per load requirement to avoid this failure. In this paper, first the model is prepare on the pro/Engineer software and after that the analysis work on the ANSYS for comparing the different such as bending stress, shear stress, and deflection of the shaft for existing condition as well as the new design which one developed for this condition. Then weight reduction is check by using E-Glass/Epoxy and HM- Carbon / Epoxy materials

Frantisek Trebuna “Analysis of Crack Initiation in the Press Frame and Innovation of the Frame to Ensure Its Further Operation”- 2011. This paper describes numerical and experimental analysis of the causes of press frame failure with the aim to propose an

optimal variant of its strengthening in order to guarantee safe operation of its original working regime. The analysis of stress states in the frame during the operation was performed using the finite element method. Experimental analysis was focused on determination of residual stresses in the locations of failures. The shapes and positions of cracks unambiguously document locations of their initiations and they are in agreement with results of analysis provided by FEM.

N.K.Mandavgade "A Review on Analysis and Optimization of Hydraulic Cotton Lint Bailing Press"-2012. Had discussed the FEA implementation for analysis and optimization of top and bottom frame for hydraulic cotton lint bailing press. The design calculations of Hydraulic press system are playing important role as we come to know the value of total force develops in the system. The value of tensile stresses developed in the system is greater than the permissible limit. Selection of good shape provides strength to the system as the system is only undergoing through bending according to the FEA Analysis the best solution is

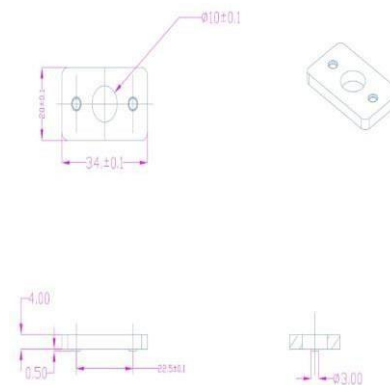
obtained by changing the shape and design of the Top and Bottom frame structure. They found that proposed design process successfully incorporates into a structural shape optimization problem. In addition to ensuring manufacturability of the structurally optimized components, the design process delivers components with minimum cost and required performance. The trade-off between structural performance and machining cost is highlighted using these design examples. Furthermore, the process starts with preliminary information about the component and delivers optimum components at the end.

Catalin Iancu - "Comparison between Analytical Calculus and Fem for A Mechanical Press Bed"-2013 In the first part of this paper is presented a method for calculating stress of press bed, based on expansion of classic methodology, using reduced frame, determined by the points of application of force and the gravity centre line, thus determining sectional geometry and maximum stress. Calculus is extended considering cross sections of the frame, from 15° to 15°, providing more

information on both maximum values and the distribution of these tensions. Values obtained confirm the assumption that using the simplified structure is obtained generally large the calculation usually used for verification.



**Modification & Parts With Figures**



#### **Salient Feature of tool manufacturing**

- The following precision and conventional processes were employed
- Wire EDM
- CNC
- Cylindrical grinding
- Surface grinding
- Milling
- Turning
- Drilling

#### **Top plate**

- Pre machined and ground
- Co-ordinate drilling including tooling hole and dowel hole  $\phi 6H7X2$  nos
- Boring of guide bush holes  $\phi 22H7X2$  nos and  $\phi 28X10$ mm Deep

for transfer plate Completed drilling, tapping , counter boring as per drawing.

**Bottom Plate**

- Pre machined and ground
- Co-ordinate drilling tooling hole and dowel hole Ø6H7 X 2nos
- Boring of guide pillar holes Ø15H7 and Ø16H7 and limit screw counter bore Ø17X15mm depth X4nos
- Completed drilling, tapping , counter boring as per drawing

**Guide pillar**

- Pre Turned
- C.G of Ø15/16g6 for Sliding fit & Ø15/16p6 for Press fit with Bottom Plate

**Guide Bush**

- Pre Turned
- Reaming of Ø15/16H7 for Sliding fit with Guide Pillar
- C.G of Ø22p6 for Press fit with Top Plate using mandrel

**Dia Plate**

- Pre machined and ground
- Co-ordinate drilling tooling hole and dowel hole Ø6H7 X 2nos
- Finishing of counterbore for shedder seating Ø 30 X 10mm depth
- WireEDM of Die profile Ø 21.00mm
- Completed drilling, tapping, as per drawing

**Stripper Plate**

- Pre machined and ground
- Co-ordinate drilling tooling hole, strip guide hole Ø4H7 X 4nos and stopper hole Ø 5H7
- Wire EDM of Die profile Ø 20.96mm
- Completed drilling and tapping as per drawing

**Punch Holder**

- Pre machined and ground
- Co-ordinate drilling tooling hole, dowel hole Ø6H7 X 2nos and Ø12H7 for piercing punch
- Finishing of counter bore Ø11 X 5mm depth for locating piercing punch
- Completed drilling as per drawing

**Piercing punch**

- Pre Turned
- C.G of Ø 10 for piercing & Ø10k6 for fitment with punch holder

Sr. No	Part Name	Material	Size	Quantity
1	Top Plate	MS	25X100 X132	1
2	Bottom Plate	MS	25X100 X132	1
3	Guide Pillar	MS	Dia 15/16X100	2
4	Guide Bush	MS	Dia 25X10	2
5	Dia Plate	MS	20X50X72	1
6	Stripper Plate	MS	10X50X72	1
7	Punch Holder Plate	MS	15X50X72	1
8	Piercing Punch	MS	Dia 10X35	2
9	Dimple Punch	MS	Dia 3X35	4

**Advantages**

- Less time required for production.
- Quality issue is low.
- Low cost as compared to the old part manufacturing.
- The requirement fulfillment as per the requirement of the industry.

### Disadvantages

- Higher scrap produced as compared to old.
- The process of segregation to be carried.
- In one strip 3 pieces are lost.

### CONCLUSION

- The development proves to be fruitful for the industry

- The production rate, quality norms are fulfilled
- The line management is to be use full because for the correction made in the project
- Financial stress reduced

The product proved to be beneficial for both the industry and we as trainee as well to develop and implement new for the better of the production & manufacturing sector.

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**Building Integrated Photovoltaic****(Solar Window)****Mahendra Patil<sup>1</sup>, Prof. Shantanu G. Pande<sup>2</sup>**<sup>1</sup> Student at Dept. of Civil Eng, <sup>2</sup> Prof. at Dept. of Civil Eng  
<sup>1,2</sup> Civil Eng. Dept., Sandip Institute of Engineering and Management**ABSTRACT**

For India, Where the whole country contains high supply of solar energy in most of the period of the year in all seasons except rainy season when there is reduction in availability of sunlight by approximate 70% an average of 20-25 days per 365 days in a year. To utilize the natural source of energy this research has been made. Models on this type of project has been already implemented in various countries but not yet done in India on a large scale.

This paper includes the practical study of how the solar energy can be used on small scale as homes as well as large scale as institutional buildings satisfying the role of green building. Practical model has been tested for the readings of voltage and currents to calculate the energy supply made by solar window to the appliances.

As it has been seen at many places that most of the construction buildings are fabricated with glazed panels for the good aesthetic purposes. Sometimes there is provision of stones or stylish tiles for wall cladding which results in good aesthetic purpose and this wall cladding have much more cost than simple wall with plaster so if we replaced this wall cladding with solar panels then we will get much more efficient look as well as sufficient amount of energy for our daily domestic use purpose. Also the huge industrial and educational buildings can generate their own electricity for machinery purposes and it will get reflected in saving or conservation of coal and environmental sources we use for generation of electricity.

**Keywords:** Transparent solar panel; Educational Building; MC4 connectors; Two-diode junction box; Multimeter; Integration Technology and Application.

**Introduction**

With the current data and analysis of sources for energy we are having, we all know that non-renewable resources are soon going to come to the mouth of end. hence, we need to find an alternate solution to overcome problems over resources.

As we have the ultimate source of power which we call as "Sun" can give us the unlimited energy over our needs. On a smaller scale also by using this type of energy resource, many consumers can become self-dependent and our non-renewable resources can be saved. In coming thought of Global Warming problem, the use of material or elements which causes some pollution after their use should be minimized or should be made limited only for commercial or needy uses. Whenever the natural resource is used for power generation, there is always zero pollution caused by procedure.

In case of Civil Engineering, the idea of placing solar panels on the roof top of a building of any type is becoming very common. There is a need to find an advance solution for perfect aesthetic and also this

method requires more place to run the project. To overcome this problem, we have a solution that we will provide solar windows instead of glass windows in buildings. The windows will not only fulfil the purpose of normal window itself by giving the privacy and passing the required sunlight but also provide electrical energy to the appliances in the house. This concept of solar window will also reduce the temperature inside the room due to overheating of the window. Forming a perfect BIPV (Building Integrated Photovoltaic) with less use of conventional energy, this project fulfils the requirement of Green Building.

**Status and Features of BIPV and Solar Windows****1.1. Status of BIPV and Solar Windows**

In Washington scientists have discovered a material for smart windows which will not only darken the screen of window when sun is bright but also produce electricity. On other hand china is at the first place to use solar energy appliances in the world.

According to current scenario it has found that India had not implemented a large-scale project

of solar windows. Many projects had been developed in India on solar energy as to place floating solar panels on the water surface, which has been implemented on a dam stored water surface in Gujrat. Many companies or chemical factories are busy in finding out the solution forming a thin solar film which will generate more electricity with major amount of sunlight passing through it.

### 1.2.Features of BIPV and Solar Windows

The main features of BIPV and Solar Windows are

#### 1) Utilization of area

The value of area per feet in metro cities are reaching the sky. In such case if the unused area of any building is replaced with other material providing energy and also giving perfect aesthetics to the building will be a perfect solution to overcome this problem. Almost in all cases, solar panels are provided on roof top of a building which stuck the large space of use on roof but in case of solar windows it won't stuck the using area of building moreover it will give a good aesthetic view to building with providing better energy to each and every room of building.

#### 2) Zero Carbon effect

Due to the fear of large area getting stuck into installation of a solar panel resources, many societies reject to use solar panels instead of conventional source of electricity which causes in rapid reduction of conventional power generating sources. But if awareness is made in people to use natural ultimate source of energy by attracting them with infatuation of good aesthetics at less cost then, it will save a tremendous amount of generating electricity by conventional methods. Installation of solar windows does not cause any type of pollution and having a long life of use.

#### 3) High initial cost

As this solar window are not just glass so they provide electricity by generating it with the help of sunlight like photovoltaic cells, they posses a high amount as compare to normal glass window. Therefore, for small budget projects the total estimated cost of building goes on higher side but also it gives profitable amount back in few years by generating own electricity and using it.

### **Application of BIPV and Solar Windows in Institutional building**

The application of solar windows and building integrated photovoltaic mainly has two aspects: Solar windows and installation of solar panels on cladding of institutional building.

#### **Solar panels on windows**

Windows are mainly used to fulfil its purpose which is to give a privacy to the room, to avoid suffocation and to provide enough amount of light as per the requirement of the room and to provide protection against weather. The more use of window can be made by updating the type of window to solar windows which will not only fulfil the basic needs of window but also give energy in the form of electricity by converting the solar energy into electrical energy. Solar windows are also best at the aesthetics at their position rather than using normal dark color (blue, green, black) coatings to reduce the extra brightness of sunlight, if dark color coated windows are replaced with solar windows then the window will reduce the intensity of sunlight coming into room and will use to remaining sunlight to generate electricity. In case of normal windows, when it comes in contact with sunlight the temperature of window glass goes on increasing and it also increases temperature inside the room which results in heating up in room. To reduce the temperature of the room one uses the Air Conditioner or ceiling fan to make room temperature normal again. Due to use of this appliances major effect causes to global warming outside the room and also separate more amount of electricity is needed to run these appliances. On other hand solar windows not only reduces the brightness coming inside the room but also absorbs the heat and gives the cool or constant room temperature needed as per owner which causes the less use of air conditioning system and respectively saves environment. Also, solar windows are with high transparency than using other darked color foils on surface of windows which gives the clear view of outside of building. Solar windows can be made by various means as per requirements of the owner or depending on the function and can also be vary with the type of building. As in type of commercial

buildings there is no much more use of view outside of the building, the only purpose is to generate greater amount of electricity by using lesser material and area hence at this type of buildings the normal solar panels can be simply installed on the existing surface of window and the connection can be provided to inner appliances on smaller scale.

In case of institutional buildings there is large amount of area available for installation of solar panels on the glasses which are only for the purpose of aesthetics and easily can be get replaced with the transparent solar glass panels which will completely fulfil the purpose of building. Some of institutional buildings are completely build with surface having only glass on front surface which gives the amazing idea to replace all glass panels by solar panels windows resulting in good aesthetics and also providing electricity to nearby lab appliances.

Providing solar windows to the residential building can be better option. As per research we came to know that solar windows provided per house can give the sufficient or more than required amount of electricity to run without using single commercial unit of electricity. When solar windows are provided to whole building, the building can run its own power generation unit and also can sell this excess generated electricity to conventional energy sources board. This application also reduces the cost of maintenance residences giving to the chairman.

### Process of Installation

As solar windows were going to be installed in institutional type of building. First the complete survey of building has done which includes the places where large amount of sunlight is present and also having high intensity. Then calculation of timing made that how much total time light is present at selected locations. Then locations where solar windows are going to be installed are finalized.



**Solar window location survey**

Testing of panels is performed after finalizing the location. In this process the panel was tested at various locations at different times in a day. Approximately 3 to 4 readings of voltage and current were measured during the testing of panels. This measured readings then compared with given readings by the manufacturer of panel. As the panel was flexible and directly came from the company, the measured reading was correctly matched with given readings by the manufacturing company of panel. As the reading of voltage was constant throughout the analysis but readings of current varied as per location changed. Also, the value of current depends on the size of cell panel is made with. Current also varied with the changing intensity of sunlight.



To install solar panel at the window making it a solar window, many ideas can be followed. But the panel was having a junction box of size approximately 8cm x 15cm and having thickness of around 1.3 cm. to overcome this problem the solution was made that the thickness of panel will be made to 2 cm by providing a foam sheet in a row or in the form of strips at the back of the panel edges. Which will give a regular thickness to the panel throughout. When it was practically done the panel had possessed a high weight due to which panel didn't get stick to the glass window. It might have required more time to get stuck with glass window. The material called silicone sealant was used to paste foam sheet and panel and also foam sheet and glass.



The used silicone sealant was of company named *NEUTRAL PLUS*.



*Sealant used for pasting*



*Foam and Panel pasting work*

Junction box behind the panel was completely studied before fixing the panel on the window making it as a solar window. The connections between the cells and diode to diode connection was studied.



*Junction box*



*Inside view of Junction box*

**Measurement of Readings**

When the solar window was fixed on a selected location, the measurement of readings of

voltage and current was taken from next day of installation. We used multimeter to measure readings of both voltage and current. Readings were measured at a specific time interval everyday with changing angle about 15, 20, 25 and 90 deg. All measured readings are stated in given table below. All readings are taken in year 2021.

Date	Time	Voltage readings (volts)		
		11:00	1:00	3:00
		AM	PM	PM
27/02	15 <sup>0</sup>	38.2	37.8	36.8
	20 <sup>0</sup>	38.5	37.7	36.7
	25 <sup>0</sup>	38.4	37.6	36.7
	90 <sup>0</sup>	38.9	37.8	37.4
01/03	15 <sup>0</sup>	38.3	38.0	36.9
	20 <sup>0</sup>	38.2	38.0	36.4
	25 <sup>0</sup>	38.3	37.9	36.4
	90 <sup>0</sup>	38.7	38.4	37.5
02/03	15 <sup>0</sup>	39.1	38.3	37.6
	20 <sup>0</sup>	38.6	38.1	37.3
	25 <sup>0</sup>	38.4	38.1	37.2
	90 <sup>0</sup>	38.9	38.8	37.8
03/03	15 <sup>0</sup>	38.3	36.7	38.5
	20 <sup>0</sup>	38.2	36.5	38.4
	25 <sup>0</sup>	38.1	36.4	38.4
	90 <sup>0</sup>	39.7	37.7	38.7
04/03	15 <sup>0</sup>	38.7	38.3	37.8
	20 <sup>0</sup>	38.6	38.2	37.2
	25 <sup>0</sup>	38.7	38.2	37.5
	90 <sup>0</sup>	39.1	38.7	38.1
05/03	15 <sup>0</sup>	38.7	38.1	38.2

	20 <sup>0</sup>	38.6	38	38		20 <sup>0</sup>	38.2	36.5	38.4
	25 <sup>0</sup>	38.8	37.9	37.6		25 <sup>0</sup>	38.1	36.4	38.4
	90 <sup>0</sup>	40.9	39.5	38.8		90 <sup>0</sup>	39.5	39.0	38.4
<b>09/03</b>	15 <sup>0</sup>	39	38.7	38.2	<b>17/03</b>	15 <sup>0</sup>	38.2	37.8	36.8
	20 <sup>0</sup>	38.9	38.5	38.2		20 <sup>0</sup>	38.5	37.7	36.7
	25 <sup>0</sup>	39	38.4	38		25 <sup>0</sup>	38.4	37.6	36.7
	90 <sup>0</sup>	40	41.2	39.9		90 <sup>0</sup>	39.2	38.4	37.7
<b>10/03</b>	15 <sup>0</sup>	38.2	37.8	36.8	<b>18/03</b>	15 <sup>0</sup>	39.1	38.3	37.6
	20 <sup>0</sup>	38.5	37.7	36.7		20 <sup>0</sup>	38.6	38.1	37.3
	25 <sup>0</sup>	38.4	37.6	36.7		25 <sup>0</sup>	38.4	38.1	37.2
	90 <sup>0</sup>	39.4	38.5	38.1		90 <sup>0</sup>	39.8	39.2	38.6
<b>11/03</b>	15 <sup>0</sup>	38.3	36.7	38.5	<b>19/03</b>	15 <sup>0</sup>	39	38.7	38.2
	20 <sup>0</sup>	38.2	36.5	38.4		20 <sup>0</sup>	38.9	38.5	38.2
	25 <sup>0</sup>	38.1	36.4	38.4		25 <sup>0</sup>	39	38.4	38
	90 <sup>0</sup>	40.2	39.4	38.3		90 <sup>0</sup>	40.1	39.8	38.6
<b>12/03</b>	15 <sup>0</sup>	39.1	38.3	37.6	<b>20/03</b>	15 <sup>0</sup>	38.7	38.3	37.8
	20 <sup>0</sup>	38.6	38.1	37.3		20 <sup>0</sup>	38.6	38.2	37.2
	25 <sup>0</sup>	38.4	38.1	37.2		25 <sup>0</sup>	38.7	38.2	37.5
	90 <sup>0</sup>	40.2	40.0	39.3		90 <sup>0</sup>	39.8	39.0	38.4
<b>13/03</b>	15 <sup>0</sup>	39	38.7	38.2	<b>22/03</b>	15 <sup>0</sup>	38.2	37.8	36.8
	20 <sup>0</sup>	38.9	38.5	38.2		20 <sup>0</sup>	38.5	37.7	36.7
	25 <sup>0</sup>	39	38.4	38		25 <sup>0</sup>	38.4	37.6	36.7
	90 <sup>0</sup>	40.2	40.0	39.3		90 <sup>0</sup>	40.3	39.7	38.8
<b>15/03</b>	15 <sup>0</sup>	38.7	38.3	37.8	<b>23/03</b>	15 <sup>0</sup>	39.1	38.3	37.6
	20 <sup>0</sup>	38.6	38.2	37.2		20 <sup>0</sup>	38.6	38.1	37.3
	25 <sup>0</sup>	38.7	38.2	37.5		25 <sup>0</sup>	38.4	38.1	37.2
	90 <sup>0</sup>	41.2	39.4	39.3		90 <sup>0</sup>	39.8	38.6	37.4
<b>16/03</b>	15 <sup>0</sup>	38.3	36.7	38.5	<b>24/03</b>	15 <sup>0</sup>	38.7	38.3	37.8

	20 <sup>0</sup>	38.6	38.2	37.2		20 <sup>0</sup>	38.9	38.5	38.2
	25 <sup>0</sup>	38.7	38.2	37.5		25 <sup>0</sup>	39	38.4	38
	90 <sup>0</sup>	38.9	38.1	37.6		90 <sup>0</sup>	38.4	37.9	37.1
<b>25/03</b>	15 <sup>0</sup>	38.3	36.7	38.5	<b>02/04</b>	15 <sup>0</sup>	38.3	36.7	38.5
	20 <sup>0</sup>	38.2	36.5	38.4		20 <sup>0</sup>	38.2	36.5	38.4
	25 <sup>0</sup>	38.1	36.4	38.4		25 <sup>0</sup>	38.1	36.4	38.4
	90 <sup>0</sup>	38.4	38.1	37.6		90 <sup>0</sup>	38.6	38.1	37.8
<b>26/03</b>	15 <sup>0</sup>	39	38.7	38.2	<b>03/04</b>	15 <sup>0</sup>	39.1	38.3	37.6
	20 <sup>0</sup>	38.9	38.5	38.2		20 <sup>0</sup>	38.6	38.1	37.3
	25 <sup>0</sup>	39	38.4	38		25 <sup>0</sup>	38.4	38.1	37.2
	90 <sup>0</sup>	39.4	38.8	38.2		90 <sup>0</sup>	39.6	39.0	38.6
<b>27/03</b>	15 <sup>0</sup>	38.7	38.3	37.8					
	20 <sup>0</sup>	38.6	38.2	37.2					
	25 <sup>0</sup>	38.7	38.2	37.5					
	90 <sup>0</sup>	39.0	38.6	37.8					
<b>29/03</b>	15 <sup>0</sup>	38.2	37.8	36.8					
	20 <sup>0</sup>	38.5	37.7	36.7					
	25 <sup>0</sup>	38.4	37.6	36.7					
	90 <sup>0</sup>	39.8	38.6	37.2					
<b>30/03</b>	15 <sup>0</sup>	39.1	38.3	37.6	<b>01/03</b>	15 <sup>0</sup>	0.92	0.73	0.70
	20 <sup>0</sup>	38.6	38.1	37.3		20 <sup>0</sup>	0.88	0.71	0.69
	25 <sup>0</sup>	38.4	38.1	37.2		25 <sup>0</sup>	0.84	0.69	0.67
	90 <sup>0</sup>	39.5	38.6	38.1		90 <sup>0</sup>	0.98	0.68	0.71
<b>31/03</b>	15 <sup>0</sup>	38.7	38.3	37.8	<b>02/03</b>	15 <sup>0</sup>	0.87	0.52	0.34
	20 <sup>0</sup>	38.6	38.2	37.2		20 <sup>0</sup>	0.87	0.53	0.34
	25 <sup>0</sup>	38.7	38.2	37.5		25 <sup>0</sup>	0.85	0.53	0.35
	90 <sup>0</sup>	38.8	38.3	37.5		90 <sup>0</sup>	0.86	0.52	0.33
<b>01/04</b>	15 <sup>0</sup>	39	38.7	38.2	<b>03/03</b>	15 <sup>0</sup>	0.88	0.74	0.81
						20 <sup>0</sup>	0.83	0.76	0.83

**Current readings (Watt)**

Date	Time	11:00 AM	1:00 PM	3:00 PM
	Angle			

<b>27/02</b>	15 <sup>0</sup>	0.8	0.5	0.36
	20 <sup>0</sup>	0.8	0.5	0.36
	25 <sup>0</sup>	0.8	0.5	0.35
	90 <sup>0</sup>	0.8	0.5	0.35
<b>01/03</b>	15 <sup>0</sup>	0.92	0.73	0.70
	20 <sup>0</sup>	0.88	0.71	0.69
	25 <sup>0</sup>	0.84	0.69	0.67
	90 <sup>0</sup>	0.98	0.68	0.71
<b>02/03</b>	15 <sup>0</sup>	0.87	0.52	0.34
	20 <sup>0</sup>	0.87	0.53	0.34
	25 <sup>0</sup>	0.85	0.53	0.35
	90 <sup>0</sup>	0.86	0.52	0.33
<b>03/03</b>	15 <sup>0</sup>	0.88	0.74	0.81
	20 <sup>0</sup>	0.83	0.76	0.83

	25 <sup>0</sup>	0.83	0.76	0.79		25 <sup>0</sup>	0.83	0.76	0.79
	90 <sup>0</sup>	0.90	0.86	0.86		90 <sup>0</sup>	0.91	0.89	0.86
<b>04/03</b>	15 <sup>0</sup>	0.89	0.78	0.72	<b>15/03</b>	15 <sup>0</sup>	0.89	0.74	0.71
	20 <sup>0</sup>	0.90	0.75	0.72		20 <sup>0</sup>	0.89	0.77	0.73
	25 <sup>0</sup>	0.86	0.73	0.70		25 <sup>0</sup>	0.87	0.77	0.74
	90 <sup>0</sup>	0.95	0.76	0.72		90 <sup>0</sup>	0.90	0.88	0.87
<b>05/03</b>	15 <sup>0</sup>	0.89	0.74	0.71	<b>16/03</b>	15 <sup>0</sup>	0.86	0.89	0.84
	20 <sup>0</sup>	0.89	0.77	0.73		20 <sup>0</sup>	0.87	0.88	0.84
	25 <sup>0</sup>	0.87	0.77	0.74		25 <sup>0</sup>	0.87	0.88	0.86
	90 <sup>0</sup>	0.92	0.79	0.76		90 <sup>0</sup>	0.89	0.88	0.86
<b>09/03</b>	15 <sup>0</sup>	0.86	0.89	0.84	<b>17/03</b>	15 <sup>0</sup>	0.8	0.5	0.36
	20 <sup>0</sup>	0.87	0.88	0.84		20 <sup>0</sup>	0.8	0.5	0.36
	25 <sup>0</sup>	0.87	0.88	0.86		25 <sup>0</sup>	0.8	0.5	0.35
	90 <sup>0</sup>	0.89	0.91	0.88		90 <sup>0</sup>	0.88	0.86	0.85
<b>10/03</b>	15 <sup>0</sup>	0.8	0.5	0.36	<b>18/03</b>	15 <sup>0</sup>	0.92	0.73	0.70
	20 <sup>0</sup>	0.8	0.5	0.36		20 <sup>0</sup>	0.88	0.71	0.69
	25 <sup>0</sup>	0.8	0.5	0.35		25 <sup>0</sup>	0.84	0.69	0.67
	90 <sup>0</sup>	0.90	0.89	0.88		90 <sup>0</sup>	0.89	0.87	0.86
<b>11/03</b>	15 <sup>0</sup>	0.92	0.73	0.70	<b>19/03</b>	15 <sup>0</sup>	0.87	0.52	0.34
	20 <sup>0</sup>	0.88	0.71	0.69		20 <sup>0</sup>	0.87	0.53	0.34
	25 <sup>0</sup>	0.84	0.69	0.67		25 <sup>0</sup>	0.85	0.53	0.35
	90 <sup>0</sup>	0.89	0.87	0.84		90 <sup>0</sup>	0.90	0.88	0.87
<b>12/03</b>	15 <sup>0</sup>	0.87	0.52	0.34	<b>20/03</b>	15 <sup>0</sup>	0.88	0.74	0.81
	20 <sup>0</sup>	0.87	0.53	0.34		20 <sup>0</sup>	0.83	0.76	0.83
	25 <sup>0</sup>	0.85	0.53	0.35		25 <sup>0</sup>	0.83	0.76	0.79
	90 <sup>0</sup>	0.91	0.89	0.86		90 <sup>0</sup>	0.89	0.88	0.86
<b>13/03</b>	15 <sup>0</sup>	0.88	0.74	0.81	<b>22/03</b>	15 <sup>0</sup>	0.89	0.74	0.71
	20 <sup>0</sup>	0.83	0.76	0.83		20 <sup>0</sup>	0.89	0.77	0.73

	25 <sup>0</sup>	0.87	0.77	0.74		25 <sup>0</sup>	0.8	0.5	0.35
	90 <sup>0</sup>	0.91	0.89	0.88		90 <sup>0</sup>	0.92	0.90	0.89
<b>23/03</b>	15 <sup>0</sup>	0.86	0.89	0.84	<b>31/03</b>	15 <sup>0</sup>	0.92	0.73	0.70
	20 <sup>0</sup>	0.87	0.88	0.84		20 <sup>0</sup>	0.88	0.71	0.69
	25 <sup>0</sup>	0.87	0.88	0.86		25 <sup>0</sup>	0.84	0.69	0.67
	90 <sup>0</sup>	0.89	0.87	0.86		90 <sup>0</sup>	0.88	0.86	0.87
<b>24/03</b>	15 <sup>0</sup>	0.89	0.74	0.71	<b>01/04</b>	15 <sup>0</sup>	0.87	0.52	0.34
	20 <sup>0</sup>	0.89	0.77	0.73		20 <sup>0</sup>	0.87	0.53	0.34
	25 <sup>0</sup>	0.87	0.77	0.74		25 <sup>0</sup>	0.85	0.53	0.35
	90 <sup>0</sup>	0.88	0.87	0.87		90 <sup>0</sup>	0.87	0.86	0.86
<b>25/03</b>	15 <sup>0</sup>	0.8	0.5	0.36	<b>02/04</b>	15 <sup>0</sup>	0.88	0.74	0.81
	20 <sup>0</sup>	0.8	0.5	0.36		20 <sup>0</sup>	0.83	0.76	0.83
	25 <sup>0</sup>	0.8	0.5	0.35		25 <sup>0</sup>	0.83	0.76	0.79
	90 <sup>0</sup>	0.87	0.86	0.84		90 <sup>0</sup>	0.87	0.86	0.85
<b>26/03</b>	15 <sup>0</sup>	0.92	0.73	0.70	<b>03/04</b>	15 <sup>0</sup>	0.8	0.5	0.36
	20 <sup>0</sup>	0.88	0.71	0.69		20 <sup>0</sup>	0.8	0.5	0.36
	25 <sup>0</sup>	0.84	0.69	0.67		25 <sup>0</sup>	0.8	0.5	0.35
	90 <sup>0</sup>	0.89	0.86	0.87		90 <sup>0</sup>	0.90	0.88	0.86
<b>27/03</b>	15 <sup>0</sup>	0.87	0.52	0.34					
	20 <sup>0</sup>	0.87	0.53	0.34					
	25 <sup>0</sup>	0.85	0.53	0.35					
	90 <sup>0</sup>	0.90	0.88	0.87					
<b>29/03</b>	15 <sup>0</sup>	0.88	0.74	0.81					
	20 <sup>0</sup>	0.83	0.76	0.83					
	25 <sup>0</sup>	0.83	0.76	0.79					
	90 <sup>0</sup>	0.89	0.89	0.87					
<b>30/03</b>	15 <sup>0</sup>	0.8	0.5	0.36					
	20 <sup>0</sup>	0.8	0.5	0.36					

These readings of voltage and current of panel was taken in the multimeter of company named KUSAM-MECO. There were four connection settings for the wires to measure both the readings at different powers. First the pointer of the multimeter was set to 200 DCV for measuring voltage and the wires of color red and black were connected to MC4 connectors accordingly. Then the reading displaying on multimeter was noted down. After taking the reading of voltage, now it was time to take reading of current of panel. So, pointer of the multimeter was now set to 200m ACA. The black wire was now inserted in the 10A hole for the measurement of current. After connecting multimeter wires to MC4 connector wire, the display of multimeter started showing

the reading of current of the panel which was later noted down.



**Connection between multimeter and panel for measurement of readings**



**Measurement of readings**

### Conclusions

From calculations it is also concluded that the difference between construction of wall cladding and placing of solar panels by fabrications comes out to be near about Rs.40,00,000. It means the cost required for fabrication of solar panels on wall is going to be much more than wall cladding due to the higher cost of panels. But by the provision of solar panels, some kind of energy is getting generated which can be used for the regular purpose of civil department as we are going to provide that panels only for civil department. Civil department will be able to create its own energy for its daily purposes. Most of the machineries, desktops, lights and fans and

everything which needs electricity to run can be run by using this energy.

Not only this but also the energy which is remaining after daily usage can be stored into batteries or can be sold to the electricity board. In return they will provide energy to the department of civil engineering in rainy seasons or at the time of maintenance when panels will be unable to produce electricity or energy. This method is going to save tremendous amount of money in future or any it will also avoid the dependency of civil department on any conventional source for electricity.

By the measurement of this readings, it has been concluded that this flexible solar panel which has been used for the calculation and measurement readings by pasting it on the glass window of civil engineering department that the energy created by solar panel by using present sunlight at place is efficient to run the appliances or machineries civil department have included. The energy produced by this panels at present place can be used in daily purposes of department and also the remaining energy can be stored or sold to conventional electricity board. This solar panels are fulfilling the purpose of department for not being dependent on conventional source of energy for electricity and making own electricity for the conservation of nature by any means.

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## Product Recommendation System Using Machine Learning Based Collaborative Filtering Technique

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### ABSTRACT

The idea of efficiently locating one's favorite product in a vast dataset of application database has become a crucial challenge to handle for online content providers in order to attract the masses as compared to their competitors in today's current period of information technology. Recommender systems, also known as recommendation systems, are information filtering systems that are typically connected with a variety of consumer and commercial applications. These systems operate as a link between numerous content providers, such as social media websites, e-commerce portals, streaming platforms, and app users, by proposing items from the app database that match the user's tastes and previous activity. Such customized solutions are especially useful when the user is unsure what they are looking for. The 'Because you watched' header on Netflix, the 'People you may know' section on Facebook, and the 'Customers who bought this also bought' division on Amazon are all examples of these algorithms permeating every facet of our life.

**Keywords:** Datasets evaluation and analysis, genre, information storage and retrieval, machine learning algorithms, rating, recommender engine, recommendation techniques and types, user's preferences.

### Introduction

Recommender engines are enabling designs for existing commercial software that take user footprints as input, analyze them, and generate acceptable probabilistic future footprints depending on the user's preferences.

One of the distinctive features of a personalized recommendation system is that it helps millions of content consumers narrow down the number of possible things to meet their own likes. They assist users in filtering products or services such as books, movies, restaurants, and other such items from the vast array of options available on the internet or through other electronic information sources.

The underlying algorithmic computations present to the user a significantly tighter range of items that are well suited to their customized description once the engine is fed with a big dataset of things and descriptions of the users' priorities. This user-centered comfort and customizing strategy lets clients connect more effectively with the system that caters to their needs, while also increasing revenue for virtual firms that host such systems.

Due to the fact that recommender engines are data-intensive and improve as more content is input into them, they require more complex

computer capacity to execute data analysis on millions of user and product records in the shortest amount of time possible.

Three essential components make up an ideal recommendation system:

- 1) User resource – study of user interests,
- 2) Item resource – analysis of item features, and
- 3) The algorithm for making recommendations.

The recommendation algorithm compares the user's interests to the item features to anticipate which products to recommend. The performance of this algorithm has an impact on the whole system's performance.

### Problem Statement

For offering data items to their users, a number of existing recommendation engines use a content-based method. However, because the breadth of recommendations is limited to a single user's prior experience and ratings, such an approach is highly narrow.

As a result, we plan to develop a recommender system based on a collaborative machine learning technique. When compared to content-based systems, such systems should produce



better explicit outcomes [4]. While content-based engines do not recommend things out of the box, limiting the user's ability to explore further, a collaborative approach computes a similarity relationship between several users based on their evaluations. Such algorithms promote things to other users with similar likes, increasing the possibility of further exploration of the company's product database.

### Objectives

For generating suggestions, most novice recommendation systems use one of the following techniques:

- 1) The user's preference (i.e. content-based filtering), or
- 2) The preference of other users (i.e. collaborative filtering).

Our project's goal is to create a reliable and accurate recommender system by combining several collaborative filtering algorithms that should:

- 1) Analyze the behavior of like-minded people to accurately suggest similar products,
- 2) Make real-time product quality assessments based on other people's experiences.

### Literature Survey

*Moviemender – A Movie Recommender System [1]*

The authors propose developing and implementing a hybrid recommendation engine that combines content-based and collaborative filtering-based recommendations. The system's intricacy and resource consumption make it impossible to deploy on a smaller scale of personal computers, despite its goal of providing accurate and efficient movie suggestions.

*Design and Implementation of Movie Recommendation System based on KNN Collaborative Filtering Algorithm [2]*

The importance of individualized recommender systems is the emphasis of this research article. When people are unsure about the content they are looking for, such systems become crucial. The authors explore collaborative filtering techniques like KNN to build and develop a system prototype. There's also a detailed principle and database architecture model.

*A Proposed Book Recommender System [3]*

The authors of this study compile a list of content filtering strategies and propose a hybrid strategy for implementing them. They also expand on existing recommendation systems' information.

*Movie Recommendation System using Machine Learning [4]*

The authors of this research emphasize the limits of content-based filtering approaches. Content-based systems are limited to people and do not offer suggestions outside of the box, restricting the opportunity to learn more. As a result, they present a model that attempts to combine both a content-based and a collaborative approach.

*Online Book Recommendation System using Collaborative Filtering (with Jaccard Similarity) [5]*

This paper discusses the difficulties that Amazon, Goodreads, and other book recommendation services confront in filtering, prioritizing, and providing correct book suggestions. The authors suggest a method that combines Collaborative Filtering with Jaccard similarity to deliver more accurate suggestions due to scalability, sparsity, and cold start concerns.

### Recommendation Techniques

The following components are typically found in recommender systems [3]:

- 1) Background data - data that systems already have owing to previous computations before the recommendation process begins,
- 2) Input data - the information that the user provides to the system in order for it to make recommendations,
- 3) A combination of recommendation algorithms that generate suggestions by combining background data and input data.

The approaches used to create suggestions can be divided into five categories [3]:

- 1) Content based filtering,
- 2) Collaborative filtering,
- 3) Demographic filtering,
- 4) Utility based filtering,
- 5) Knowledge based filtering.

*Content based Filtering Technique [1]*

Products are recommended based on comparisons between item profile and user profile in content-based filtering. A user profile

is a set of pre-assigned keywords collected by an algorithm from objects judged interesting by the user, whereas an item profile is a set of pre-assigned keywords for an object.

The following is an example of a content-based filtering strategy in use today: Assume a customer wants to purchase a pastry from a neighborhood baker's shop. Unfortunately, the shopkeeper informs him that the desired pastry is unavailable and advises him to choose another dessert with similar taste, flavor, price, and components. This is very similar to the content-based approach.

IMDB and Pandora are two well-known internet services that use this strategy. The technique of Locality-Sensitive Hashing is used for this filtering. For products with high-dimensional data, Locality-Sensitive Hashing (LSH) performs probabilistic reduction of product dimensions or characteristics. The products are mapped into related categories using a hashing technique. The goal is to increase the likelihood of comparable products colliding. The Jaccard similarity methodology is commonly used to determine product similarity.

Advantages of content based filtering are:

- 1) It can recommend unrated products as well,
- 2) Knowing the item profile of an item allows us to easily forecast recommendations, and
- 3) It only needs the rating of the concerned user to make suggestions, not that of other similar users.

Limitations of content-based filtering are:

- 1) It is inefficient for a newly logged-in user who has yet to review any product,
- 2) It does not recommend unusual goods,
- 3) Limited content is analyzed to generate suggestions, and
- 4) It does not recommend goods outside of the box, so restricting the user's exploration.

#### *Collaborative Filtering Technique [1]*

Collaborative filtering-based systems function by matching the similarity among like-minded individuals and their preferences for certain data pieces to recommend products.

A famous example of collaborative filtering is when a person asks his friends to propose movies to him, assuming that those friends have similar tastes in movies to the individual.

Furthermore, the item-to-item collaborative filtering strategy, which is adopted by Amazon, an e-commerce behemoth, is a recently popularized algorithm.

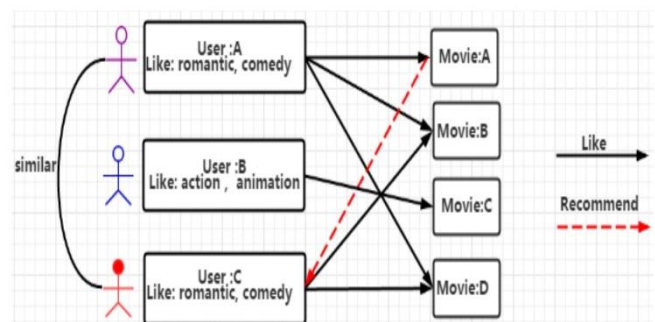
Previously, social networking sites employed a pure form of collaborative filtering to promote new virtual friends and groups to users based on the similarity of their relationships with their existing friends.

Advantages of collaborative filtering are:

- 1) It is content-independent because it is based on the similarity of user relationships,
- 2) Such systems can recommend unfamiliar items by observing similar-minded people's behavior, and
- 3) They can conduct real-time quality assessments of things by considering other people's experience.

Limitations of collaborative filtering are:

- 1) Early rater problem (cold start problem) - Because there are no user ratings yet to compute a prediction, collaborative filtering systems cannot make suggestions for newly added products in the repository,
- 2) The grey sheep dilemma - It's difficult to recommend things to people who don't like the same genre every time,
- 3) Sparsity problem - In most circumstances, the majority of active users will only score a small portion of the total database. As a result, even the most popular things may have a small number of ratings, making them ineligible for recommendations,
- 4) Scalability - With millions of users and items, large-scale systems require a lot of computational capacity to make suggestions.



**Fig. 1: Example of collaborative filtering algorithm [2]**

*Demographic Technique [3]*

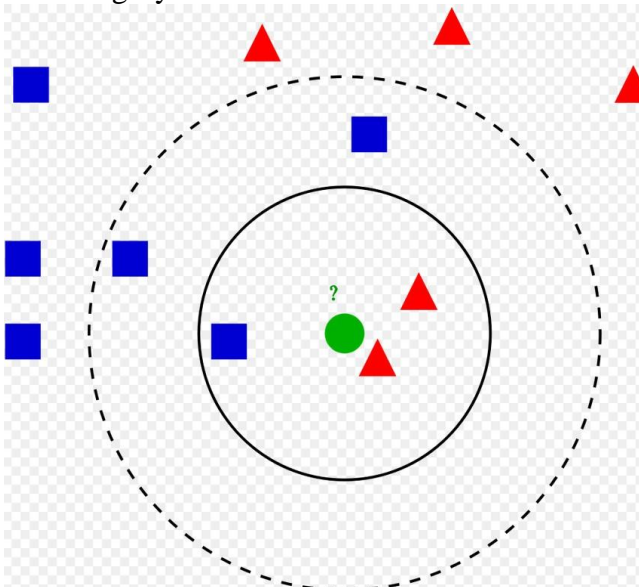
The engines that classify users based on personal traits and create recommendations based on pre-determined demographic classifications are known as demographic recommender systems. Grundy, a 1979 system that suggested e-books to users based on personal data acquired via an interactive interface, was an early example of such a system. Personal responses from a survey were matched to a database of user classes that had already been compiled. In contrast to collaborative and content-based strategies, such an approach does not require historical data of previous user ratings.

**Proposed System Methodologies**

This part delves into the technical approaches that will be used to implement the proposed system, as well as the sequence of steps. In addition, the proposed system's operations, functions, and events are described.

*KNN Algorithm [2]*

The KNN algorithm is short for "K-Nearest Neighbor." The premise behind this approach is that if a majority of a sample point's k-most comparable neighbors (points) belong to a specific problem space category, then the sample point is also considered to belong to that category.



**Fig. 2: Illustration of KNN algorithm**

Assume the green circle represents the sample point for which the closest neighbors with the most similarity are to be discovered. Because there are two red triangles and only one blue square, the green sample point is allocated to the majority red triangles category if  $k = 3$

(solid line circle). Because there are three blue squares and only two red triangles, the green sample point is assigned to the majority blue squares category if  $k = 5$  (dotted line circle).

*Collaborative Filtering based KNN Algorithm [2]*

The KNN collaborative filtering algorithm is based on collaborative filtering. It searches, analyses, and selects the most comparable nearest neighbors using the KNN algorithm. The following are the steps that must be followed in order to implement this algorithm:

- 1) User similarity calculation,
- 2) KNN nearest neighbour selection, and
- 3) Predict score evaluation.

*User Similarity Calculation*

Consider the dimensionality matrix for users and products below. The user set,  $U = \{u1, u2, u3, u4\}$  and the movie set,  $M = \{m1, m2, m3, m4, m5\}$  are considered here.

U\M	m1	m2	m3	m4	m5
u1	1	3	3	4	2
u2	3	1	4		
u3	2	4		1	5
u4	2		2		

**Fig. 3: User-product matrix [2]**

The relevant ratings supplied by each user to each movie are represented by the values in the matrix. We'll need their respective rating vectors to calculate the similarity between users. Let's say we wanted to determine the degree of similarity between users,  $u1$  and  $u3$ . Then  $u1 = \{1, 3, 4, 2\}$  and  $u3 = \{2, 4, 1, 5\}$  are their equivalent vectors.

The similarity between two users  $x$  and  $y$  is frequently determined using the following formula:

*Cosine Similarity*

To calculate the similarity, cosine of angle between two vectors is used.

$$\text{sim}(x, y) = \cos(\vec{X}, \vec{Y}) = \frac{\vec{X} \cdot \vec{Y}}{|\vec{X}| * |\vec{Y}|} = \frac{\sum_{s \in S(x,y)} r(x,s) * r(y,s)}{\sqrt{\sum_{s \in S(x,y)} [r(x,s)]^2} \sqrt{\sum_{s \in S(x,y)} [r(y,s)]^2}} \tag{1}$$

Here,

sim(x,y) = similarity between users x and y,

r(x,s) = rating by user x to product s,

r(y,s) = rating by user y to product s,

s(x,y) = set of movies that both users rated.

Pearson Correlation Similarity

To calculate the similarity, linear relation between two vectors is used.

$$\text{sim}(x,y) = \frac{\sum_{s \in s(x,y)} [r(x,s) - \bar{r}_x][r(y,s) - \bar{r}_y]}{\sqrt{\sum_{s \in s(x,y)} [r(x,s) - \bar{r}_x]^2} \sqrt{\sum_{s \in s(x,y)} [r(y,s) - \bar{r}_y]^2}} \tag{2}$$

Here,

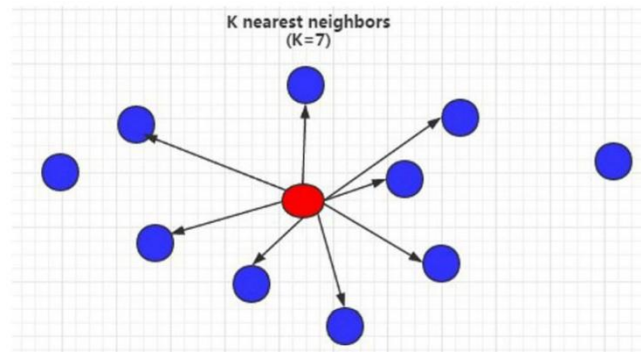
sim(x,y) = similarity between users x and y,

$\bar{r}_x$  = average rating by x,

$\bar{r}_y$  = average rating by y.

**KNN Nearest Neighbor Selection**

Consider the following diagram for k-nearest neighbor selection, where k = 7 and the red point represents the sample data item for which the most similar 7 neighbors must be calculated.



**Fig. 4: Illustration of KNN for k=7 [2]**

**Predict Score Evaluation**

The average rating score calculation for a data item 'i' is given by,

$$r(u,i) = \bar{r}_u + k \sum_{u' \in U} \text{sim}(u,u') * [r(u',i) - \bar{r}_u] \tag{3}$$

Here,

$$k = \frac{1}{\sum |\text{sim}(u,u')|}$$

(4)

r(u,i) = predicted rating of item 'i' to user 'u'.

**Mathematical Model**

Consider the proposed system to be a set of tuples such that:

S = {I, O, F, Success, Failure}, where

S = Proposed system,

I = Set of inputs to the system,

O = Set of outputs from the system,

F = Set of system functions,

Success = Success case,

Failure = Failure case.

Here,

I = {I1, I2, I3}, where

I1 = User credentials, I2 = User ratings, I3 = Addition of products to existing database by the admin,

O = {O1, O2}, where

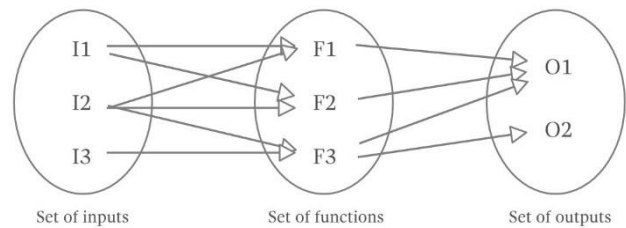
O1 = Generating recommendations, O2 = Displaying recommendations,

F = {F1, F2, F3}, where

F1 = User similarity calculation, F2 = KNN nearest neighbor selection, F3 = Predict score evaluation,

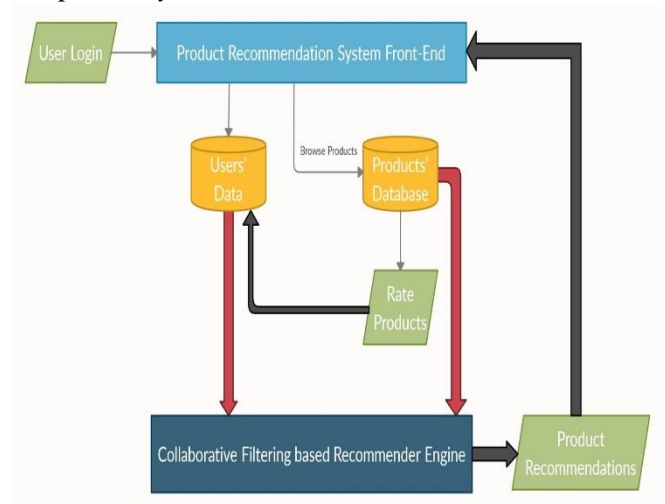
Success = Generating feasible and optimum product recommendations based on collaborative filtering technique,

Failure = Not generating recommendations based on collaborative filtering technique.



**Fig. 5: Proposed mathematical model**

**Proposed System Architecture**



**Fig. 6: Proposed system architecture**

**Feasibility Study**

**Technical Feasibility**

We intend to build our recommender system on the Python based libraries and toolkits such as scikit, numpy, pandas, etc. in order to not only reduce the line of code but also improve abstraction of data, by utilizing the

mathematical and machine learning capabilities of these libraries and packages. It is with these toolkits that the relevant training datasets will be fed into the system, so that appropriate techniques and algorithms such as KNN can be employed efficiently. The system is proposed to be hosted on Microsoft Azure for accessing remote computing capabilities. At the same time, the Application Programming Interface (API) is supposed to be developed using web2py or TensorFlow. The intuitive frontend user interface can be attempted using VueJS (a JavaScript reactive package) or Flutter.

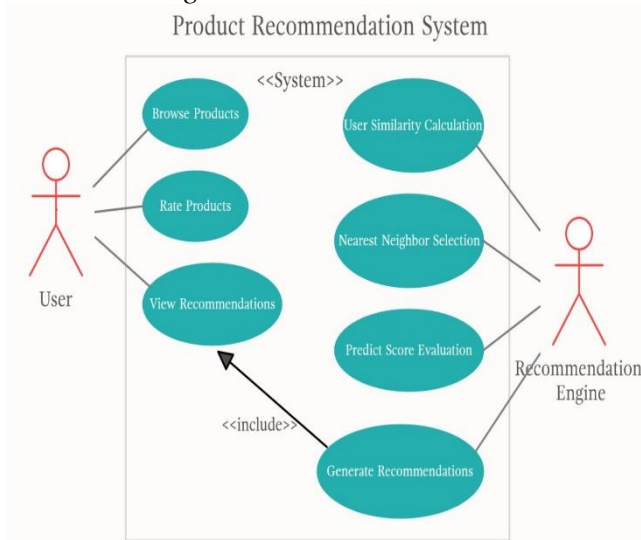
**Operational Feasibility**

The recommender is expected to be implemented in a manner that it will allow the generation of relevant recommendations in an optimum way. Moreover, a user-centric interface will be presented in a modular fashion.

**UML Diagrams**

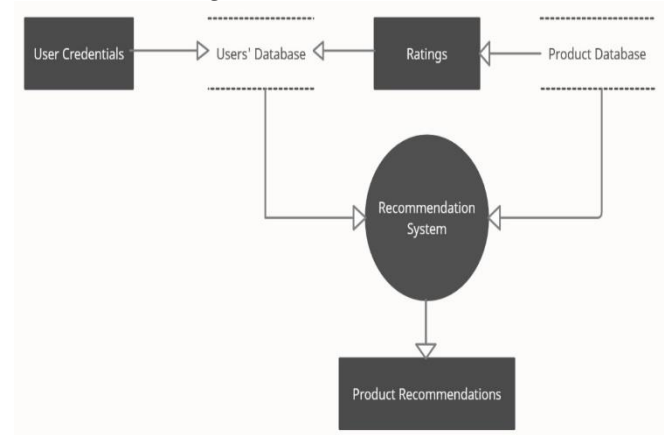
The abbreviation UML stands for Unified Modelling Language, a software engineering area that specifies numerous standard techniques to depict system architecture. The diagrams for our suggested system are as follows:

**Use Case Diagram**



**Fig. 7: Use case diagram**

**Data Flow Diagram**



**Fig. 8: Data flow diagram**

**Implementation**

The dataset we are using is from MovieLens [5], a movie recommendation service, and it describes 5-star rating and free-text tagging behavior. Over 9742 movies, it has 100836 ratings and 3683 tag applications. Between March 29, 1996, and September 24, 2018, 610 users created this data. On September 26, 2018, this dataset was created.

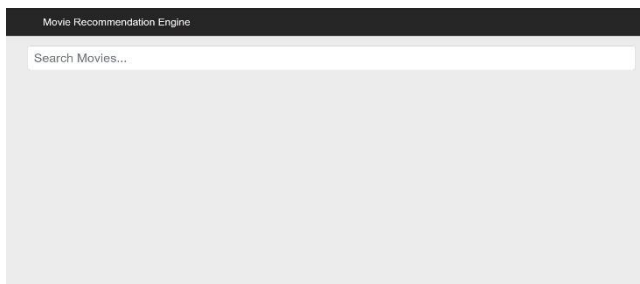
The participants were chosen at random. All of the individuals who were chosen had rated at least 20 films. There is no demographic information provided. An id is assigned to each user, and no other information is provided.

The files 'links.csv', 'movies.csv', 'ratings.csv' and 'tags.csv' contain the information. This is a development dataset. As a result, it may change over time and is not suitable for sharing study findings.

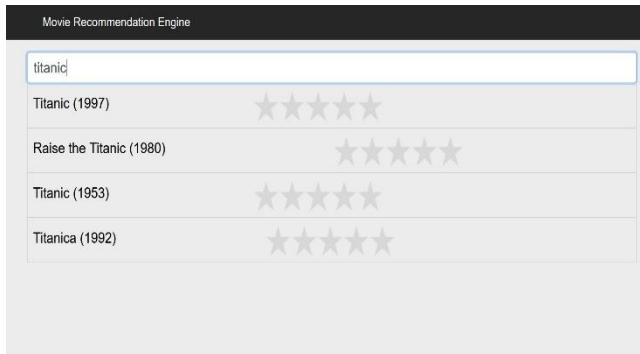
This, as well as other GroupLens datasets, are open-source and freely available [6].

The suggested recommendation system is built using the technologies described in the Feasibility Study section above.

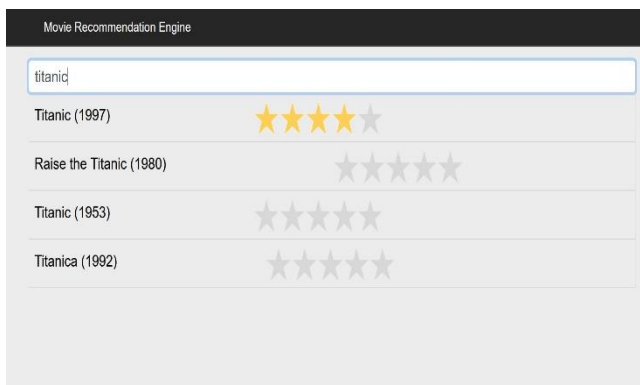
A few screenshots of the implemented recommender system are shown below:



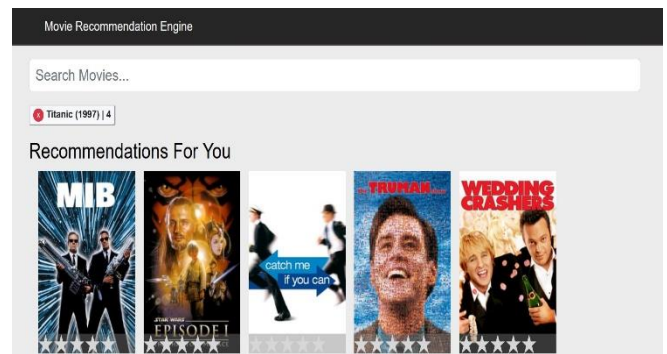
**Fig. 9: Recommendation system home page**



**Fig. 10: Recommendation system movie search**



**Fig. 11: Recommendation system movie rating**



**Fig. 12: Recommendation system generated movie recommendations**

### Acknowledgment

All of the well-wishers and benefactors who helped us propose the defined model and its connected architecture deserve our sincerest gratitude. Furthermore, we would like to express our gratitude to Dr. Kamini C. Nalavade, our research paper advisor and guide, under whose tutelage our potential endeavors came to fruition. We owe a debt of gratitude to the authors of our literature review and their respective prestigious publishing houses.

### Conclusion

Because the suggested recommendation system is based on a machine learning-led collaborative filtering strategy, its results are predicted to be distinct from those of systems that use a content-based approach. Our system is supposed to calculate the similarities among a large number of product retail application users, taking into account their similar tastes, and then, based on their ratings for the data products, recommend items to other users who have similar tastes, allowing them to explore more of the commercial repository.

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### Fully Automated Vegetable Cleaner Using Ozone Disinfectant

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### ABSTRACT

Ozone, a form of oxygen commonly associated either with its ability to guard against the sun's harmful ultraviolet radiation or with smog, recently gained approval for use in the U.S. food processing industry to help rid food of dangerous pathogens (bacteria, parasites, fungi, and viruses). Ozone is a universal disinfectant that can oxidize organic matter and inorganic compounds, destroy viruses, bacteria and other pathogens. For over a century, ozone has been used in water treatment processes and only recently it has started to play a major role in the food and agriculture industry. Increased demand from consumers and current regulations have led to an exhaustive overhaul of the types of disinfectants used in the washing processes for fruit and vegetables. The use of ozone for washing salads and vegetables produces water with a high degree of purity that is unattainable with other methods. Its disinfection power and the total absence of chemical products in the end-product make this system the ideal choice for this type of process. With 4 ppm of residual ozone in the wash water, a reduction of 99.99% in terms of surface contamination can be obtained. These results are equal or better than those obtained using 50 ppm of chlorine. Another advantage is that after washing, the water used is not contaminated and there are no alternations in the product's color, quality or texture. Sometimes, the average product life is even prolonged through this process. The more we research and learn about ozone, the more impressive Ozone's resume becomes. The number of applications completely dominated by Ozone is staggering. Ozone kills most bacteria within 15 seconds. After 20 seconds Ozone destroyed all E-coli. Chlorine's efficiency is quite poor compared to ozone. The paper is aimed to highlight the latest work in this field.

**Keywords:** Vegetable Cleaner, Ozone Disinfectant, Fully Automated.

### 1. INTRODUCTION

when one increases the consumption of fruits and vegetables, they get many health benefits. However, there is a catch when it comes to the intake of fruits and vegetables. The produce available in the supermarkets is ridden with contamination on the surface which can make us extremely sick. With the pollution levels at an all-time high, the contamination of fruits and vegetables is apparent. Washing the produce is certainly not enough in today's day and time. However, it is almost impossible to get rid of the contamination from pesticides and microbes which can be dangerous for your health. Vegetables, including leafy vegetables, are an important component of a healthy diet;

they contain nutrients that are now known to be beneficial for the health of consumers. These nutrients are often referred to as phytochemicals or phytonutrients. There is sufficient information in the literature to show that they protect consumers from heart disease, inflammation, cancer formation and many other chronic diseases. In India, dehydration of vegetables has a bright prospect over other foods because disinfecting agents have a widespread application to assure safety and quality in the food industry. the food industry is in search of applications that are:

- Effective in inactivation of common and emerging pathogens and removing toxic contaminants.
- Leading less loss in product quality.

- Adaptable to food processes
- Environmental friendly.

**In recent years, increasing attention has been focused on the safety of vegetables, and in particular on the intervention methods to reduce and eliminate human pathogens from fresh produce.** Traditional technology utilizes water with or without a sanitizing agent to wash fresh vegetables. Chlorine is the most widely used sanitizing agent available for fresh produce, but it has a limited effect in killing bacteria on fruit and vegetable surfaces. The most that can be expected at permitted concentrations is a 1- to 2-log population reduction. Furthermore, the environmental and health communities have expressed concerns about the residual by-products of chlorine. An alternative treatment is being sought to improve food safety. Research and commercial applications have verified that ozone can replace traditional sanitizing agents and provide other benefits. Washing of vegetables on-farm is a practice that is used routinely by vegetable growers over many countries. Vegetables need washing for three main reasons:

- 1) They need washing to remove dirt and dust so that they can be presented to the consumer in a visually appealing manner,
- 2) They need washing with sanitizers for postharvest treatment purposes so that postharvest plant diseases can be kept under control and thus increase vegetable shelf life and
- 3) They need washing with sanitizers for food safety purposes so that human pathogens that may be present on the surface of vegetables are not passed on to consumers.

The latter purpose is becoming more and more important as supermarkets, wholesalers and processors are pushing food safety down the line of supply to growers. Vegetable growers however have not kept up with developments in the area of sanitizers and most have not moved away from Chlorine solutions due to the fact that little or no independent information is filtering down to them in terms of new sanitizers. Chemical industry sales representatives are often the only source of information for the growers but this source of advice can be one-sided and skewed towards the product they sell.

Ozone treatment has the potential to meet these criteria and gives encouraging results for some problems of the food industry. The term “ozone” comes from the Greek word “ozein” which means “to give off odour”. Ozonation has been used for years to disinfect water for drinking purposes in Europe. An expert panel in 1997 decreed that ozone was a GRAS (generally recognized as safe) substance when used in accordance with good manufacturing practices. It has now been approved for use as a disinfectant or sanitizer in food processing in the US. However, any regulations for usage of ozone in the food industry have not been established in countries such as Turkey. Ozone was tested for inactivation of microorganisms, removing toxic substances and extending the shelf life of a number of products including fruits and vegetables. Ozone was quite efficient for these applications. Especially, ozone revealed promising results in solving the problems of the food industry like mycotoxin contamination and pesticide residues. However, some detrimental effects of ozone on certain products, such as apples, bananas and leafy vegetables, were also reported. [3, 4] This article gives some general information about ozone and reviews the studies based on ozone applications mainly in fruits and vegetables. Moreover, the effects of ozone on product physiology and quality were evaluated. And finally, the suitability of ozone applications in the vegetable industry was discussed.

## 2. LITERATURE REVIEW

**Vithu Prabha, Ranjit Singh, Aditya Madan (Aug 2015)-** Interest in ozone has expanded in recent years in response to consumer demands for ‘greener’ food additives, regulatory approval and the increasing acceptance that ozone is an environmentally friendly technology. Ozone, a powerful oxidant, is effective against various kinds of microorganisms on fruits, vegetables, meat grains and their products. The multifunctionality of ozone makes it a promising food processing agent. Excess ozone auto decomposes rapidly to produce oxygen and thus leaves no residues in foods from its decomposition. Ozone as an oxidant is used in water treatment, sanitising, washing and disinfection of equipment, odour removal, and



fruit, vegetable, meat and seafood processing. Ozone treatment assures the retention of sensory, nutritional and physicochemical characteristics of food. Treatment conditions should be specifically determined for all kinds of products for effective and safe use of ozone.

**Nisha Verma, Amit Nath, Debashis Dutta (Feb 2014)**- The use of ozone in the processing of foods has recently come to the forefront as an anti-microbial agent for food treatment, storage and processing. Ozone is now being used as a safe, powerful disinfectant to control biological growth of unwanted organisms in products and equipment used in the food and beverage industries. In liquid solution, ozone can be used to disinfect equipment, process water, and some food products. In gaseous form, ozone helps sanitize and assist in the preservation of certain food products, and is also used to sanitize food packaging materials. Some products currently being preserved with ozone include eggs during cold storage, fresh fruits and vegetables, and fresh fish. In the agriculture industry ozone is being used for disinfection. Another important application is the use of ozone as an alternative to methyl bromide as a fumigant to control insect infestations in stored food, grains and other agricultural products. It is also being used as a general soil fumigant/sterilant in drip irrigation systems. In this review, present status of ozone application in food industry was discussed.

**Adesoji Olaniyan, Samuel Kehinde Oyeniyi (march 2014)**- A fruit washing machine was designed and fabricated taking into consideration the techno-economic status of the micro, small and medium scale fruit farmers who are the intended users of the machine. Considerations also included high washing capacity and efficiency and the desire to make the construction materials of stainless steel to ensure the quality of the washed product. Other consideration was a strong main frame as support to ensure structural stability of the machine. The machine was designed for ergonomic value, safety and ease of operation and maintenance by incorporating guards around the moving parts and components. Rollers were also incorporated in the design to ensure easy movement of the machine. The machine was tested using 50 samples of orange

for the washing operation. During the testing, the belt conveying mechanism was such that the fruits were conveyed under high jet spray pressure in order to get rid of the attached foreign materials. The test result showed that the washing capacity was 0.0163 tonnes/h or 16.3 kg/h and washing efficiency was 62.5 %. Powered by a 1 hp single phase gear electric motor, the machine has a production cost of USD 300 while all the construction materials were available locally.

**Ms. Anjali Meshram, Dr. S. R. Ikhhar, Dr. A. V. Vanalkar (June 2018)**- Vegetables of fruits and root vegetables should be cleaned before weighting and grading as harvesting process leaves soil and foreign materials stick to the vegetables. Soil and other foreign materials must be removed, especially for medium and heavy textured soil in which a pre-harvest irrigation is used to loosen the soil prior to hand harvesting. Washing of fruits and root vegetables is vital steps in any processing operation, which give attractive and chemical free fruits. At the present time, washing of fruits is carried out manually which very tedious and time consuming and expensive process. As we know that time and human power are the important concern now a days in every field so there is requirement to design and develop a vegetable cleaning machine which will reduce the required human effort and make their task easy to work. The main objective of this study is to design and develop a vegetable cleaning machine, using CAD - Software and FEA-Techniques. In this paper, the design calculations and CAD modeling and Finite Element analysis of the vegetable cleaner is presented to conclude the safe design of machine.

**Dang Hoang Minh, Bui Van Phuong, Phung Van Binh, Nguyen Viet Duc (jan 2020)**- Loam soil often sticks to fruit and vegetable, once they are harvested from the field in developing countries due mainly to agricultural farming habits. Subsequently prior to be sold on the market and used by people, it is obligatory to clean soil particle from their surface. Although they can be washed by hand, this manner seems to be common only in family. For the medium-size businesses or

restaurant, it is truly required to have a mechanical washer. Bearing in mind the existing washing concepts, in this paper, a multi-functional fruit and vegetable washer was proposed. This new-type washer used a combination of horizontal shaking and rotation yielded by slider-crank mechanism with spring to clean the sample. The first prototype was successfully manufactured and its performance was evaluated by washing different types of vegetables including water spinach, bok choy, and carrot. Indeed, these vegetables were visually free of soil particle, once they had been machined-washed. A positive outcome of the first prototype promises for commercial production in the near future.

**Anjali Meshram<sup>1</sup> Dr. S. R. Ikhar<sup>2</sup> Dr. A. V. Vanalkar<sup>3</sup> (vol II) (2020)-** Root vegetables and fruits should be cleaned before weighting and grading as in the harvesting process it leaves the soil and foreign materials stick to the vegetable surface. Soil and other foreign materials must be removed, especially for medium and heavy textured soils in which a pre-harvest irrigation is used to loosen the soil prior to hand harvesting. Washing of fruits and root vegetables is vital steps in any processing operation, which give attractive, polished and chemical free fruits and vegetables. At present time, washing of fruits and root vegetables is carried out manually which is very tedious and time consuming and expensive process. As we know that time and human power are the important concern, now a days in every field so there is a requirement as to be design and develop a vegetable cleaning machine which will reduce the required human effort and make their task easy. Main objective of this study is design and develop a vegetable cleaning machine, using CAD model and FEM-Analysis Techniques. In this study, the design calculations and CAD modeling and Finite Element Analysis of the vegetable cleaner machine is present to conclude the safe design.

**Robert Premier et al (2017)-** in this the aim of this project was to compare the efficacy of sanitizing chemicals available in Australia in reducing both spoilage and pathogenic microorganisms on vegetables, particularly leafy vegetables. Leafy vegetables are often consumed uncooked and hence the way that

they are washed is critical in preventing food safety incidents at point of consumption. The comparison between sanitizers was done in a realistic commercial setting, using equipment already present on farm. The vegetables used in the testing were part of a normal harvest on that same farm. This project

- studied the efficiency of peroxyacetic acid and acetic acid sanitisers
- studied the efficacy of chlorine and chlorobromo sanitisers
- studied the efficacy of organic sanitisers derived from natural material
- studied the efficacy of new and emerging chemical free sanitiser technology
- studied the shelf life of leafy vegetables after treatment with a number of sanitisers.
- extended the knowledge to individual growers on the importance of the sanitation step
- supplied information to the vegetable industry on the correct ways to sanitise leafy vegetables in wash baths and hydro coolers.
- Washing vegetables in water containing 100 ppm of chlorine remains the most suitable system available to growers that wash on-farm at the moment. Chlorine has advantages in terms of efficacy, cost effectiveness and ease of handling. This is closely followed by Chlorobromo sanitisers, which are just as effective but have a slightly higher cost.

**Hakan Karaca (2014)-** Suggested that as widely used sanitizers, such as chlorine, have some disadvantages because of their limited effects in reducing microorganisms and concerns about their probable effects on health. Methyl bromide, a fumigant commonly used in farming and industry, has detrimental effects on ozone layer. Because of these reasons, the usage of these chemicals has been restricted, and they are thought to be phased out in near future. Ozone, a powerful oxidant, is effective against various kinds of microorganisms on fruits and vegetables. Promising results have been revealed in solving the problems of the food industry like mycotoxin and pesticide residues by ozone application. Spontaneous decomposition without forming hazardous residues in the treatment medium makes ozone safe in food applications. If improperly used, ozone can cause some deleterious effects on products, such as losses in sensory quality.

Treatment conditions should be specifically determined for all kinds of products for effective and safe use of ozone. Ozone application has given promising results for important problems of food industry, such as mycotoxin and pesticide residues. Degradation products, formed after ozonation of these residues, have not exactly been determined, and this seems to be the most crucial obstacle on this subject. In vivo and in vitro toxicological tests are needed to be conducted to screen the effects of degradation products on human and animal health. Through emerging new techniques, as well as improvements and innovations in ozone generating and application systems, the subject will be evaluated more effectively in future.

### 3. SCOPE OF WORK

Ozone (O<sub>3</sub>) is formed by a high energy input that splits the oxygen (O<sub>2</sub>) molecule in the air. Single oxygen (O) molecules rapidly combine with available O<sub>2</sub> to form ozone ( $3 O_2 \leftrightarrow 2 O_3 + \text{heat and light}$ ). In nature, the source of this high energy is the ultraviolet irradiation from the sun and also lightning discharge. Commercially, ultraviolet irradiation and more frequently corona discharge method is used to generate ozone. A schematic diagram of ozone generation by corona discharge method is given in Fig. 1. There are two electrodes in corona discharge, the high tension and low tension electrodes, separated by a dielectric medium in a narrow discharge gap. When electrons have sufficient energy to dissociate the oxygen molecule, a certain fraction of these collisions occur and a molecule of ozone can be formed from each oxygen atom. In addition to photochemical and electric discharge methods, ozone can be produced by chemical, thermal, chemo nuclear and electrolytic methods

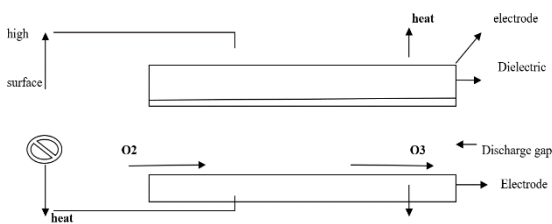


Fig1: Schematic diagram of ozone generation by corona discharge method.

There are two electrodes in corona discharge, the high tension and low tension electrodes, separated by a dielectric medium in a narrow

discharge gap. When electrons have sufficient energy to dissociate the oxygen molecule, a certain fraction of these collisions occur and a molecule of ozone can be formed from each oxygen atom. In addition to photochemical and electric discharge methods, ozone can be produced by chemical, thermal, chemo nuclear, and electrolytic methods. Ozone, relatively stable in air but highly unstable in water, decomposes in a very short time. It cannot be stored and must be generated continuously. The only product of ozone, when it decomposes, is oxygen; so, food products treated with ozone are free of disinfectant residue. Ozone exists in the gaseous state at room and refrigeration temperature and it is partially soluble in water. It has a pungent, characteristic odor described as similar to "fresh air after a thunderstorm." Ozone has an oxidation-reduction potential of 2.07 mV, which is a rather higher value than the potentials of other oxidants (hydrogen peroxide: 1.78mV, hypo chlorous acid: 1.49 mV, chlorine: 1.36mV, chlorine dioxide: 1.27, etc.)

#### Implementing Ozone Technology:

To safely adopt ozone technology, a company should do the following before making any major capital investment:

- Understand the process flow, to know exactly where ozone will fit in and why.
- Conduct pilot trials before starting commercial application, because every ozone application is unique. Ozone efficiency will be affected by many factors, such as water quality, temperature, pH, and composition of products. Pilot testing will help the engineer to determine the size of the generator and the costs of the system.
- Know the water and wastewater parameters. If processors want to recycle process water (it is always a good practice to use ozonated water to wash produce, if it is to be recycled), knowing the plant water and wastewater parameters will be useful in designing the system.
- Work with an ozone company experienced in the produce industry, since ozone applications there are significantly different from those in other industries, such as water treatment and the laundry industry. The partner selected to work with should be able to identify

opportunities; help conduct ozone testing; provide applications technology expertise on produce; conduct cost analysis; provide reliable equipment; recommend ozone level and contact time; have expertise in ozone production and injection; have the ability to design and install a commercial system; and understand the regulatory and safety issues to assure compliance and environmental and public health.

#### **4. SYSTEM DESCRIPTION AND METHODOLOGY**

##### **4.1. System description:**

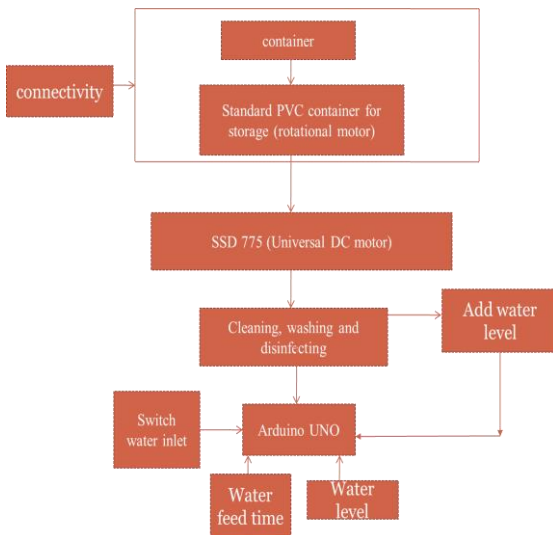
The increasing demand for sanitation as a means for controlling infection and disease in food and the need for reducing the emission of polluting substances have made researchers search for safe and new sanitizing methods. Ozone has proved to be suitable for this purpose. The molecule has a pungent and characteristic odour and at high levels of concentration it is blue at ordinary temperatures. At the level of concentration at which it is normally used, the color is not noticeable.

##### **4.2. Why Ozone?**

The potential utility of ozone in the produce industry depends on the fact that as an oxidizing agent, it is 1.5 times stronger than chlorine and is effective over a much wider spectrum of microorganisms than chlorine and other disinfectants. Ozone kills bacteria such as *Escherichia coli*, *Listeria*, and other food pathogens much faster than traditionally used disinfectants, such as chlorine, and is free of chemical residues. Ozone is a high-energy molecule. Its half life in water at room temperature is only 20 min, and it decomposes into simple oxygen with no safety concerns about consumption of residual ozone in the treated food product. It can also be used for recycling water. Fresh fruits and vegetables are washed first by ozonated water, and the wash water can be recaptured and treated by a combination of ozonation and filtration. The treated wash water is free of bacteria, color, and suspended solids and can be recycled to reduce water usage. Unlike conventional

chlorine-based washing systems, waste water discharged by an ozonation process is free of chemical residues, a growing concern related to the environment and groundwater pollution. Ozone can also destroy pesticides and chemical residues, such as chlorinated by-products. Gaseous ozone is a strong sanitation and fumigation agent and can be used to sanitize foods in the storage room and during shipping to prevent bacteria, mold, and yeast on the food surface and to control insects. It can eliminate undesirable flavor produced by bacteria and chemically remove ethylene gas to slow down the ripening process, thus allowing extended distribution. For decades, it has been known that ozone is an effective disinfectant and sanitizer for the treatment of food products. Thus, ozone can successfully replace traditional sanitizing agents to control food pathogens. It is partially soluble in water and, like most gases, increases in solubility as the temperature decreases. It is effective in killing microorganisms through oxidation of their cell membranes. Ozone has a unique property of auto decomposition and will leave no toxic residues. It has an oxidation potential 1.5 times stronger than that of chlorine and has been shown to be effective over a much wider spectrum of microorganisms than chlorine and other disinfectants. Ozone is generated naturally by ultraviolet irradiation from the sun and from lightning. It can be generated commercially by UV lights (at 185 nm) or corona discharge. If a high concentration of ozone is desired, corona discharge is commonly used. There are two types of feed gas—air, generally at a concentration of 1–3% (w/w), and oxygen, generally at 2–12 %). One way to maintain or even improve the safety of fresh produce is to wash vegetables and fruits using ozonated water.

##### **4.3. Methodology**



The given machine as shown in the diagram was designed to operate the vegetables in to the specific limit of the batches. These batch limits will be based on the volume, how much the PVC external device can withstand it. Let's assume about 20 kg of the vegetables can be fed per batch into the washing chamber through the external device consisting of motor plugged over there. This motor is a moving or rotational motor and the device used here is SSD 775 universal DC motor.

Over to this block up above there is an additional block of one more container, this container is the stationary container which holds the overall system. It is having a lid which is made up of fiber. The motor attached to this block is the stationary block motor which generally holds the overall system. As the motor rotates the speed of the motor is variable. There are additional two pumps attached over the system. The two pumps are inner and outer pump. The main function of the outer pump is to keep the water level consistent. It performs the function over the loop that when all the water gets drained inside, it will automatically throw the water inside. The inner pump is also called as the feed pump, this is because it performs the function of extraction and this pump is submersible. The pump is closed with the air tight container, as the motor is rotating over the pump.

The water supplied from the external pump is fed over to this internal pump. Over to this the pipe is connected to the systems made up of rubber. Through this pipe, our ozone disinfectant carries out its function. Through

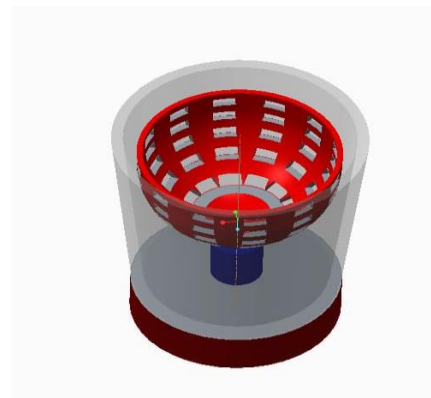
the external feed pump pipe, the supply of the oxidized oxidation is carried out and it is supplied to the container containing the vegetables in the bucket. The overall system uses O3 pure vegetable washer Ozoning technology to clean the produced. The motor produces O3 and mixes it with the water.

In return, ozonated water performs the function of breaking down the toxic material in vegetables and frees them from all the dirt, dust and pesticides. The centralized unit attached to this is arduino UNO where all the operation will take place. The connectivity to the system is the centre and to this all the blocks are connected. The timing motor, temperature checker and the rotational motor are connected over this block. The rotational motor will be performing the functions and the system will detect the speed of the motor. As soon as the rotor will start to rotate the slow, medium or fast will plug out. The motor will rotate and feed pump will move over 400 rpm.

It will calculate the time and work accordingly. The time taken to fill the water will be 10 seconds, and consequently the motor will rotate for 5 minutes, the vegetables will get wash, and followed by this it will be disconnected by the next 1 minute. There will be three modes from which user will select and perform the function accordingly. The discharging process of the system will regulate automatically. Thus the time saving machine with good results will be available.

## 5. DESIGN, CONSTRUCTION, WORKING

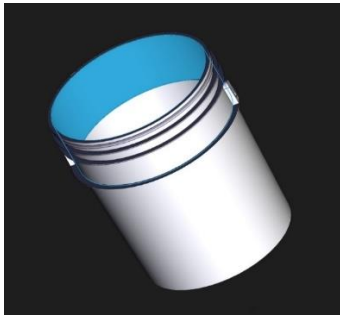
### 5.1. Design





**5.2. Our design includes various components such as-**

1) Plastic container – A Plastic container is used to store the vegetable and to perform cleaning process with the help of ozone. The plastic container is of 17 ltr which is used in this project.



2) Basket for Vegetables- A Netted basket is also used here. This basket is used to keep the vegetable or fruits which are to be cleaned. The netted basket is used so that the water will drain out and we will get the vegetables and fruits cleaned easily. The storage capacity of the basket is 15 ltr.



3) RS775 Gear motor – the main function of gear motor is to rotate the basket. This rotation will result in cleaning of the vegetables and fruits in it. We can also relate this with a washing machine where the fruits are kept inside of basket and the motion of the basket will help to clean vegetables.

Specification of motor- 775 dc motor 12V-36V 3500-9000RPM, 775 shaft diameter :5mm, Shaft length: 17mm, Body length:66.7 mm



4) Submersible AC pump - While there is water flowing in it we need to make a sophisticated discharge of water therefore submersible AC pump is been used so to remove the water from the cabinet.

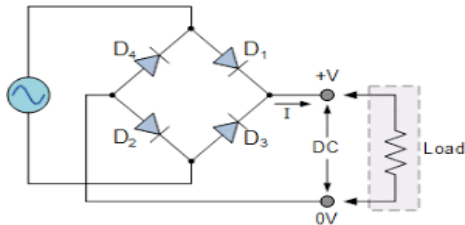
5) 6V DC solenoid valve ½" - water is to be provided for cleaning of the vegetables and fruits therefore a solenoid valve of 6V is used to supply feed water.

6) Programmable Time delay Relay circuit board with digital display- time delay relay circuit board is used to keep a count on time and also there is a digital display to view time and note down. Also the time shown on digital display shows anticlockwise time in seconds.



7) 12-0-12 Transformer for power source- 12-0-12 transformer is used to give a power source to the system to run.

8) Full wave bridge rectifier- A Full wave rectifier is a circuit arrangement which makes use of both half cycles of input alternating current (AC) and converts them to direct current (DC).

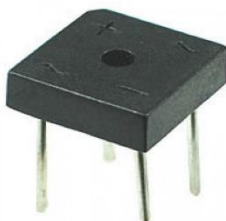


9) Inlet & Outlet pipes- Inlet and Outlet pipes are used to supply water in the system. Flexible transparent pipes are used in the system to supply water.

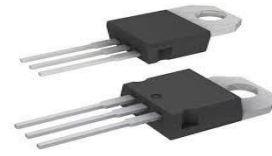


10) Voltage Regulator LM317- The LM317T is an adjustable 3-terminal positive voltage regulator capable of supplying different DC voltage outputs other than the fixed voltage power supply of +5 or +12 volts, or as a variable output voltage from a few volts up to some maximum value all with currents of about 1.5 amperes.

With the aid of a small bit of additional circuitry added to the output of the PSU we can have a bench power supply capable of a range of fixed or variable voltages either positive or negative in nature. In fact this is more simple than you may think as the transformer, rectification and smoothing has already been done by the PSU beforehand all we need to do is connect our additional circuit to the +12 volt yellow wire output.



11) MOSFET ST P55N for switching-



### 5.3. Construction and Working-

Vegetable Purifier is powered by the revolutionary Ozone Disinfection Technology. Ozone, when mixed with water, sterilizes the surface of fruits and vegetables, and is also an effective way of getting rid of harmful pesticides and microbes.

Ozone gas produced by Vegetable Purifier is completely safe for the health and is dissolved in water before any introduction to fruits and vegetables. It oxidizes the residual chemicals left over by pesticides from the surface of vegetables, fresh fruit and meat. With an ozone output of 400mg/h, it effectively gets rid of all pollutants.

Fungicides, pesticides and other chemicals used during farming practices can contaminate the surface of food. This can be potentially dangerous as simple washing cannot remove these accumulations. Ozone can be used to oxidize the chemicals and remove the contaminate safe for sale or for further processing.

The fruits and vegetables bought straight from the market need to be washed to remove all the impurities and chemicals on it for safe consumption.

These fruits and vegetables should be kept in the basket which is in the bucket. This basket is attached with a gear motor so that the baskets will get a motion.

This rotation of the basket in opposite direction of bucket will make the vegetables and fruits clean.

For example, just like the washing machine works, the basket revolves which in inside the bucket. This basket consists of clothes on which water and washing powder is supplied through pipes. This combination of washing

powder and rotation of basket make the clothes to rub to themselves and gets clean.

Same as with the fruits and vegetables, this basket revolves and the ozone added to the water will remove all the dirt and pesticides which is on them. Water is supplied through the solenoid valve through the inlet and outlet pipes. The bubbles produced by the ozone in the basket make it to removing of the contaminants on fruits and vegetables.

Ozone (O<sub>3</sub>) is formed by a high energy input that splits the oxygen (O<sub>2</sub>) molecule in the air into free radical oxygen. Single oxygen (O) molecules rapidly combine with available O<sub>2</sub> to form ozone (3 O<sub>2</sub> → 2 O<sub>3</sub> + heat and light). In nature, the source of this high energy is the ultraviolet irradiation from the sun and also lightning discharge. Since ozone is unstable, it splits back into oxygen molecule.

Therefore this ozone cleans our fruits and vegetables which are safe for consumption and free from all the toxic components. Leading to healthy life.

	vegetables	
9	Microcontroller circuit board	1050
10	Relay board	45
11	Relays = 2 units X 25	50
12	Transformer 230V to 12-0-12	210
13	Micro rocker switch = 4 units X 5	20
14	PVC Pipe with end caps	55
15	Fasteners	45
16	Epoxy resin adhesive	450
Total		6460 Rs

**6. MATERIAL COSTING**

Material costing		
SR NO	MATERIAL	COST (Rs)
1	O <sub>3</sub> generator	2150
2	Magnetic drive pump	695
3	Submersible water pump	350
4	RS775 Gear motor	410
5	½ inch solenoid	520
6	½ inch hose	30
7	Cabinet enclosure	290
8	Tray for fruits and	90

**7. CONCLUSION**

- 1) While growing fruits and vegetables, farmers usually spray various chemicals and pesticides on them. These chemicals make fruit look attractive and keep insects away but is very toxic for human body. Also other impurities like dust and dirt are carried on vegetables and fruits.
- 2) Most of the fruits and vegetables that we purchase from the market come laced with harmful contaminants like bacteria, viruses, and several other infectious agents.
- 3) Simply rinsing the food items with water does not remove these pathogens. Also, shell for some of the vegetables like spinach can't be removed to clean harmful chemicals, bacteria, and viruses. Our project is a Vegetable and fruit cleaner uses revolutionary ozone disinfection technology for cleaning fruits & vegetables.



4) The vegetable and fruit cleaner kills bacteria, viruses, fungi, and other pathogens that are present on the surface of food items and keeps you safe from foodborne diseases. Ozone technology used by the vegetable cleaner effectively oxidizes residual chemicals from food items, making it safe for consumption. It has been found that Ozone gas

can, not only controls but can also kill Bacteria, harmful Viruses.

Hence our project will help in cleaning the vegetables and fruits specially now a days when human health and immunity is so much important.

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## Wireless Monitoring of COVID Affected Patients Using Zigbee Communication

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### ABSTRACT

*In the month of March 2020, the severe acute respiratory syndrome coronavirus hit in India and the healthcare facility severely suffered. When COVID affected patients are at peak then there is huge burden on healthcare system. There is shortage of electronic vital sign monitors and operators to monitor COVID affected patients in large numbers. The COVID-19 is highly contagious and brings about multi-organ failure in many cases. Therefore, in this paper we have developed wireless monitoring of such patients using Zigbee communication approach which is straightforward, reliable, and inexpensive and remotely operated which help to avoid spread of disease. In proposed system the monitoring of temperature, pulse rate, oxygen level of patient and saline level of liquid drugs have been employed in addition to provide a simplified Graphical User Interface on operator's dashboard in future. Our system provides real time data storage facility which is benefited to doctor for critical monitoring of patient throughout cycle right from admission, discharge and post-COVID development process.*

**Keywords:** COVID-19, MAX 30100 Sensor, Wireless Patient Monitoring, ZigBee

### INTRODUCTION

World Health Organization (WHO) declared the COVID-19 as pandemic in the month of March 2020 because rapid positive cases identified worldwide [1]. By the end of May, 2021 total deaths in India are recorded more than three lakhs [2]. Across country, many hospitals faced lack of healthcare services and medical staffs and in addition to this there is no particular medicine available to completely eliminate COVID virus [3]. The speed of transmission is high in case of COVID as compared to other influenza viruses [4]. The most common symptoms in COVID affected patient is "Happy Hypoxia" in which blood clot is formed and oxygen supply is prevented through cells in lungs [5]. Hence, it is very much important to monitor the oxygen level of affected person failure to which cause fatalities. Also, it is observed that many healthcare professionals are getting affected due to contact with COVID affected patients [6] and therefore it is require to have wireless monitoring system to observe the patient from remote location. The various medical parameters are monitored and gathered data is sent to computer assisted graphical user interface which is available at operator's dashboard.

In conventional method, we observed that there are bundle of cables surrounded across a patient in hospitals which feels very uneasy to patient and may lead to small mishaps as there are multiple patients [7]. The compact biological sensors are used in wireless monitoring system which continuously tracks the record of every parameter and if any parameter varies from their standard tolerance value due to patient inherent condition, then such alert is given to respective medical staff in time.

The various wireless technologies are used in monitoring of patients especially Wireless LAN, Bluetooth, ZigBee etc. The Wireless LAN architecture has large size and requires high power consumption whereas Bluetooth has issue with short range and limited data rate for signal transmission [8]. The ZigBee is targeted in this paper as it requires low power, long battery life, low cost and secured network. In this paper, we have designed the system in which four sensors viz. LM 35 temperature, MAX 30100 pulse rate sensor cum oxygen level indicator and saline level indicators are used and based on predefined threshold the sensor output is compared. If sensor output exceeds normal reading then the alarm is activated and intimation of the same is sent to medical staff.

The paper is constructed as follows: Section II explained various techniques developed in this domain followed by its findings. The block schematic and dataflow of proposed system is elaborated in Section III. The experimentation is carried out through simulation software and its results are discussed in Section IV. In Section V, the conclusion is provided.

### RELATED WORKS

In patient monitoring system, there are various techniques have been implemented in past few years which are discussed below:

Currently, in the healthcare system different patient monitoring techniques are adopted viz. Mortara s12 monitor, Mindray VS 600, vitalogik 4000, dyanascope 8001, Comen NC5, lifescope vismo PVM-2703 etc. which are more accurate but expensive [9]. Navid Bin Ahemed et.al proposed patient monitoring system by using MAX30100 as portable pulse rate cum blood oxygen saturation sensor which is interfaced with Atmel Atmega 328 MCU in [10]. The experimentation is carried out on different age groups and then verified the accuracy of the system. Also, the data gathered from system is validated with standard device Rossmax SB 150.

Nubenthan and Ravichelvan developed Wireless Monitor (Wi-Mon) [11] which works on the principle of Wireless Body Area Network (WBAN) and measured crucial parameters like blood pressure, EEG, pulse rate etc. every ten minutes with real time live stream recording facility especially on dengue patients. In the end, the results are validated with Vismo PVM-2703. Yang Yang et.al designed skin touch RF wireless transducer to detect ECG signal and achieved remote patient monitoring in [12].

Anamika Chauhan et.al developed smartphone application with wearable technology like photoplethysmography (PPG) which is used to monitor cardiac function of patient in [13]. Authors in [14] designed MEDICAL WARNING precursor (MEDIWARN) architecture which uses virtual biosensors and monitoring station and simulated the system using OMNeT++ simulation platform and components from INET framework. Ibrahim Kareem Hanoon implemented patient monitoring system in [15] using heart rate and blood oxygen level sensor

MAX30100 and body temperature sensor MLX90164 which are interfaced with ATmega 2560 microprocessor and collected information is stored on cloud through access using ESP8266-01 Wi-Fi module. Similarly, authors in [16] used temperature, blood oxygen and heart rate sensors and sent data to mobile device which uses Bluetooth technology to send the data onto IoT server. Such servers are connected to local machine which is controlled by doctors.

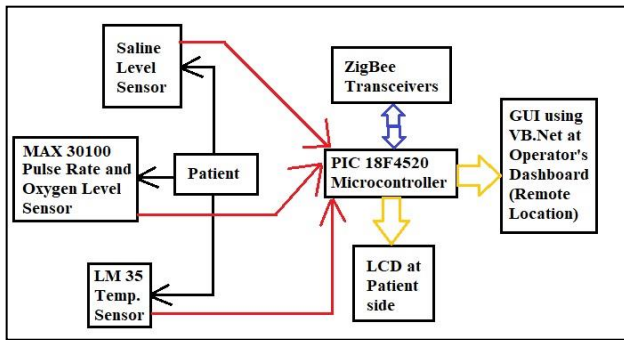
Vu Duy Hai et.al developed wireless central monitoring system [17] in which eight patient monitors which are connected to dsPIC6010 microcontroller through RS232 and send the packets through Wi-Fi transmitter module ZG2100M to multichannel receiver. The multichannel receiver is connected to display software which is available centrally in hospital which is then monitored by various medical staff. Also, researchers in [18]-[19] implemented gesture based communication technique for various applications like medical and transportation fields.

Based on above methodologies implemented in patient monitoring system it is observed that most system require complex infrastructure, internet dependency with high operating costs and therefore to alleviate these issues, we propose wireless patient monitoring using ZigBee with compact affordable biological sensors which critically monitor COVID affected patient in stipulated time.

### PROPOSED SYSTEM

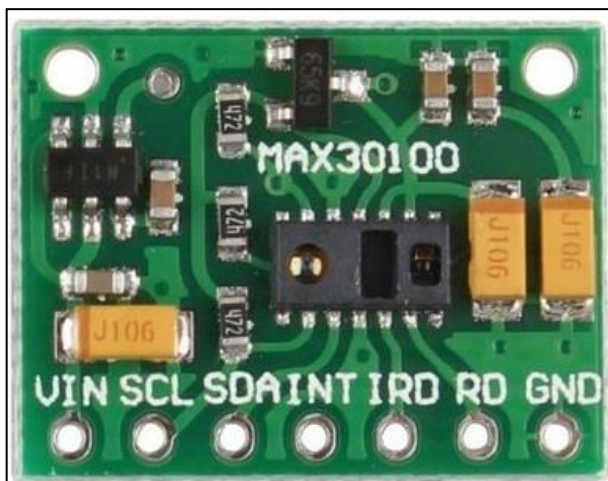
In our proposed system, patients are monitored based on four parameters viz. body temperature, pulse rate, oxygen level of patient and saline level of drug using wireless communication as shown in Fig. 1.

The Pulse rate cum oxygen level sensor MAX30100 as shown in Fig. 2 is interfaced with PIC18F4520 microcontroller and ADC of controller converts analog signal into its corresponding digital signal. The sensor consists of red light and infrared light emitting diodes.



**Block Diagram of Proposed System**

For pulse rate measurement, only the infrared light is needed while both lights are used in case of oxygen level measurement in blood. While heart pumping, volume of blood increased and in case of relaxation volume of blood decreased. The pulse rate is computed based on time difference between increase and decrease of oxygenated blood. Finally, the oxygenated blood absorbed more infrared light and deoxygenated blood absorbed more red light.



**MAX 30100 Sensor**

The blood oxygen saturation is calculated from formula shown in eq. (1). The sampling of sensor depends on 10-bit ADC, and therefore the sampling is recorded as 1024.

$$\%SpO_2 = \frac{\log\left(\frac{redACValueSqSum}{samplesRecorded}\right)}{\log\left(\frac{irACValueSqSum}{samplesRecorded}\right)} \times 100 \tag{1}$$

The LM 35 is temperature sensor which senses the temperature within range -55°C - +150°C. The output of sensor gives equivalent electrical

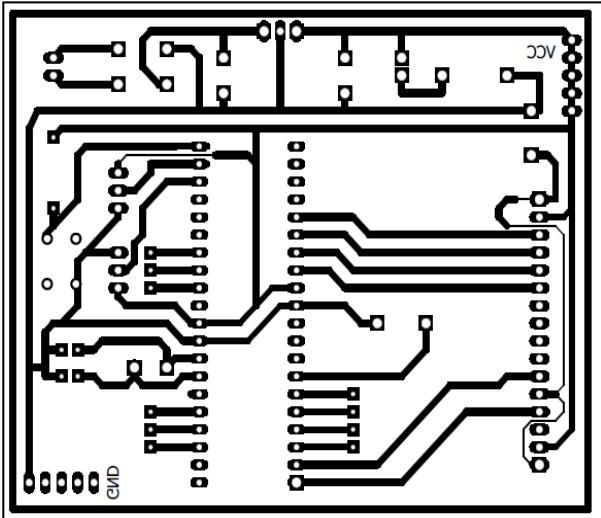
voltage to the temperature which then increases 10mV per °C rise in temperature.

The saline level indicator is worked on the principle of water level indicator. We have considered four levels in saline level indicator. Each level is connected with electrode probe which is dipped in saline solution bag at different positions. These probes are connected to base of transistors which acts as switch and drive the LED. When solution reached to the prescribed level it provided electrical connection with base of transistor and corresponding LED glowed. The logic used here is one electrode is placed at bottom of saline bag with ground terminal. When saline level reduces it touches respective probes, then it short-circuit the connection and indication is displayed on LCD.

The PIC microcontroller compared the sensor output with predefined threshold value and based on it alerted the system through buzzer as well as blinking of values on LED at patient side. Similarly, the reporting is made on GUI which is at operator side placed remotely in hospital. The flow chart of the proposed system is shown in Fig. 3.



ZigBee receiver is connected to personal computer by using serial communication USB which is located remotely at doctor's side. The Putty software is used to display the received data of monitored parameter on screen of personal computer. The ZigBee virtual terminal also shows same value which has been sensed by sensors which indicate the successful wireless communication has taken place. The PCB Layout is designed using Proteus software and trackside part of the proposed system is shown in Fig. 6.



**PCB Layout of Sensor and Microcontroller Section**

## CONCLUSION

We have discussed the different methodologies used in patient monitoring system and it is highlighted that the wireless monitoring of COVID affected patients is safe and secure. We have developed ZigBee based wireless monitoring of such patients by tracking their body temperature, pulse rate, oxygen saturation level in blood and status of saline level. The experimentation of proposed system is performed using Proteus circuit simulation software and results are obtained based on various sensors used to monitor patient health. As this research is our on-going work, in future the testing and troubleshooting of hardware part will be carried out and will be interfaced with Graphical User Interface using VB.Net platform.

## ACKNOWLEDGEMENT

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## Review on Design And Manufacturing of Thermal Energy Storage Tank Using Molten Salts For CSP

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### ABSTRACT

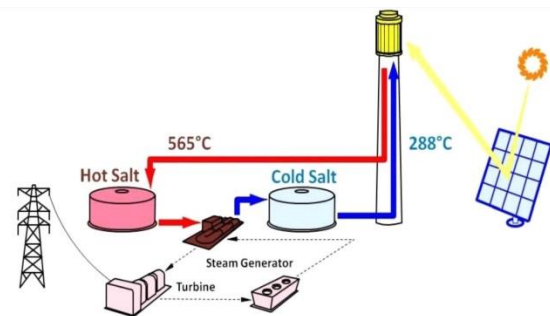
CSP plants are unique among renewable technologies in that they provide utility-scale, dispatchable electricity to the power grid. Dispatchable delivery means power is reliably available when it is needed to meet the utility load demand. This feature is due to the incorporation of TES into the power plants. TES allows electricity to be generated consistently at times when sunlight is not available, including momentary cloud transients, which otherwise disrupt electricity generation and cause widely varying power output. For longer time scales, TES allows CSP plants to generate electricity well into the evening hours when electricity is highly valued, making the power plant more cost effective. TES also allows greater use of the turbine and other power-block components. These features provide an economic incentive for the addition of TES. Without TES, CSP solar power is an intermittent power resource that depends on sunlight availability. In addition to enhancing CSP dispatchability, TES enables increased deployment of renewables in general by adding flexibility to a grid with photovoltaic and wind power systems.

**Keywords:** thermal energy storage (TES); concentrated solar power (CSP) plants

### INTRODUCTION

Sunlight based energy is an inexhaustible wellspring of energy for power age particularly in light of the fact that it doesn't create any hurtful gases instead of ordinary petroleum derivative run power plants. A significant test in gathering sunlight-based energy is the irregularity of the Sun's accessibility because of climate, just as diurnal and occasional varieties. Different issues remember the befuddle for energy creation and use, which effect sly affects the general productivity of the framework. Overabundance energy can be switched in the event that it isn't totally overseen or used, in this manner making shakiness the framework, expanded current issues, and insurance mis-coordination. When there is an over-request, extra ordinary assets are used to fulfill that need, which in the long run expands carbon impression. Creation side is exceptionally non-deterministic due to its irregular conduct, while utility examples are likewise not uniform and there are pinnacles and trenches of energy utilization on the client side. This confuse can be successfully damped by presenting an energy stockpiling unit that will store the excess energy by sustainable methods or the off-top power by a wide range of assets. The put away energy can be utilized in the

event of non-accessibility of sustainable sources. All CSP advances have comparative segments – sun-based authorities, recipients, and Thermal force change frameworks. They are gathered into two general sorts as indicated by Their authority/beneficiary calculations: point-center and line focus.



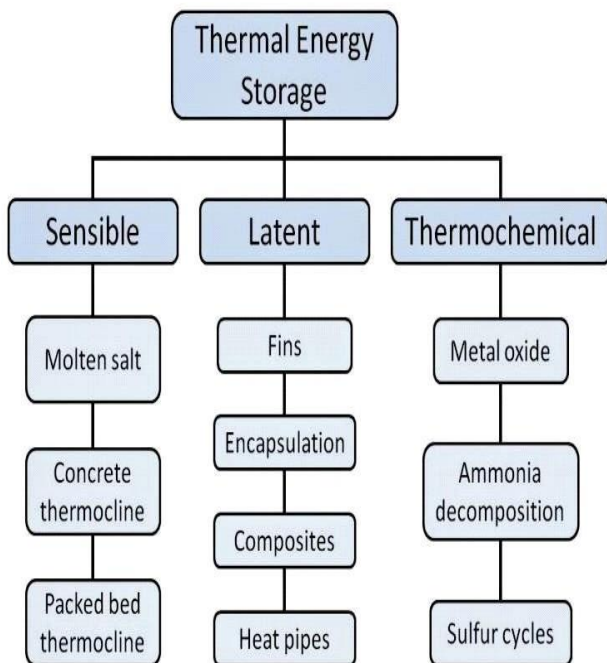
**Figures 1: - Schematic of power tower with direct, two tank molten salts storage**

Point-center calculations are the force tower and allegorical dish. The force tower comprises of A solitary beneficiary that is situated at the highest point of a pinnacle (Figure 1). The pinnacle is encircled by a Field of two-hub following mirrors, or heliostats, that reflect and concentrate daylight to the Receiver. A HTF circles to the collector, gathers nuclear power contained in the Concentrated daylight, and gets back to the force block where it is utilized to produce steam for the turbine power cycle.

Force towers utilizing liquid salt HTF regularly store the hot and cold Salt in tanks that consider division of the sunlight-based assortment and force age cycles.

**TYPES OF THERMAL ENERGY STORAGE**

Figure 2 records an assortment of TES choices for CSP plants. They fall into three general classes: reasonable, dormant, and thermochemical capacity. A book distributed during the 1980s gives a thorough study of the basics of the capacity choices, instances of frameworks, and the issues that should be addressed for innovations in the reach from low to high temperatures. The solitary TES framework that as of now works with several hours of capacity is the reasonable, two-tank, liquid salt framework. This framework is utilized in light of the fact that the segments related with liquid salt taking care of—siphons, valves, tanks, and warmth exchangers—have shown solid activity at business scale.



**Figure 2: - Thermal energy storage options for CSP technologies**

The molten-salt storage fluid is a mixture of NaNO<sub>3</sub> and KNO<sub>3</sub>. This fluid is liquid in both the charge and discharge states, so there are minimal heat-transfer limitations, making the heat-exchanger design relatively straightforward. One drawback for this system is the

relatively low stored energy density, which results in a large storage medium inventory, requiring large insulated storage vessels. Implementation of this TES system into parabolic trough power plants requires an indirect configuration—distinct heat-transfer and storage fluids—because the storage salt has a high freezing point (220oC) and could possibly freeze in the solar collectors if used as the HTF. The indirect system requires a heat exchanger for transferring thermal energy between the HTF and storage fluid. This heat exchanger reduces the performance of the storage system and adds cost to the plant. This approach has been demonstrated commercially in Spain at the Andosol plants. Implementation of this TES system into power towers can use a direct configuration—Common heat-transfer and storage fluids—because steps can be taken to prevent the freezing of molten salt in the receiver and transfer lines within the vertical tower that are not possible in a parabolic trough configuration. This type of system was demonstrated during the Solar Two project in Barstow, California.

**PROBLEM STATEMENT**

In our country not a single CSP Plant is installed and running for electricity generation. There are some examples of CSP are available but they are all used for local needs. Indian central and state governments are giving lots of attention towards renewable energy sources. They made budgetary allocation for installation of renewable energy plants and also providing lots of incentives to private players to installed and to make investment in renewable energy sector. But their major focused is on only Photovoltaic solar cells and wind energy and this is the real tragedy in the development of CSP Plant in India. Nowadays, many foreign players are interested for installation of CSP Plant in India we have need to push then forward.

**OBJECTIVES**

There are many objectives for Implementation and establishment of TES tank with contemporary CSP cycle. When we attached TES tank with contemporary CSP

Plant it increases electricity generation capacity of plant by many folds by just doing little changes in regular plant cycle.

## LITERATURE REVIEW

**Calin Seborrheic Et.Al.** express that the Thermal energy stockpiling (TES) is an innovation that stocks nuclear power by warming or cooling a capacity medium so the put away energy can be utilized sometime in the not-too-distant future for warming and cooling applications and force age. TES frameworks are utilized especially in structures and in modern cycles. This paper is centred around TES innovations that give a method of vaporizing sun powered warmth and diminishing the energy interest of structures. The standards of a few energy stockpiling techniques and computation of capacity limits are portrayed. Reasonable warmth stockpiling advancements, including water tank, underground, and stuffed bed stockpiling strategies, are momentarily explored. Also, dormant warmth stockpiling frameworks related with stage change materials for use in sun-oriented warming/cooling of structures, sunlight-based water warming, heat-siphon frameworks, and concentrating sun-based force plants just as thermo-substance stockpiling are examined. At last, cool nuclear power stockpiling is additionally momentarily explored and extraordinary data on the presentation and expenses of TES frameworks are incorporated.

**Naseer K. Kasim Et. Al** express that Due to the way that Solar warm innovation is serious in some restricted business sectors, a hypothetical and test study has been completed for plan and manufacture of sun oriented warm framework. The most widely recognized use for sun oriented warm innovation has been for water warming and cooking in radiant environments. Notwithstanding, because of the unpredictable plan and expenses of creation and support, sun oriented warm frameworks have remained behind in the realm of Renewable energy frameworks. The customary plan of sunlight based warm framework is comprise of an allegorical concentrator with

the beneficiary set along the line between the focal point of the concentrator and the sun, this considers powerful gathering and focusing of the approaching sun-oriented illumination. The concentrator gets roughly 5.2 kW.h/m<sup>2</sup> of sun-oriented insolation (reliant upon season), which is thought and reflected to the beneficiary. By concentrating the approaching radiation, the working temperature of the framework is expanded altogether, and in this way diminishes the effectiveness of the transformation from daylight to nuclear power. For the current framework which is with a fixation proportion 37%, the concentrator and hypothetically fit for creating temperatures upwards 761 K. Nonetheless, because of corruption of the optics and other different elements, temperatures as high as 450 degrees centigrade have been accomplished tentatively. It is tracked down that the authority (concentrator +receiver) yields a productivity 64%. The general productivity of the framework that changes this concentrated sun-based energy over to nuclear power (which is utilized for water warming) is half at capacity tank temperature(water) Test=77 °C, and 45% for sun-oriented cooker at 112°C utilizing oil in heat move liquid. The qualities likewise demonstrate that the warmth misfortune coefficient was influenced by numerous elements, for example, wind speed, encompassing temperature.

### Description of thermal energy storage types

#### Sensible Energy Storage

The adequacy of TES frameworks relies fundamentally upon the thermophysical properties of the capacity materials. Warm conductivity, thickness, consistency, dissolving and edges of freezing over, and enthalpies of combination or response all effect the plan, execution, and cost of the TES framework, just as the completely incorporated force plant. A piece of current work is to distinguish the effect of these properties, alongside working conditions, on TES framework execution. The accompanying examination for capacity liquid warmth limit is given to act as an illustration of the investigations that will help characterize new exploration bearings

### **Cost Benefit from Improved Heat Capacity of Sensible Storage Fluids**

The effortlessness and effectiveness of direct two-tank stockpiling makes it an engaging way to deal with TES. A generally simple approach to improve the financial aspects of this framework is to improve the warmth limit of the capacity liquid. The base required warmth limit with regards to a reasonable stockpiling material is an element of the temperature drop across the turbine. The warmth limit and temperature drop together decide the put away energy thickness of the TES framework. Different variables are the expenses of the capacity material, tank, and funneling materials that are needed for the TES framework. For the two-tank stockpiling framework, the low-temperature tank is typically at 300oC (as indicated by the steam-cycle squeeze point), so the temperature drop across the force block is controlled by the most extreme working temperature.

Examination was acted in which the expense of TES was assessed as an element of the greatest working temperature from 400oC to 1,100oC. Warmth capacities with regards to the capacity liquid differed from 1.5 J/g-K, which is the warmth limit of the twofold NaNO<sub>3</sub>/KNO<sub>3</sub> combination that is at present utilized in the two-tank stockpiling framework, to 4.5 J/g-K or a factor of 3 more prominent than the double salt. The expense of the tank divider material differs with temperature. From 400oC to 450oC, carbon steel can be utilized as the divider material for the hot tank. From 450oC to 650oC, tempered steel is required or more 650oC, a nickel-based combination is required. The expense distinction between these materials essentially impacts the expense of the TES framework as an element of working temperature. The examination decided the expense of the TES framework in the temperature range representing the expanded expense of the tank divider material as temperature increments. Consequences of the examination show that the TES cost objective of \$15–\$20/kWh can be reached at temperatures in the scope of 450oC and at 650oC if the warmth limit of the capacity liquid is between 3–4.5 J/g-K. For

temperatures more prominent than 650oC, the significant expense of nickel-based amalgams makes it hard to meet the expense target utilizing this kind of capacity framework.

### **Phase-Change Storage**

A similar ability needs that were distinguished for reasonable capacity are relevant to stage change stockpiling, also. For stage change stockpiling, it is especially essential to foster new materials with high warm conductivity to develop releasing (freezing) of the PCM. Completely incorporated frameworks displaying is fundamental to decide the determinations and execution for PCM stockpiling since its conduct is more mind boggling than that of reasonable stockpiling frameworks. Of explicit interest is the need to more readily show heat move between the warmth move liquid and PCM in complex calculations. New methodologies should be found to conquer the misfortunes because of develop of strong stage at heat-trade surfaces. Embodiment of stage change media at scales from nano to full scale should be created to improve heat move and development of a course of PCMs that cover the working scope of the force cycle.

High-temperature materials portrayal is additionally fundamental for PCM stockpiling. PCM stockpiling matches well to Stirling motors since energy move to the Stirling motor is isothermal. There is a need to foster PCMs that are explicit to this application. Additionally, the requirement for high warmth move rates and satisfactory force thickness is required and might be met by the utilization of warmth pipes coordinated with the beneficiary and Stirling motor segments.

### **Limitations of Thermal Energy Storage Systems and Their Proposed Solutions**

The subsequent sections contain the limitations of contemporary TES systems. Different approaches to mitigate these issues also have been summarized.

#### **High Temperature Corrosion**

One basic issue in TES for high-temperature applications is erosion of the TES control materials, which causes a consumption cost of

up to 3–5% volume of industrialized nations' gross public item. A large portion of the liquid salts utilized for TES are exceptionally destructive. The responses of salts and the resulting event of consumption isn't totally perceived, and the issue actually needs consideration, particularly with regards to pressure erosion breaking in liquid salt media. The eroded layer is either as an oxide layer on the holder or corruption of the compartment material. Standard primary materials (tempered steel or carbon) debase in the wake of interacting with salt chlorides by the chlorination.

Introductory testing of an enemy of consumption covering was led on steel items with minor upgrades in the security against erosion. In specific cases, warm properties upgrading nanoparticles agglomerate and structure groups throughout some stretch of time. This agglomeration of nanoparticles debilitates the exhibition of warm liquids. A quaternary salt with low liquefying point (85.4 °C), wide working reach (600 C), diminished danger of blockage, and great erosion obstruction was as of late created. A new audit directed nitty gritty examinations of consumption in CSP plants. The examination asserted that the danger of consumption by the utilization of liquid salt couldn't be killed; notwithstanding, the impact could be secured against erosion utilizing a consumption safe compartment. A few covering materials and strategies have been summed up to decrease the impact and seriousness of erosion brought about by liquid salts.

Various evaluations of steel as a compartment for high-temperature energy stockpiling materials have been proposed, as given underneath:

- Low composite carbon steel ( $\leq 400$  °C).
- Cr–Mo steel ( $\leq 500$  °C) (Cr-content up to around 9 wt. %).
- Stainless Cr–Ni steel ( $\leq 570$  °C) (with and without alloying components as Mo, Nb, Ti).
- Ni composites ( $\leq 650$  °C) (i.e., Alloy 800).

As of late, expansion of nanoparticles into liquid salts has been connected to the increment in consumption. It was seen that interparticle porosity and ensnared air

expanded the consumption rate by 2 to multiple times the real rate. The expansion of various particles additionally expanded the non-consistency in covering because of non-uniform erosion. Fernandez and Cabeza as of late investigated the consumption instruments including nitrate-based salts in TES frameworks for CSP. A portion of the overall ways to deal with secure consumption are

- Tuning the arrangement of holder by expanding the non-receptive substance;
- Removal of debasements in liquid salt frameworks or the expansion of inhibitors;
- Surface treatment.

Rea et al. utilized aluminum (88%)– silicon (12%) eutectic amalgam as a PCM in their examinations to create less expensive power utilizing CSP innovation. The eutectic PCM was contained in steel, and in its liquid structure it rots the steel holder at a high rate. A defensive covering (MgO–Zr<sub>2</sub>O<sub>3</sub>) was applied utilizing plasma shower technique onto the steel parts powerless against consumption. Inside a short experimentation of 4 days, it was seen that the defensive covering fizzled at certain areas and it uncovered the compartment material to the PCM. Because of the consumption, thickness of steel diminished from 2.4 to 0.36 mm in only 4 days. Somewhat more time can cause the disappointment of the capacity tank and can cause spillage of the PCM. Grosu et al. fostered a calcium carbonate layer onto steel to repress consumption. The consumption tests were directed under idle and air openness conditions with isothermal temperature up to 500

C. The layer was steady in the tests; nonetheless, powerful testing is needed to check the adequacy of the layer. Moreover, the presence of layer onto the entire steel structure is critical to stay away from restricted erosion. Issues of such erosion are not just the disappointment of the holder—response of iron in steel with the eutectic PCM structures non-liquefying aluminides which can't work for the following pattern of dissolving freezing. Folio and Hastener proposed plan rules to contain the Al–Si eutectic PCM into 316L steel through delayed examinations. Nonetheless, the examinations depended on the steady

temperature conditions, which may have various results when contrasted with the real transient temperatures; subsequently, research is going through to oblige every single genuine condition. Numerous options dependents on the receptive materials and comparing types are proposed for consumption opposition. Fernandez et al tried alumina-shaping austenite combinations for erosion opposition. Albeit the examples were eroded, the pace of consumption was significant. Ding et al. explored the business combinations in the nonpartisan climate by openness to various PCM at 700 °C for over 500 hours. Lamentably, all the amalgams couldn't fit the bill for high temperature applications in view of the consumption rate over the suggested level considering a long-term lifetime of the framework.

One approach to deal with the issue is the expansion of erosion inhibitor into the receptive material. Another way to deal with bypass the erosion issue is to embody the receptive materials into steady and non-responsive shell material preceding their working. Zhang et al. created silica shell receptive bicarbonate salts with the softening point and warmth of combination of 540 °C and 220 kJ/kg, individually.

### Life Cycle Assessment of TES

A daily existence cycle appraisal (LCA), otherwise called life cycle investigation, is a method to evaluate ecological effects related with all phases of an item's life (i.e., from crude material extraction through materials preparing, producing, appropriation, use, fix and upkeep, through to removal or reusing). Nonetheless,

LCA of TES in CSP plants is one the most un-examined themes in energy stockpiling, and there is a huge hole of information around here. LCA presents a relative appraisal of the ecological issues including the innovation. On account of operational ecological effects of environmentally friendly power advances, most outcomes would be misdirecting on the grounds that the factor included is excessively little. Maybe, LCA is truly necessary to introduce a clearer picture, beginning from the extractions of materials to the use through to its

possible removal. A piece of examination detailed that liquid salt creates the most extreme ecological effect each kilowatt-hour (kWh) energy stockpiling in correlation with the substantial and PCM-based capacity frameworks. The reason is that liquid salt framework is profoundly intricate and includes more materials. Moreover, the ecological effect of liquid salt is less on account of PCM stockpiling when contrasted with reasonable capacity. Another examination on a CSP plant in Spain revealed nitrate arrangement and plan of steel-made capacity as causing a significant natural effect. Another examination analyzed the LCA of three force plants energized by oil, gas, and sun-based force by thinking about three variables—human wellbeing, environment, and assets. Eco-marker 99 uncovered that albeit the natural effect of a CSP plant is altogether lower on human wellbeing and assets, it is still essentially higher than a gas power plant. The two contending innovations were additionally examined utilizing a "blending triangle approach", contingent upon the extent of harm caused to each factor. In this methodology, a CSP plant is ideal over an oil/gas plant, as more weightage is given to wellbeing and asset exhaustion when contrasted with the biological system.

Here, focuses On and B address the two distinctive thoughts about situations, while A reflects 80% environment, 10% assets, and 10% wellbeing. Gas plants perform better based on these boundaries when contrasted with the CSP; be that as it may, it will exhaust the assets rapidly. Then again, considering point B with 40% biological system, 40% assets, and 20% wellbeing, the exhibition of a CSP plant is superior to that of a gas power plant.

### Economic Analysis of TES

An achievable expense of any new innovation is the main consideration for its market infiltration. To make the cost of power created through CSP equivalent to that of other sustainable power sources, advancement of option economical materials, optical and warm proficiency of the individual segments inside the in general CSP plant, and

incorporation of TES for dispatchability are prime elements. Energy stockpiling thickness is a significant factor impacting the expense of TES in view of the size of capacity tanks and on the grounds that the warm stockpiling material is subject to it. Energy necessity for helper assets is another factor that impacts productivity and cost. Nonetheless, the impact of warm proficiency of a TES framework on the framework cost is nearly low. Cost of the framework can be diminished by some straightforward methods. For instance, to improve the thermophysical properties of liquid salts, various added substances are suggested, albeit these added substances are related with different difficulties like sped up erosion. For example, expansion of CuO nanoparticles (1% wt.) in nitrate liquid salt expanded the particular warmth limit, reasonable, and inactive energy stockpiling by 21.24%, 9.27%, and 67%, individually. Notwithstanding, the CuO nanoparticles, when bought straightforwardly from business providers, are excessively exorbitant. On the other hand, these particles can be delivered by the vanishing of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  utilizing one-venture technique. The business result of CuO nanoparticles cost £60.5 for 25 grams, while a similar sum can be delivered by vanishing for £6.83, roughly multiple times lower cost than the business item.

Pacheco et al. fostered a thermocline stockpiling for TES utilizing a solitary tank rather than two stockpiling tanks, which chips away at the guideline of warm inclination. The framework is 33% less expensive when contrasted with the two-tank stockpiling frameworks. Zurita et al. researched the coupling of TES framework and battery stockpiling framework with a half and half PV and CSP plant for techno-financial assessment. The investigation uncovered that 60% to 90% expense decrease of the battery stockpiling framework is compulsory for the framework to be financially practically identical to that of set-targets.

The United States Department of Energy (DOE) reported a venture "The SunShot Initiative" in 2011 fully intent on lessening the levelized cost of power (LCOE) by 75%, done by creating the Utility-scale power through

CSP plants with an expense of under 6¢/kWh by 2020. LCOE is the all-out cost isolated by the complete force age. With the drive, dynamic and target-situated examination has been directed in the new past. For instance, a very novel particular plan of 100 kW electric has been recommended that can be increased or down in the scope of 10 to 1000 kW electric with an expense variety of just 3%. In the plan, sun based collector, nuclear power stockpiling unit, and force block unit are set on top of one another, all on one pinnacle. At present, the Stirling motor is thought of; be that as it may, the framework is equipped for reconciliation with other force cycles. With minor enhancements in the boundaries, Authors accept that creation of power from such CSP plants is at 8.1¢/kWh. Rea et al. Researched the area based monetary investigation for CSP innovation since scope, climate Conditions, and accessibility of work in that specific district impact the expense of the framework. The investigation looked at the impact of a solitary 100 kW electric plant with a group of numerous little plants with a similar yield. This methodology is profoundly significant in decentralization, use of such frameworks for far off regions, or joining of these with microgrids for uniform conveyance. Tehrani et al. chipped away at various blends of PCMs and their plan boundaries. Rather than LCOE strategy, stockpiling explicit expense was considered for examination of various frameworks. This expense was the capacity cost partitioned by the capacity limit. Analysts announced a particular expense decrease of 62% on account of double media thermocline with substantial framework when contrasted with the two-tank liquid salt stockpiling framework. Le et al. performed financial investigation of a venture in Binh Thuan. The LCOE of the framework was 21¢/kWh [103]. Lindquist et al. displayed a secluded CSP plant with changing power creation limit utilizing a Stirling motor, basically for the states of Morocco. The examination researched different frameworks with fluctuating stockpiling times. It was accounted for that LCOE decreases when limit of the CSP plant is expanded; nonetheless, the sun oriented to-power

transformation effectiveness is brought down with the augmentation in limit.

### CONCLUSION

In our project work we successfully designed and fabricated TES tank. We successfully managed to stored heat in molten salt + water solution for 9 hours with the minimal heat loss from 220°C to 178°C. Decision of selection asbestos as insulation layer is proved to be

correct as it is substantially reduced heat loss. Again, implementation of air gap in between tank and insulation layer is performed good, it further reduces heat loss from tank. When we going to build larger TES system we need to used cement-concrete as a tank material then it is enough to provide strong point contact with optimum air gap.

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## Experimental and FEA Investigation of V Shape Spring with Steel and Composite Material Under Different Loading Conditions

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### ABSTRACT

The Automobile Industry has shown keen interest for replacement of steel leaf spring with that of progressive rate spring unit, since that has good part loading and minor to maximum shock absorption properties. In this paper we have outline on the new mechanism for progressive rate spring. The main leaf spring and V- shape strip spring model is created by modeling software like Pro-E. The dimensions of an existing conventional steel leaf spring of a light commercial vehicle are taken for modeling. And the structural analysis of both springs is carried via finite element analysis using ANSYS-12 software. Result shows that, the V-shape strip spring has Total deflection 16.93 % & Strain energy 38.20 % more than steel leaf Spring for partly loading. It also shows equivalent von- misses stresses for both spring.

It is observed that the V- shape strip spring is great under part loading i.e. minimum loading action and is superior for progressive rate spring, is best suitable for carrying export quality fruit from farm to wear house or customer market and mini ambulance vehicle. All material used in this unit is easily available, so it commercially adopted in automotive mini trailer manufacturer. Also it has less complexity and economically advantageous for middle class farmer. Composite E- Glass/ Epoxy V shape spring going to be analysis and analytically validate under static loading condition.

**Keywords:** Leaf spring, V-shape strip spring, FEA, Part loading, Total deflection, Strain energy, E-Glass/ Epoxy

### INTRODUCTION

Finite Element analysis tools offer the tremendous advantage of enabling design teams to consider virtually any molding option without incurring the expense associated with manufacturing and machine time. The Ability to try new designs or concepts on the computer gives the opportunity to eliminate problems before beginning production.[1] Additionally, designers can quickly and easily determine the sensitivity of specific molding Parameters on the quality and production of the final part. The main leaf spring and V- shape strip spring model is created by modeling software like Pro-E and it is imported in to the analysis software ANSYS- 12, the loading, boundary conditions are given to the imported model and result are evaluated by post processor. The different comparative results of main steel leaf spring and V- shape strip spring are obtained to predict the advantages of V- shape strip spring for progressive rate loading for mini trailer which is used in farm for carrying export quality fruit. V – shape spring we can made up of composite material.

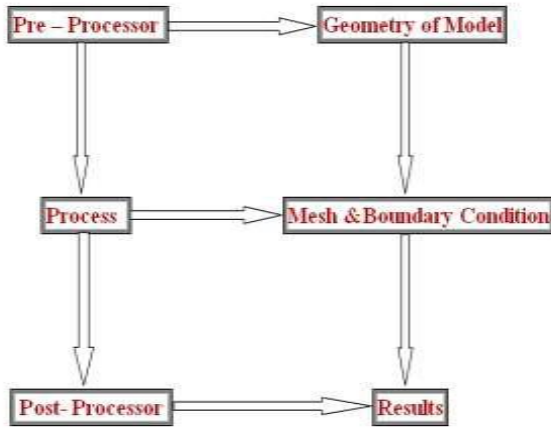
### A. Introduction of Structural Analysis

Finite Element analysis tools offer the tremendous advantage of enabling design teams to consider virtually any molding option without incurring the expense associated with manufacturing and machine time. The Ability to try new designs or concepts on the computer gives the opportunity to eliminate problems before beginning production. Additionally, designers can quickly and easily determine the sensitivity of specific molding Parameters on the quality and production of the final part. The spring model is created by modeling software like Pro-E , and it is imported in to the analysis software and the loading, boundary conditions are given to the imported model and result are evaluated by post processor.

### FEA PROCEDURE

FEA tool is the mathematical idealization of real system. Is a computer based method that breaks geometry into element and link a series of equation to each, which are then solved simultaneously to evaluate the behavior of the entire system. It is useful for problem with

complicated geometry, loading, and material properties where exact analytical solution are difficult to obtain. Most often used for structural, thermal, fluid analysis, but widely applicable for other type of analysis and simulation.[6] Figure 1 shows procedure of FEA.



**Fig. 1 Typical FEA procedures by commercial software (ANSYS-12)[6]**

**B. Materials for Spring**

Plain carbon steel, Chromium vanadium steel, Chromium- Nickel- Molybdenum steel, Silicon manganese steel, are the typical materials that are used in the design of leaf springs. The material selected for steel leaf spring is 65Si7 and for composite spring is E-Glass/ Epoxy. The design parameters selected for spring are listed in table I, II, III.

**Table I: Design Parameters of Steel Leaf Spring.[6]**

Parameters	Values
Material selected Steel	65Si7
Tensile strength	1962 N/mm <sup>2</sup>
Yield strength	1470 N/mm <sup>2</sup>
Young’s modulus(E)	2e5 N/mm <sup>2</sup>
Total length	650 mm
Arc height at axle seat	76 mm
Normal static loading (max)	2500 N
Available space for spring width	50 mm X 6 mm
Number of leaves	02

**Table II: Design Parameters of Steel V-Shape Strip Spring.**

Parameters	Values
Material selected Steel	65Si7
Tensile strength	1962 N/mm <sup>2</sup>
Yield strength	1470 N/mm <sup>2</sup>
Young’s modulus(E)	2e5 N/mm <sup>2</sup>
Total length between V end	100 mm
Included angle of V-shape	45 <sup>0</sup>
Normal static loading (max)	2500 N
Available space for spring width	30 mm X 4 mm
Number of strip	01

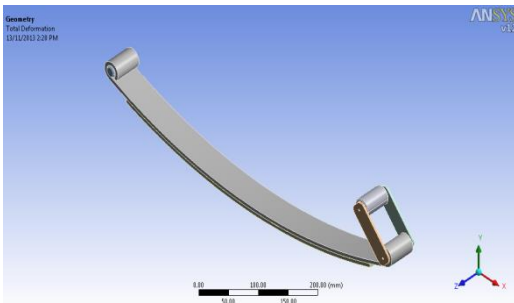
**Table III: Material properties of E-Glass/Epoxy**

Parameters	Values
Tensile modulus along X-direction (Ex), MPa	34000
Tensile modulus along Y-direction (Ey), MPa	6530
Tensile modulus along Z-direction (Ez), MPa	6530
Tensile strength of the material, MPa	900
Compressive strength of the material, MPa	450
Shear modulus along XY-direction (Gxy), MPa	2433
Shear modulus along YZ-direction (Gyz), MPa	1698
Shear modulus along ZX-direction (Gzx), MPa	2433
Poisson ratio along XY-direction (NUxy)	0.217
Poisson ratio along YZ-direction (NUyz)	0.366
Poisson ratio along ZX-direction (NUzx)	0.217
Mass density of the material (ρ), kg/mm <sup>3</sup>	2.6e6

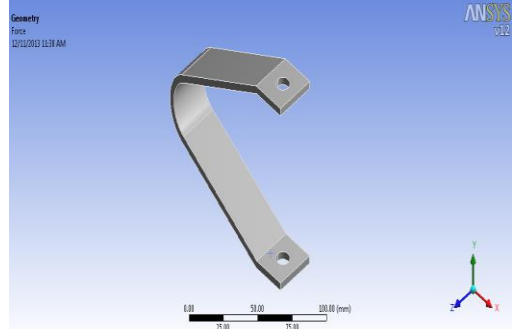
**C. Geometry of Main Leaf Spring & V-Shape Strip Spring**

Figure 2 shows the imported geometry of mono leaf spring & figure 3 shows the imported geometry of V-shape strip spring. This geometry has been created in Pro-E. Figure shows the 3D model of leaf spring with camber

of leaf spring. Total length of mono leaf is 650mm and 76mm is the arc height at axel seat.



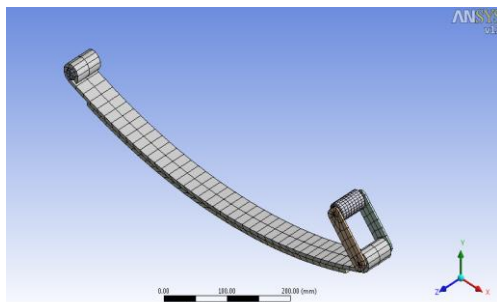
**Fig. 2 Geometry of Main Leaf Spring.**



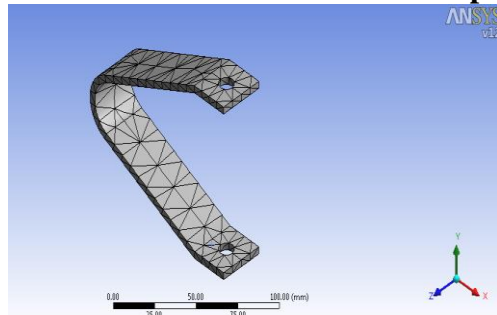
**Fig. 3 Geometry of V- Shape Strip Spring.**

**D. Meshed Model of Main Leaf Spring & V-Shape Strip Spring**

Meshing is nothing but the descritization of object into the small parts called as the element. Figure 4 & figure 5 shows the meshed model of both spring with brick and triangular elements are used. Previous Studies show that the best results are obtained using brick mesh.



**Fig. 4 Meshed Model of Main Leaf Spring.**



**Fig. 5 Meshed Model of V- Shape Strip Spring.**

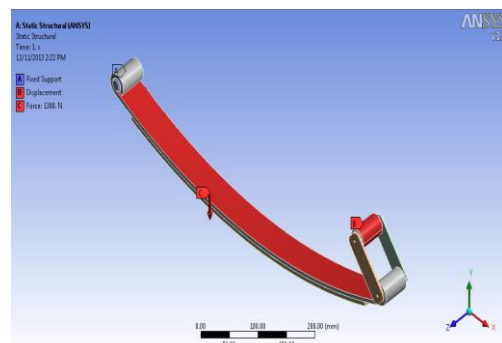
**E. Loading & Boundary Conditions Main Leaf Spring & V- Shape Strip Spring**

**1) Fixed Support**

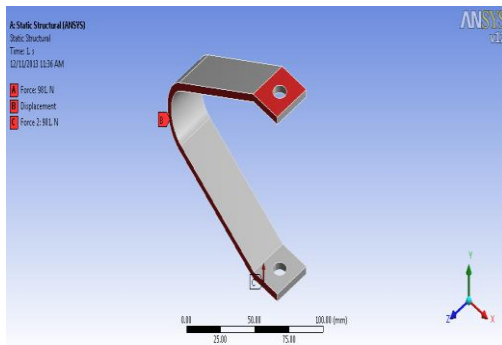
Fixed support has restriction to move in X and Y direction as well as rotation about that particular point. For the leaf spring analysis one eye end of the leaf spring is fixed to the chassis of the vehicle. So this eye end of the leaf spring cannot move in any of the directions i.e. all the degrees of freedom are blocked. V- shape strip spring expands & compress in up and down direction so it has no any fixed support but it firmly attached with main leaf spring at up side & bracket at down side in assembly of whole unit.

**2) Displacement support**

As there is shackle provided at other end of the leaf spring because of which the leaf spring only translates in one plane and other movements i.e. degree of freedom are blocked. So with the reference of this a displacement support is applied to the other eye end of leaf spring model. This support allows the movement of the leaf spring in X axis, rotation about Z axis and fixed along Y axis.[6] Also for V-shape strip spring curvature end having free movement in X & Y axis Direction but constant in Z axis.



**Fig. 6 Loading & Boundary Conditions**

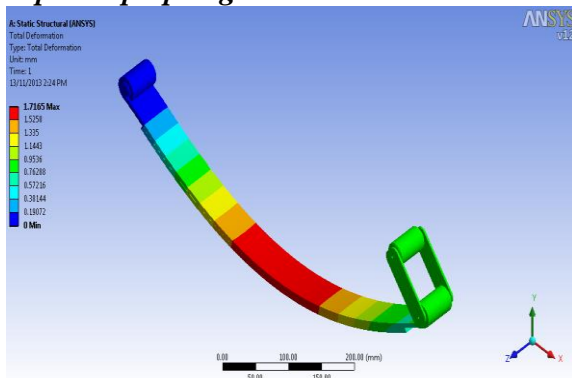


**Fig. 7 Loading & Boundary Conditions of Main Leaf Spring, of V-Shape Spring.**

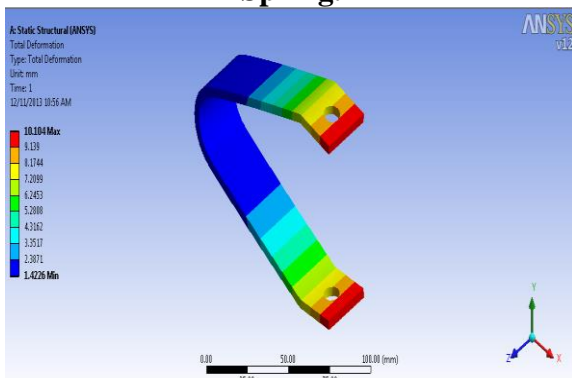
Since the load is uniformly distributed on the leaf spring, here in this study uniformly distributed load 1380N which is 20% more of the unladen weight of trailer. For V- shape strip spring it uniformly distributed load 690N that is applied on doth side from upward and downward of spring model. The uniformly distributed load is shown in figure 6 & figure 7.

**F. Results and Discussion**

**1) Total Deflection of Main Leaf Spring & V-Shape Strip Spring**



**Fig. 8 Total Deflection of Main Leaf Spring.**

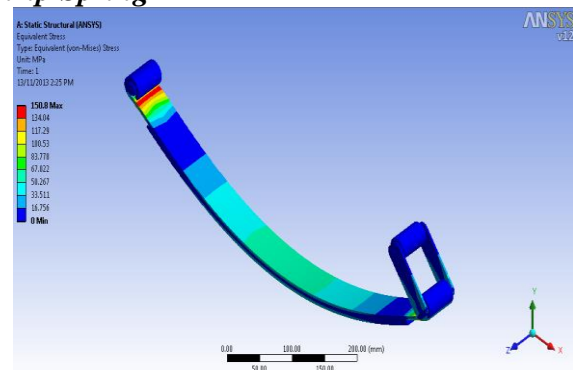


**Fig. 9 Total Deflection of V- Shape Strip Spring.**

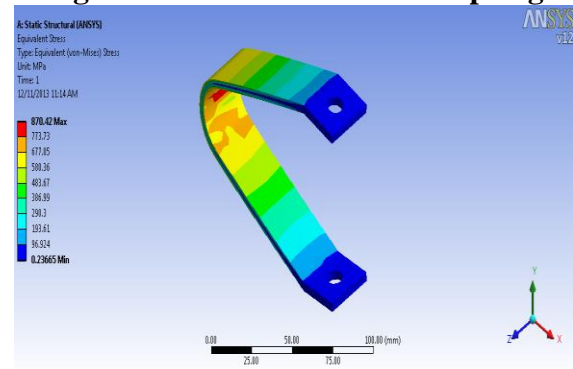
Figure 8 shows the deflection of steel leaf spring & Figure 9 shows the deflection of steel

V- shape strip spring with leaf spring under the application of 1380N total load. The maximum deflection is at the centre of the leaf spring is 1.71 mm and V- shape strip spring its maximum value is 10.10mm from both side. Red zone indicates the area of maximum deflection and blue zone indicates the area of minimum deflection, which are shown by color band. According to this v- shape spring shows the 16.93 % more deflection than leaf spring.

**2) Stress for Main Leaf Spring & V- Shape Strip Spring**



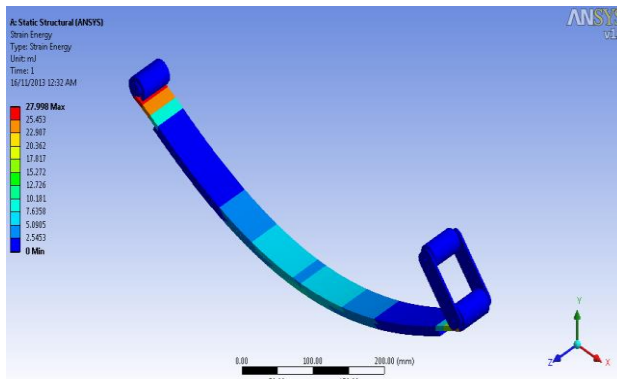
**Fig. 10 Stress for Main Leaf Spring**



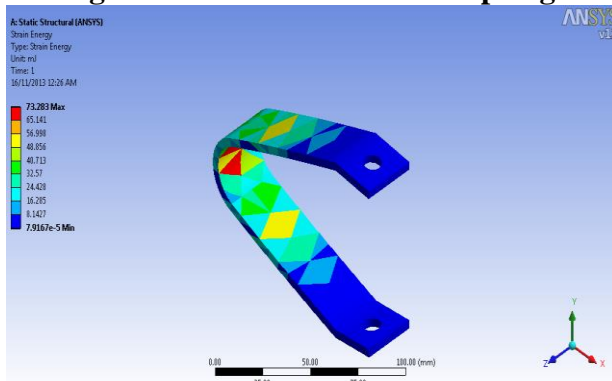
**Fig. 11 Stress for V- Shape Strip Spring**

Figure 10 & figure 11 shows the equivalent von-miss stress induced in steel leaf spring and V- shape strip spring under the action of 1380N load. The maximum stress is induced at nearer to fixed eye end of leaf spring and the curvature end of V- shape strip spring its maximum value is  $150.8\text{N/mm}^2$  &  $870.42\text{N/mm}^2$  respectively. Red zone indicates the area of maximum stress and blue zone indicates the area of minimum stress.

**3) Strain Energy for Main Leaf Spring & V-Shape Strip Spring:**



**Fig. 12 Strain for Main Leaf Spring.**



**Fig. 13 Strain for V- Shape Strip Spring.**

Figure 12 & figure 13 shows the strain energy induced in steel leaf spring and V- shape strip spring under the action of 1380N load. The maximum strain energy is induced at nearer to fixed eye end of leaf spring and the curvature end of V- shape strip spring its maximum value

is 27.998MJ & 73.283MJ respectively. Red zone indicates the area of maximum stress and blue zone indicates the area of minimum stress.

## CONCLUSION

The 3-D modeling of both steel spring is done and analyzed A comparative study has been made between V- shape strip spring and leaf spring with respect to Total deflection, von-miss stresses and strain energy. From the results, It is observed that the V- shape strip spring shows more deflection i.e 16 % and strain energy 38.20 % than that of steel leaf spring material. It is observed that the V- shape strip spring is great under part loading i.e. minimum loading action and this unit of progressive rate spring is best suitable for fruit carrying trailer and mini ambulance vehicle. The V- spring unit is gradually brought into operation according to the load being applied and progressively increases in proportion to the load being carried and also it is more economical than the conventional steel spring with similar design specifications. Similarly composite material V- spring going to be analysis under the static loading condition.

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**ENTRY SYSTEM FOR DISABLE PASSENGERS IN TRAINS****P.M. Sutar<sup>1</sup>, Kunal Ajage<sup>2</sup>, Abdul Ahad Khan<sup>3</sup>, Gaurav Chavhan<sup>4</sup>, Lokesh Khairnar<sup>5</sup>**<sup>1,2,3,4</sup> Scholar, Mechanical Department, SIEM, Nashik, Maharashtra, India<sup>5</sup> Assistant Professor, Mechanical Department, SIEM, Nashik, Maharashtra, India**ABSTRACT**

Indian railways run dedicated trains for handicapped passengers in different parts of India. But the trains which are allocated for handicapped persons do not have proper system or device for passengers to board the train by themselves. They have to board train with the help of train cure. In this research an effort has been made to make handicapped passenger self-sufficient to board and onboard the train. The compact convertible ramp work on scissors extension mechanism powered by pneumatic or electric actuator. The ramp can handle weights up to 250 kg. It can compact and fit in train's inner compartment which makes it more aerodynamic than regular stairs. It will also be convenient for children's and senior citizens as ramp covers the gap between platform and train makes it easier for passengers to board train. The existing or next generation of trains can apply certain type of systems with minimum modification to make boarding and unbaring trains safe and with minimum efforts.

**Keywords:** train, handicapped passengers

**Introduction**

The working handicapped population is considerably large in India there are lots of efforts made in providing sufficient number of jobs for them but there are still problems related to traveling especially for the part of groups which does not own a private medium of transportation. Among those who travels in trains or locals faces issues to board and onboard the train, As there is still a gap in between train and platform and it varies between the heights of 20 to 30 inches approximately.



The old ladder design of trains are not much convenient even for the normal passengers or children's and senior citizens, there were some incidents on the past while boarding the train passenger falls in gap between train and platform, which causes in some serious injuries.

In order to reduce risks of falling in between platform and rail tracks and to make it easier for handicapped passengers to board and onboard train we have come up with an idea which if implies solves the issues stated above. In order to fill the gap between platform and train we decided to use a ramp which will eliminate the risk of falling and handicapped passengers on wheel chair can easily board the train.

But we want the ramp to be so small to be attached to the train bogie itself so we have to make it convertible so it can unfold when needed and can be converting in compact size while the train starts. So we have decided scissors extension mechanism for the purpose which can be operated by electrical or pneumatic actuators to fold and unfold the system.

Our three major concerns were addressed on our research on topic which were,

**System should be compact enough** which not required more will space than existing system. So even the trains which are operating in present times can acquire them with minimum design change dimensions of bogies.

**Approach angle of ramp should be less than 30 degrees.** So it will require fewer efforts for passengers on wheel chair to board the train.

**To make it accessible for not only handicapped passengers but also for normal passengers.** The system is made to solve issues

of handicapped passengers without effecting normal passengers.

### Literature Review

#### **“Deriving a Generalized, Actuator Position-Independent Expression for the Force Output of a Scissor Lift” By Amay Saxena University of California, Berkeley**

Scissor lifts, a staple of mechanical design, especially in competitive robotics, are a type of linkage that can be used to raise a load to some height, when acted upon by some force, usually exerted by an actuator. The position of this actuator, however, can affect the mechanical advantage and velocity ratio of the system. Hence, there needs to be a concrete way to analytically compare different actuator positions. However, all current research into the analysis of scissor lifts either focuses only on the screw jack configuration, or derives separate force expressions for different actuator positions. This, once again, leaves the decision between different actuator positions to trial and error, since the expression to test the potency of the position can only be derived once the position is chosen. From that paper we have learned the use of hydraulic actuator to operate scissors extension mechanism.

#### **“Automatic step-climbing wheelchair for physically disabled people,” by “Abhilash Ajmera (11010379) and Ritesh Kumar (11010354),**

In this thesis, the design and analysis of an affordable automatic step climbing wheel-chair for physically disabled is presented. The motivation is to cater the needs of disabled people who are at economically disadvantage position. It may be noted that the electrically operating lifts are not common in two or three storey buildings. The motive of the researchers is to build wheelchair to climb stairs in affordable rates, But The structure of stairs of railways are different from other stairs so it will require its unique solution. On basis of that paper we have also learned different problems faced by handicapped people.

**“Evaluation of disable friendliness of a railway transport facility in Ludhiana city of Punjab, India” by Ruchi Sharma, Manoj Kumar and Amarjeet Singh. It was only after**

interviewing the authorities that the location of the ramp was known. The available ramp was too far from the main platform. The ramp to cross over to the next platform was at a far distance from the main platform resulting in PWDs to arrive late to their respective platform. The step edges of the stairs were not of different color or texture to be identified by low vision and the vision impaired, and there was no ramp next to the stairs. The gap between trains and platforms was difficult or impossible to negotiate and there was inconsistency in providing tactile safety features on platforms often confusing sightless people. A serious concern and changes are needed to ensure convenience for all. It has been widely accepted that disabled people have fewer opportunities and lower quality of life than the non-disabled. In addition to poor accessibility, disabled people face more challenges and difficulties while travelling and using public transport. Therefore, it becomes increasingly difficult to ignore the issues related to the disabled while using the facilities of public transport. Many disabled persons access transport systems only in the case of health and/or emergency needs. As a result, most do not get a chance to participate in education, employment, and social activities and are thus often isolated and tend to be poor

#### **TRANSPORTATION RELATED CHALLENGES FOR PERSONS WITH DISABILITIES by Grayson W. Besom.**

Examine individuals with disabilities' social and community participation in relation to their access to transportation. A self-administered online questionnaire was disseminated to individuals with disabilities throughout the United States. Individuals were found to use private vehicles less often and public transportation more often than previous studies have shown. Individuals with increasingly significant disabilities were more likely to face transportation-related exclusion. Almost half of the participants had to cancel an appointment because of a transportation-related conflict. The majority of participants felt that the level of access to transportation hindered their social life.

#### **RAILWAY SYSTEM ACCESSIBILITY EVALUATION FOR WHEELCHAIR USERS: CASE STUDY IN THE CZECH**

**REPUBLIC by Yaroslavl Mazurka.** It deals with accessibility of rail transportation as a system. Presented methods bring ways of rail infrastructure and train accessibility evaluation. Applied two-stage model enables evaluation of departure halls accessibility. The level of train accessibility is defined by coefficients of time and direction non-uniformity. While opportunities for barrier-free travelling are relatively balanced in monitored regions, coefficients show a time imbalance in the results. Opportunity to travel barrier-free (according to the non-uniformity coefficients) shows that there are fluctuations at weekends and on weekdays. These are not of crucial importance. However, the train services are barrier-free particularly for travelling on long distances, whilst suburban and regional ones are still mostly inaccessible for wheelchairs, which is not very favorable. Since 2010 the accessibility level has improved in this area in the Czech Republic. Comparison with neighboring countries showed strong and weak points of guaranteed barrier-free services in each country

**Assessment Of Accessibility For Disabled Persons In Rail Transit Stations In Clang Valley**

**By Mohd Syafiq Sallehuddin, Mohd Zakwan Ramli, Daud Mohamad, Norlela Ismai.** This paper was published to present the current condition of accessible facilities for disabled persons provided in rail transit stations in Clang Valley. Accessibility is one of the most important criteria in designing a public transport station. With poor accessibility, the disabled people confront more difficulties and challenges while travelling and using the Public transport. Thus the objective of this study is to assess and then to compare the accessibility for disabled persons on rail transit stations around Clang Valley. For this purpose, this study proceed with a qualitative and quantitative approach where an assessment and a questionnaire survey are used as the means to collect the data. A rating system was developed taking the idea from QCLASSIC to assess the accessibility of the rail transit stations and its facilities. It is found that KTM stations are averagely accessible by 50.32% and LRT stations are averagely accessible by 71.53%. Overall, both stations are accessible by 61% and its facilities

are accessible by 69%. With all the data acquired in the study, this paper shows how the accessibility on rail transit stations are associated with the disabled persons.

## Methodology

### 3.1 Concept of Working:

System will be powered by train electricity itself. pneumatic or electric actuator will be used to extend scissors extension mechanism. The ramp will unfold and extend as actuator extend with the help of two scissors extension mechanisms. Until lower portion of scissors extension mechanism touch the platform the ramp will be fully unfolded joining the train and platform with ramp having surface coated with rubber strips for tighter grip of wheels of wheel chair so that the person can board unburden train by himself without anyone's help. As to reduce the efforts of handicapped person while boarding or unbaring the angle of approach and angle of departure will be low. As the ramp will completely breach the gap between train and platform there will be no danger to fall or stuck between railway lines. after all person board the train, then the ramp will be folded back in its compact size as the pneumatic or hydraulic cylinder contracts with no contact or extension outside the bogie. The safety feature can be added so ramp cannot be open while train is running.

### 3.2 Dimensions:

The dimensions of standard wheelchairs are 60-65cm wide, which is sufficient to fit person with wheelchair in train.



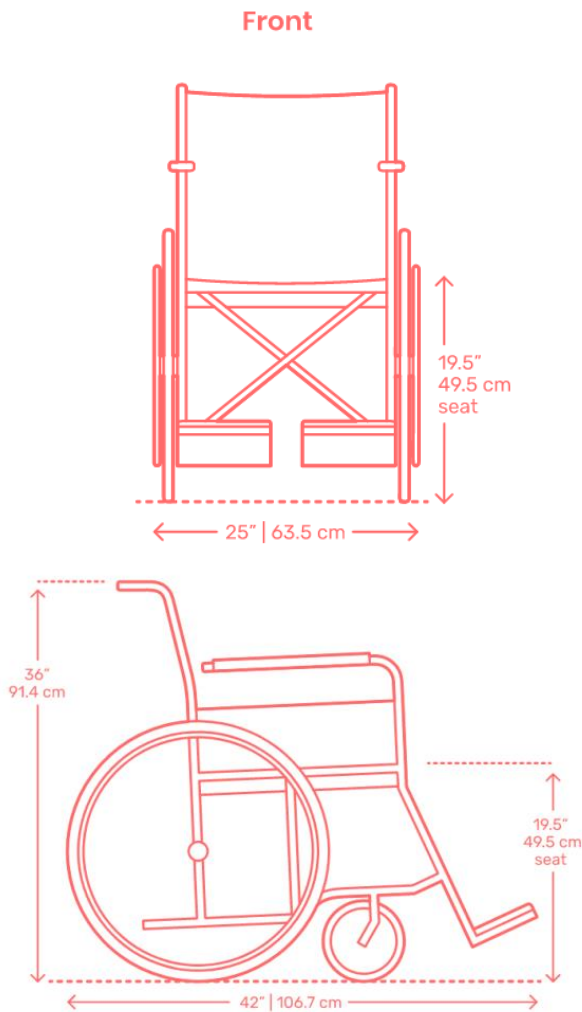


Figure 3.2.1 Dimensions of a standard wheel chair.

The scissors extension mechanism used has 4 pairs of extension links, each pair contains two links, each link is of 30 inch (76.2cm) which is represented by (D) in Following Figure.

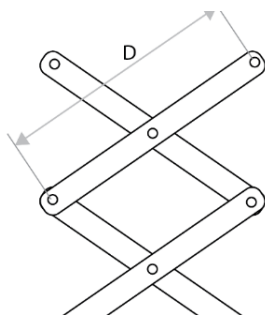


Figure 3.2.2 Scissors extension mechanism.

The ramp will extend till it touches the platform, the distance between platform and train varies between 20-30 inches depends on platforms in that area, the approach angle is less than 30\* degrees so passengers will require less efforts to board the train.

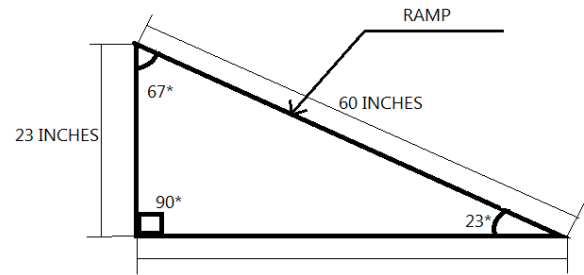


Figure 3.2.3 Representation of approach angle and height of railway entrance from platform.

### 3.3 Calculations

#### 3.3.1 Approach angle and extension of ramp

Height of train from platform = 23 inch  
 Desirable angle approach = >30\* degrees  
 Extension of ramp = 60 inch

Angle of approach :  $\sin @ = \frac{\text{opposite side}}{\text{hypotenuse}}$

$$@ = \sin^{-1} \frac{23}{60}$$

@ = angle of approach = 22.54 = 23 degrees

#### 3.3.2 Maximum Weight Carrying Capacity

We have approached by calculating capacity of weakest link to handle stresses for finding the maximum weight caring capacity of system. As we find out the weakest link in system was the bolt which was connecting links of scissor extension mechanism, as bolt was under shear stress we calculated shear load up to which bolt can function properly as below:

Shear load of M6 bolt:  
 Shear strength of material =  $\tau$   
 Shear load =  $P_s$   
 Diameter of bolt =  $d$

$$P_s = \frac{\tau \times \pi \times d^2}{4}$$

$P_s = 3.22 \text{ KN}$   
 Which is 328 kg, so the Weight caring capacity of system is 328 kg.

### Conclusion

In this research we have studied the problem faced by handicapped passengers while traveling in trains, and have come up with a solution to solve current and future issues of handicapped population, and safety of passengers, the scissors extension ramp can solve the basic problem faced by handicapped people without effecting normal people instead

making them safe for little children's, and senior citizens, There is still a lot of scope for research in these field. We have achieved our goal to make handicapped passenger self-sufficient and to board the train safer with dimensions compatible for modification in existing trains.

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**DESIGN AND DEVELOPMENT OF SOLAR POWER AERATION SYSTEMS**

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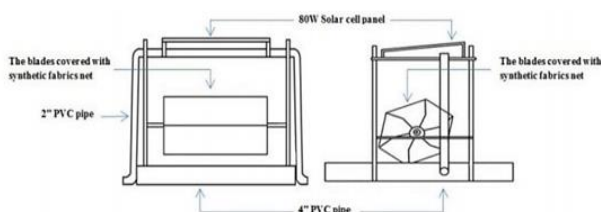
**ABSTRACT**

*Biological treatment of organic material and ammonia requires ample oxygen to facilitate degradation and removal. However, minimal Dissolved Oxygen (DO) is typically present in raw wastewater, and must be added to the treatment process to enhance and facilitate biological removal of soluble organic material and ammonia. Water Resource Recovery Facilities (WRRFs) rely on aeration systems to transfer oxygen from a gaseous state to a dissolved liquid form that is available to support biological treatment. Aeration can be provided through mechanical agitation of the liquid surface to entrain DO in the aeration tanks (mechanical aeration) or through introducing oxygen into the aeration tanks through porous devices (diffused aeration).*

**Keywords:** Dissolved, Ammonia, Aeration, Porous

**Introduction**

Aeration systems are designed to increase the air-water interface within a process liquid, allowing for sufficient oxygen transfer required to support the biological processes. Mechanical aeration consists of motor-driven impellers, propeller aspirators, or rotors that generally operate at the liquid surface to provide DO within the aeration tanks. The impeller and rotor transfer oxygen by mixing the liquid surface while the propeller aspirator injects atmospheric air into the liquid. The equipment used depends on which configuration was utilized for the treatment process. There are four general configurations for mechanical aeration systems: radial flow low speed, axial flow high speed, horizontal rotors, and aspirating devices



1) The Standard Aeration Efficiency (SAE) of each configuration is dependent upon the design of the equipment used (impeller, rotor, or propeller aspirator), tank geometry, effects of adjacent walls,

input power to tank volume, and various other factors.

- 2) Oxygen was important to livelihoods and lives as oxygen empowered all body processes for life growth
- 3) Water in nature came with dissolved oxygen value of 5-7 mg/L. If it was lower than 3 mg/L, the water was considered polluted. As pointed out above, the researcher planned the research guideline by inventing a prototype solar energy aerator.
- 4) Oxygen was important to livelihoods and lives as oxygen empowered all body processes for life growth. Provided that there was insufficient amount of oxygen, lives could not survive. Likewise, aquatic animals were in need of dissolved oxygen (DO) in water. In general, it was derived through atmosphere and photosynthesis performed by aqua plants.

**Literature Review**

- 1) Mohammad Tanveer, Subha M Roy, M Vikneswaran, P Renganathan and S Balasubramanian, done the work on, Surface aeration systems for application in aquaculture: A review, according to his work, Surface aeration systems viz., paddle wheel and spiral aerators are the most commonly used aeration systems in intensive aquaculture practices.

- 2) Use of aerators in intensive aquaculture is important for ensuring better survival, optimal oxygen supply, higher production, and disease free environment. Hence, selection of properly designed and high efficient aerators is necessary to maintain adequate and continuous supply of dissolve oxygen (DO) in semi-intensive and intensive aquaculture. In the present study a review on previous studies related to standard aeration efficiency (SAE) and standard oxygen transfer rate (SOTR) of paddle wheel and spiral aeration systems has been discussed.
- 3) Paddle wheel aerator is found to be the best due to its low cost, low maintenance, ease in operation and high SOTR as well as SAE in intensive pond culture systems.
- 4) Samsul Bahri, Radite P.A. Setiawan, Wawan Hermawan & Muhammad Zairin Junior, done the work on, Design and Simulation of Paddle Wheel Aerator with Movable Blades, according to his work, The development of movable blade is based on fact that power is required only when blade of paddle wheel aerator entering water and in contrary action of aeration effect only when the blade is about leaving the water.
- 5) Jayraj P, Subha M. Roy, C. K. Mukherjee and B. C. Mal, done the work on, Design Characteristics of Submersible Aerator, according to his work, Aeration experiments were conducted on original and modified submersible aerator to evaluate its performance and to optimize the aeration efficiency.

### Problem Definition

There was a huge closed pond located in all Nashik cities. In the pond, there was no ventilation. As time went by, water in the pond had become polluted due to the deduction of the oxygen in the water. There were aquatic lives in the pond such as various fish. Due to this issue, aerators were installed all over the pond areas. The recent water treatment devices obtained electricity supplied by the Electricity Authority MSEB Board. This stemmed in significantly huge expenses on a monthly basis electricity cost that they had to bear with in order to maintain and increase the oxygen level

in the pond. To overcome that problem it is need to make aerator system using Solar energy use.

### Objective

The followings are some of the objectives behind development of solar power aeration system given below,

- 1) The main objective of this project is to assess the feasibility and economic viability of utilizing Solar based standalone power supply systems to meet the load requirements for aeration system.
- 2) To make nonconventional system which will give continues & sufficient power in all working conditions for aeration system.
- 3) To make energy efficient aeration system as an low cost alternatives to conventional one.
- 4) To optimize usage of electricity by substituting its mode of generation for aeration system.
- 5) To develop a small aeration system scale model for assessing feasibility of system.
- 6) To design the aeration system this is cost effective, reliable and also efficient.

### Metallurgical Specification:

The machine is basically made up of mild steel. Reasons:

- 1) Mild steel is readily available in market.
- 2) It is economical to use.
- 3) It is available in standard sizes.
- 4) It has good mechanical properties i.e. it is easily machinable.
- 5) It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure.
- 6) It has high tensile strength.
- 7) Low co-efficient of thermal expansion

### Properties of Mild Steel:

M.S. has carbon content from 0.15% to 0.30%. They are easily weldable thus can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric or arc welded. With increase in the carbon percentage weld ability decreases. Mild steel serve the purpose

and was hence was selected because of the above purpose

### Mechanical Design

In mechanical design the components are listed down and stored on the basis of their procurement in two categories. • Design parts • Parts to be purchased. For designed parts detailed design is done and dimensions there obtained are compared to next dimensions which are already available in market. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified. The process charts are prepared and passed to manufacturing stage. The parts to be purchased directly are selected from various catalogues and are specified so as to have ease of procurement. In mechanical design at the first stage selection of appropriate material for the part to be designed for specific application is done.

### Motor Selection:

Thus selecting a motor of the following specifications Let us assume the force to be required for Carrying Load on rotor of aerator  $1\text{kg} = 9.81\text{N}$ .

So that power will be transmitted by chain drive having sprocket dia. 60mm.

Torque  $T = F \times R = 9.81 \times 30 = 294.3 \text{ N.m}$ .  $T = 0.2943 \text{ N.m}$

Thus selecting a motor of the following specifications.

$P = 2 \pi N T 60 = 2 \pi \times 60 \times 0.2943 60 T = 1.849 \text{ N-m}$

We Select:

- DC motor
- Power =  $1/15\text{hp} = 50 \text{ watt}$
- Speed = 60 rpm

Motor Torque  $P = 2 \pi N T 60 T = 60 \times 50 2 \pi \times 60 T = 7.96\text{N-m}$

Power is transmitted from the motor shaft to the input shaft by means of a chain drive, center is set to medium, span angle center set to fine, smoothing set to medium.

### VIII-A) Design of chain drive:

(V.B. Bhandari, DME Book. Third edition, p.no.550, 551) (Table 14.2, 14.6)

Let speed of pinion is 60 rpm. The driving sprocket is mounted on the same shaft so that, Speed of driving sprocket  $N_1 = 60 \text{ rpm}$ .

Let us we select power rating Table 14.2 Speed of sprocket is 100rpm for 08A chain.

Power  $P = 50 \text{ watt} = 50 \times 10^{-3} \text{ kw}$ .

Let, Dia. Of driving sprocket  $d_1 = 180 \text{ mm}$ .

Dia. Of driven sprocket  $d_2 = 75 \text{ mm}$ .  $N_2 = 144 \text{ rpm}$ . No. of teeth on driving & driven sprocket is ,

$Z_1 = 42, Z_2 = 18$

Let,  $K_s = \text{Service factor} = 1$

$K_1 = \text{Multiple strand factor} = 1$  (Table 14.4)

$K_2 = \text{Tooth correction factor} = 1$  (Table 14.5)

$K_w = K_w = 0.504 K_w$ . Select chain 08A. Pitch of chain sprocket (Table 14.1) P.No.547

$P = 12.70 \text{ mm}$ . Table 14.6.

Pitch circle diameter  $P_1 = 169.94 \text{ mm}$ .

Pitch circle diameter  $P_2 = 73.136 \text{ mm}$ .

Center distance between two sprockets  $a = 375 \text{ mm}$ . No. of links on chain  $L_n = 2$  ( $L_n = 89.54$   $L_n = 90 \text{ Links}$ ).

Corrected center distance  $a = a = ( )$

{  $[ L_n - a = ( a = 377.8 \text{ mm}$ .

### VIII-B) Shaft design:

find diameter of shaft by ASME code For commercial steel shaft,

Actual shear stress  $\tau_{act} = 55\text{N/mm}^2$

$T = 1/16 \times \tau_{act} \times d^3 7.76$

$d^3 = 737.089$

$d = 9.033\text{mm}$  select  $d = 10\text{mm}$

### VIII-C) Bearing selection:

As shaft dia. – is 10mm so we have selection a bearing having shaft outer dia. – 10mm

.In selection of ball bearing the main governing factor is the system design of the drive i.e.; the size of the ball bearing is of major importance; hence we shall first select an appropriate ball bearing.

Taking into consideration convenience of mounting of ball bearing.

As shaft diameter is 10mm & selected a ball bearing having shaft outer dia-10mm ball bearing to support the shaft of 10mm. No. 6200.

Total radial load on bearings are = 5kg. = 49.05 N. Design and development of solar power aeration systems.

Radial load on each bearings  $F_r = 49.05 / 2 = 24.525 \text{ N}$ .

Equivalent dynamic load  $P_e = V.F_a.K_r = 1 \times 24.525 \times 1.5$   
 $P_e = 36.787$  N bearing life is, L  
 Lh10 from graph 4.6

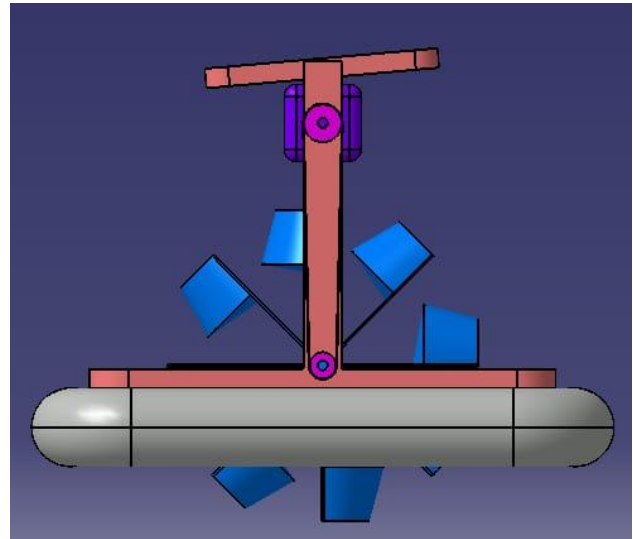
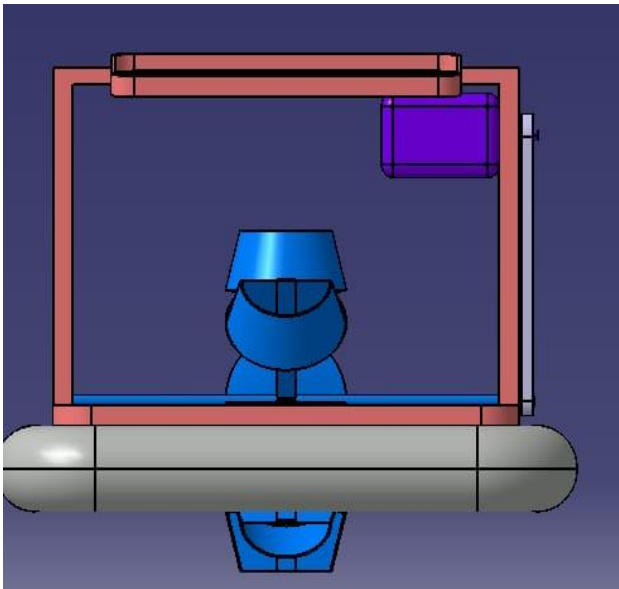
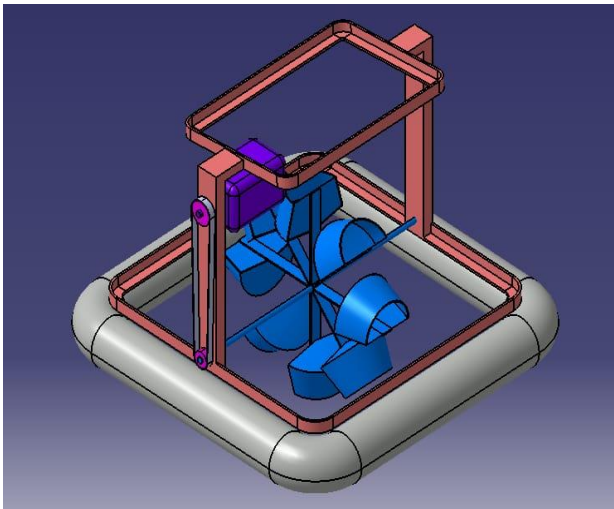
PSG Design data book for 20000 rpm  
 maximum speed of ball bearing is 200000  
 Hours.

PSG Design data book P.No. 4.13.

$L_{10} = 720$  millions of revolutions.  $L_C = X$   
 $36.787$   $C = 329.71$  N.  $\leq 4000$  N (Bearing is  
 safe.)

PSG D.D.Book.P.No.4.13.

### CAD Design



### Advantages

The advantages covered by the propose aeration system are listed as,

- 1) Overcoming disadvantages of conventional system by using standalone renewable electrical energy generation for running aeration system.
- 2) Since, the system doesn't complexity of system testing and understanding became easy in terms of difficulties.
- 3) Aeration System maintains is remarkably reduced and becomes easy.
- 4) Renewable energy sources are utilized so, no waste production.
- 5) Once the system is designed and developed or manufactured, the installation of system is easy.
- 6) Within certain time period the installation cost gets covered.
- 7) Improves the aesthetics and overall health of ponds and lakes.
- 8) Eliminates the need for harmful chemicals
- 9) Reduces maintenance, saving your money and time.
- 10) Improves Water Quality and Clarity.
- 11) Improves Fish and Water fowl habitat.

### Applications:

- 1) For aquatic environments ranging in size from small ornamental ponds to lakes up for filtration.
- 2) Remote areas installation
- 3) Environmentally beneficial landscaping / aqua scaping.

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## A REVIEW OF AUTOMATIC BREAKING FLUIDLEAKAGE DETECTION WITH SAFETYBYPASS BREAKING SYSTEM

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### ABSTRACT

*The braking system was designed and applied on a car to make the driving process safety using embedded system design. Most of the accident occurs due to the delay of the driver to hit the brake, so in this project work braking system is developed such that when it is active it can apply brake depending upon the object sensed by the ultrasonic sensor and speed of vehicle. Currently, vehicles are often equipped with active safety systems to reduce the risk of accidents, many of which occur in the urban environments. The most popular include Antilock Braking Systems (ABS), Traction Control and Stability Control. All these systems employ different types of sensors to constantly monitor the conditions of the vehicle, and respond in an emergency situation. An intelligent mechatronic system includes an ultrasonic wave emitter provided on the front portion of a car producing and emitting ultrasonic waves forward in a predetermined distance. An ultrasonic receiver is also placed on the front portion of the car operatively receiving a reflective ultrasonic wave signal. The reflected wave (detected pulse) gives the distance between the obstacle and the vehicle and RPM counter gives speed of vehicle. The microcontroller is used to control the braking of the vehicle based on the detection pulse information to push the brake pedal and apply brake to the car stupendously for safety purpose.*

**Keywords:** Ultrasonic Sensor, Intelligent Mechatronic system, RPM counter, Microcontroller

### Introduction

Braking systems of commercial vehicles were always given the highest importance concerning safety issues and in particular active safety. Inappropriate braking of these vehicles may cause heavy accidents due to relatively longer stopping distances and higher energy output of brakes particularly in the case of vehicle combinations. The traditional medium used for brake system (compressed air) can be now controlled with the speed and precision offered by modern electronic abilities. Intelligent Braking System (IBS) introduced in commercial vehicles providing rapid brake response and release for every single wheel therefore ensuring safety. The extremely rapid response time provided by the electronic control can be used for crucially shortening the braking distance by introducing advanced control of braking system operation. Such a complex task imposed to the control of braking system cannot be based on the driver abilities and need to be done independently of the driver. An improved IBS braking forces management would certainly enable to reach the given task. The advanced strategy for the braking force management, proposed here, is based on intelligent controlling of the braking

forces distribution between the front and rear axle of power-driven vehicle and/or between towing/trailer combination and/or between tractor/semi-trailer. Intelligent braking system has a lot of potential applications especially in developed countries where research on smart vehicle and intelligent highway are receiving ample attention. The system when integrated with other subsystems like automatic traction control system, intelligent throttle system, and auto cruise system, etc. will result in smart vehicle maneuver. The driver at the end of the day will become the passenger, safety accorded the highest priority and the journey will be optimized in term of time duration, cost, efficiency and comfortability. The impact of such design and development will cater for the need of contemporary society that aspires quality drive as well as to accommodate the advancement of technology especially in the area of smart sensor and actuator. The emergence of digital signal processor enhances the capacity and features of universal microcontroller. The overall system is designed so that the value of inter-vehicle distance from infrared laser sensor and speed of follower car from speedometer are fed into the DSP for processing, resulting in the DSP issuing



commands to actuator to function appropriately [1]. The most popular systems like Antilock Braking Systems (ABS), Traction Control and Stability Control employ different types of sensors to constantly monitor the conditions of the vehicle, and respond in an emergency situation. An intelligent mechatronic system includes an ultrasonic wave emitter provided on the front portion of a car producing and emitting ultrasonic waves frontward in a predetermined distance. An ultrasonic receiver is also placed on the front portion of the car operatively receiving a reflective ultrasonic wave signal. The reflected wave (detected pulse) gives the distance between the obstacle and the vehicle. Then a microcontroller is used to control the speed of the vehicle based on the detection pulse information to push the brake pedal and apply brake to the car stupendously for safety purpose [2].

## 1.2 SYSTEM SURVEY

Visiting numbers of workshops like Maruti Suzuki, Bafna Motors, Naik motors, going through detailed study of the ABS from various sources such as books, internet and carefully understanding mounting of each components of ABS such as ECM, Hydraulic control module warning system got clear idea about the existing advance braking technologies. Workshop technicians got mixed feedback from owners of vehicles with ABS. Drivers reported that they find stopping distance for regular conditions are lengthened by ABS either because there may be errors in the system or because of clinking or noise of ABS may contribute to driver not braking at same rate. Hence concluded that braking system present on vehicle are either so advance that they take the braking control away from driver and increase the risk factor or some of them are not that much advance to perform precisely, so we decided to make such system which can allow the driver brakes manually at the same time system also controlling the brakes to reduce risk factors in panic situation. An ABS can be expensive to maintain. Expensive sensors on each wheel can cost hundreds of dollars to fix if they get out of calibration or develop other problems. For some, this is a big reason to decline an ABS in a vehicle. Moreover many commuter vehicles in India

don't have the option of ABS because it's very expensive. It's easy to cause a problem in an ABS by messing around with the brakes. Problems include disorientation of the ABS, where a compensating brake sensor causes the vehicle to shudder, make loud noise or generally brake worse. ABS can only help if the rider applies it in the right time manually and maintains the distance calculations. ABS has its own braking distance. Volvo's laser assisted braking could not work effectively in rainfall and snowfall season and laser is easily affected by atmospheric conditions. In our project we are using Ultrasonic sensors and Microcontroller with which the speed of the vehicle is automatically reduced and voice alarms are given to the user when it approaches an object by automatically sensing the position of the object/vehicle.

## Methodology

An intelligent mechatronic system includes an ultrasonic wave emitter provided on the front portion of a car producing and emitting ultrasonic waves frontward in a predetermined distance. An ultrasonic receiver is also placed on the front portion of the car operatively receiving a reflective ultrasonic wave signal. The reflected wave (detected pulse) gives the distance between the obstacle and the vehicle. The microcontroller is used to control the speed of the vehicle based on the detection pulse information to push the brake pedal and apply brake to the car stupendously for safety purpose. The extremely rapid response time provided by the electronic control can be used for crucially shortening the braking distance by introducing advanced control of braking system operation. The control of commercial vehicle's braking system operation is related not only to vehicle speed but also to lateral acceleration together with the yaw moment control and significantly reducing the possibilities of the vehicle rolling over. Obviously, such a complex task imposed to the control of braking system cannot be based on the driver abilities and need to be done operated independently of the driver.

- Development of an idea
- Detail study of literature
- System survey
- Drawbacks in existing approach

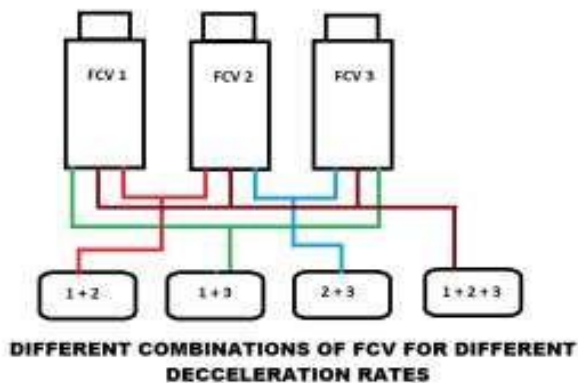
- Cost estimation and specification for standard parts
- Load distribution analysis
- Braking force and pressure analysis
- Experimentation
- Results and discussion

### Experimentation

Our future course of action is to assemble a system on vehicle & perform various experimentations by varying different parameters. Those parameters are as follows:

- Vehicle Speed
- Obstacle distance
- Sensor Position
- Varying deceleration rate

In Order To Avoid Jerky Motion of the vehicle due to sudden braking, we can use combinations of different flow rates to achieve smooth braking and avoid vibrations and for faster response of system we can use electronically operated flow control valve which may add extra cost to the system.



**Figure 3.1 Braking fluid distributions**

### 3.1 DRAWBACKS IN USING HYDRAULIC ACTUATION

1. Actuation time and response time required is more which makes the system less effective.
2. Requires more components
3. System becomes more complex and installation is bit difficult.
4. Add unnecessary weight in vehicle.
5. More expensive.

Because of the above reasons we switched over to electrically actuated solenoid which has following advantages:

1. Response time required is less.

2. Require very less components as compared to hydraulic actuation.
3. System becomes simpler.
4. Less expensive.

### 3.2 ADVANTAGES OF INTELLIGENT BRAKING SYSTEM (IBS)

As mentioned above, an IBS prevents lock-ups and skidding, even in slippery conditions. IBS brakes have been proven to save lives in some situations by helping drivers keep control of a vehicle.

An IBS shares some of the infrastructure of a traction control system, where new technology helps ensure that each wheel has traction on the road. That makes it easy for manufacturers to install both of these features at the factory.

Intelligent braking systems coordinate wheel activity with a sensor on each wheel that regulates brake pressure as necessary, so that all wheels are operating in a similar speed range. And help drivers have better control of a vehicle in some road conditions where hard braking may be necessary.

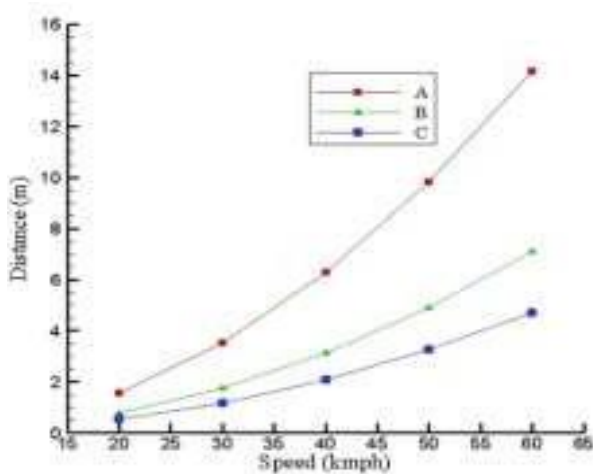
- An ultrasonic sensor, cheaper and less demanding of hardware than other types of sensors presently used.
- As ultrasonic sensors can detect any kind of obstacle, this system can also prevent collision of the vehicle with pedestrians, or can at least reduce the injuries occurring.
- This lower cost of ultrasonic sensors compared with other kinds of sensors, could facilitate the application and mounting of the system in many low-end vehicles, helping to improve comfort and safety and offer a hassle free driving experience at a reduced cost.
- As system does not take whole control from driver, the 'risk' factor due to false indication gets reduced.

When vehicle is in motion, different forces acts on it during braking of vehicle. i.e. Sum of all the static and dynamic forces comes in picture .To achieve safe and smooth braking operation we works on different parameters as follows.

#### 1. Obstacle distance:

We carried out experimentation of different obstacle distance from vehicle. In our

prototype model we try to achieve safe anti-collision braking within 5 metre.

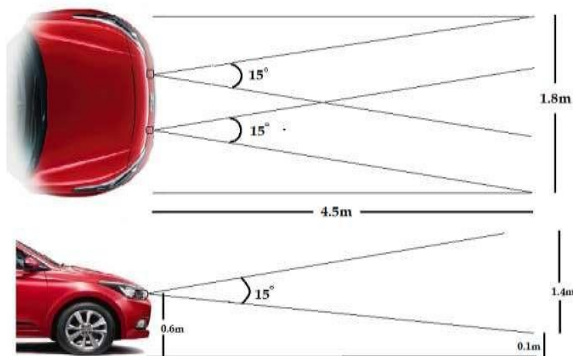


**Figure 3.2 Graph of Speed Vs Stopping distance**

## 2. Current variation to actuator:

Actuator we used is of variable actuator speed i.e. from 3mm/sec to 20mm/sec. We can achieve this variation with the help of different current rating (1amp to 3amp) during high speed condition and critical braking condition we have to apply brake immediately but without jerk.

## 3. Ultrasonic Sensor position:



**Figure 3.3 Ultrasonic sensor position**

To get maximum catchment area in front of the vehicle and to avoid false indication we have to adjust the sensor position. Also number of sensors use is crucial parameter because if one sensor faces the failure then other can do the work.

## Discussions

In the present work, a prototype of an ultrasonic distance measurement for stationary obstacle is obtained. And controlling the speed

of vehicle accordingly to predetermined distance is shown. An ultrasonic sensor, cheaper and less demanding of hardware than other types of sensors presently used, such as the sensors based on computer vision or radar, is used to measure the distance between vehicle and the obstacle. The relative speed of the vehicle with respect to the obstacle is estimated using consecutive samples of the distance calculated. These two quantities are used by the control system to calculate the actions on both the accelerator and also the brake, thus to adjust the speed in order to maintain a safe distance to prevent accidents. As ultrasonic sensors can detect any kind of obstacle, this system can also prevent collision of the vehicle with pedestrians, or can at least reduce the injuries occurring. Since the control system does not use the absolute speed to calculate the safety distance as done by the currently existing systems, the interaction with automotive electronics is limited to actions on the accelerator and brake. This matter, coupled with the fact of lower cost of ultrasonic sensors compared with other kinds of sensors, could facilitate the application and mounting of the system in many low-end vehicles, helping to improve comfort and safety and offer a hassle free driving experience at a reduced cost.

## Conclusions

In this report the innovative idea of implementing intelligent braking system is discussed and thereby analyzed its various parameters for regular realistic application. Intelligent braking is one of the smart options which can be implemented in various applications for stopping a moving body without jerky motion. The previous research study clearly explains that Ultrasonic sensor and microcontroller action plays vital role in determining intelligent braking torque generated by brake actuation assembly. Design of intelligent brake applications basically depend upon effectiveness of Ultrasonic sensor and RPM counter. In the present work various experiments were conducted to check the effect of various parameters such as obstacle distance, output current and sensor position on moving vehicle braking. The parameters were varied using different arrangements of sensors, varied amount of current which leads to

various conclusions. In the present work, a prototype of an ultrasonic distance measurement for stationary obstacle is obtained. And controlling the speed of vehicle accordingly to predetermined distance is shown. An ultrasonic sensor, cheaper and less demanding of hardware than other types of sensors presently used, such as the sensors based on computer vision or radar, is used to measure the distance between vehicle and the obstacle. The speed of the vehicle is estimated using RPM counter. These two quantities are used by the control system to calculate the actions of the brake, thus to adjust the speed in order to maintain a safe distance to prevent accidents. As ultrasonic sensors can detect any kind of obstacle, this system can also prevent collision of the vehicle with pedestrians, or can at least reduce the injuries occurring. Since the control system does not use the absolute speed to calculate the safety distance as done by the currently existing systems, the interaction with automotive electronics is limited to actions on the accelerator and brake. This matter, coupled with the fact of lower cost of ultrasonic sensors compared with other kinds of sensors, could facilitate the application and mounting of the system in many low-end vehicles, helping to improve comfort and safety and offer a hassle free driving experience at a reduced cost.

We have used the previous work on advance braking system and use that to define the basic braking control problem and have developed intelligent control method for this

system. Clearly the approaches and conclusions that we present are somewhat preliminary and are in need of further significant investigations. For instance, it would be useful to perform stable, hassle free braking and also help to evaluate this safety-critical automotive braking system. While the model that we have developed has proven to be quite adequate for the development of microcontroller system that has been evaluated on a vehicle, it would be valuable to evaluate the developed controllers in the field. This would force us to take a very careful look at the requirements for real-time implementations of the intelligent braking system. Our present work realized us that implementation of this smart system can be feasible and of real time use.

Approaches and conclusions that we present are somewhat preliminary and are in need of further significant investigations. While car is taking a turn sensor can give the false indication of obstacle. To avoid this we will make an arrangement such that this system goes off while turn. This can be achieved by mounting sensors on car wheel that are capable of measuring wheel turning. At present, this system is readily suitable for automatic transmission. While making some changes we can use this on any available vehicle. Also improved and precise programming is necessary for real time operation. Application of intelligent braking system for critical dynamic condition need to be analysed.

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## A REVIEW OF AUTOMATIC BRAKING FLUIDLEAKAGE DETECTION WITH SAFETYBYPASS BRAKING SYSTEM

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<sup>3,4,5</sup> Scholar, Mechanical Department, SIEM, Nashik, Maharashtra, India

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### ABSTRACT

The braking system was designed and applied on a car to make the driving process safety using embedded system design. Most of the accident occurs due to the delay of the driver to hit the brake, so in this project work braking system is developed such that when it is active it can apply brake depending upon the object sensed by the ultrasonic sensor and speed of vehicle. Currently, vehicles are often equipped with active safety systems to reduce the risk of accidents, many of which occur in the urban environments. The most popular include Antilock Braking Systems (ABS), Traction Control and Stability Control. All these systems employ different types of sensors to constantly monitor the conditions of the vehicle, and respond in an emergency situation. An intelligent mechatronic system includes an ultrasonic wave emitter provided on the front portion of a car producing and emitting ultrasonic waves frontward in a predetermined distance. An ultrasonic receiver is also placed on the front portion of the car operatively receiving a reflective ultrasonic wave signal. The reflected wave (detected pulse) gives the distance between the obstacle and the vehicle and RPM counter gives speed of vehicle. The microcontroller is used to control the braking of the vehicle based on the detection pulse information to push the brake pedal and apply brake to the car stupendously for safety purpose.

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**Keywords:** Ultrasonic Sensor, Intelligent Mechatronic system, RPM counter, Microcontroller

### Introduction

Braking systems of commercial vehicles were always given the highest importance concerning safety issues and in particular active safety. Inappropriate braking of these vehicles may cause heavy accidents due to relatively longer stopping distances and higher energy output of brakes particularly in the case of vehicle combinations. The traditional medium used for brake system (compressed air) can be now controlled with the speed and precision offered by modern electronic abilities. Intelligent Braking System (IBS) introduced in commercial vehicles providing rapid brake response and release for every single wheel therefore ensuring safety. The extremely rapid response time provided by the electronic control can be used for crucially shortening the braking distance by introducing advanced control of braking system operation. Such a complex task imposed to the control of braking system cannot be based on the driver abilities and need to be done independently of the driver. An improved IBS braking forces management would certainly enable to reach the given task. The advanced strategy for the braking force management, proposed here, is

based on intelligent controlling of the braking forces distribution between the front and rear axle of power-driven vehicle and/or between towing/trailer combination and/or between tractor/semi-trailer. Intelligent braking system has a lot of potential applications especially in developed countries where research on smart vehicle and intelligent highway are receiving ample attention. The system when integrated with other subsystems like automatic traction control system, intelligent throttle system, and auto cruise system, etc. will result in smart vehicle maneuver. The driver at the end of the day will become the passenger, safety accorded the highest priority and the journey will be optimized in term of time duration, cost, efficiency and comfortability. The impact of such design and development will cater for the need of contemporary society that aspires quality drive as well as to accommodate the advancement of technology especially in the area of smart sensor and actuator. The emergence of digital signal processor enhances the capacity and features of universal microcontroller. The overall system is designed so that the value of inter-vehicle distance from infrared laser sensor and speed of follower car

from speedometer are fed into the DSP for processing, resulting in the DSP issuing commands to actuator to function appropriately [1]. The most popular systems like Antilock Braking Systems (ABS), Traction Control and Stability Control employ different types of sensors to constantly monitor the conditions of the vehicle, and respond in an emergency situation. An intelligent mechatronic system includes an ultrasonic wave emitter provided on the front portion of a car producing and emitting ultrasonic waves forward in a predetermined distance. An ultrasonic receiver is also placed on the front portion of the car operatively receiving a reflective ultrasonic wave signal. The reflected wave (detected pulse) gives the distance between the obstacle and the vehicle. Then a microcontroller is used to control the speed of the vehicle based on the detection pulse information to push the brake pedal and apply brake to the car stupendously for safety purpose [2].

## 1.2 SYSTEM SURVEY

Visiting numbers of workshops like Maruti Suzuki, Bafna Motors, Naik motors, going through detailed study of the ABS from various sources such as books, internet and carefully understanding mounting of each components of ABS such as ECM, Hydraulic control module warning system got clear idea about the existing advance braking technologies. Workshop technicians got mixed feedback from owners of vehicles with ABS. Drivers reported that they find stopping distance for regular conditions are lengthened by ABS either because there may be errors in the system or because of clinking or noise of ABS may contribute to driver not braking at same rate. Hence concluded that braking system present on vehicle are either so advance that they take the braking control away from driver and increase the risk factor or some of them are not that much advance to perform precisely, so we decided to make such system which can allow the driver brakes manually at the same time system also controlling the brakes to reduce risk factors in panic situation. An ABS can be expensive to maintain. Expensive sensors on each wheel can cost hundreds of dollars to fix if they get out of calibration or develop other problems. For some, this is a big

reason to decline an ABS in a vehicle. Moreover many commuter vehicles in India don't have the option of ABS because it's very expensive. It's easy to cause a problem in an ABS by messing around with the brakes. Problems include disorientation of the ABS, where a compensating brake sensor causes the vehicle to shudder, make loud noise or generally brake worse. ABS can only help if the rider applies it in the right time manually and maintains the distance calculations. ABS has its own braking distance. Volvo's laser assisted braking could not work effectively in rainfall and snowfall season and laser is easily affected by atmospheric conditions. In our project we are using Ultrasonic sensors and Microcontroller with which the speed of the vehicle is automatically reduced and voice alarms are given to the user when it approaches an object by automatically sensing the position of the object/vehicle.

## Methodology

An intelligent mechatronic system includes an ultrasonic wave emitter provided on the front portion of a car producing and emitting ultrasonic waves forward in a predetermined distance. An ultrasonic receiver is also placed on the front portion of the car operatively receiving a reflective ultrasonic wave signal. The reflected wave (detected pulse) gives the distance between the obstacle and the vehicle. The microcontroller is used to control the speed of the vehicle based on the detection pulse information to push the brake pedal and apply brake to the car stupendously for safety purpose. The extremely rapid response time provided by the electronic control can be used for crucially shortening the braking distance by introducing advanced control of braking system operation. The control of commercial vehicle's braking system operation is related not only to vehicle speed but also to lateral acceleration together with the yaw moment control and significantly reducing the possibilities of the vehicle rolling over. Obviously, such a complex task imposed to the control of braking system cannot be based on the driver abilities and need to be done operated independently of the driver.

- Development of an idea
- Detail study of literature

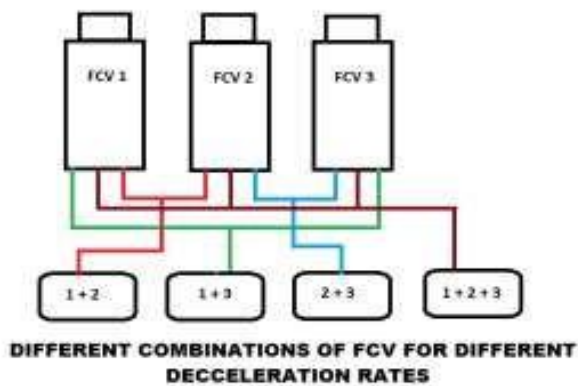
- System survey
- Drawbacks in existing approach
- Cost estimation and specification for standard parts
- Load distribution analysis
- Braking force and pressure analysis
- Experimentation
- Results and discussion

### Experimentation

Our future course of action is to assemble a system on vehicle & perform various experimentations by varying different parameters. Those parameters are as follows:

- Vehicle Speed
- Obstacle distance
- Sensor Position
- Varying deceleration rate

In Order To Avoid Jerky Motion of the vehicle due to sudden braking, we can use combinations of different flow rates to achieve smooth braking and avoid vibrations and for faster response of system we can use electronically operated flow control valve which may add extra cost to the system.



**Figure 3.1 Braking fluid distributions**

### 3.1 DRAWBACKS IN USING HYDRAULIC ACTUATION

6. Actuation time and response time required is more which makes the system less effective.
7. Requires more components
8. System becomes more complex and installation is bit difficult.
9. Add unnecessary weight in vehicle.
10. More expensive.

Because of the above reasons we switched over to electrically actuated solenoid which has following advantages:

1. Response time required is less.
2. Require very less components as compared to hydraulic actuation.
3. System becomes simpler.
4. Less expensive.

### 3.2 ADVANTAGES OF INTELLIGENT BRAKING SYSTEM (IBS)

As mentioned above, an IBS prevents lock-ups and skidding, even in slippery conditions. IBS brakes have been proven to save lives in some situations by helping drivers keep control of a vehicle.

An IBS shares some of the infrastructure of a traction control system, where new technology helps ensure that each wheel has traction on the road. That makes it easy for manufacturers to install both of these features at the factory.

Intelligent braking systems coordinate wheel activity with a sensor on each wheel that regulates brake pressure as necessary, so that all wheels are operating in a similar speed range. And help drivers have better control of a vehicle in some road conditions where hard braking may be necessary.

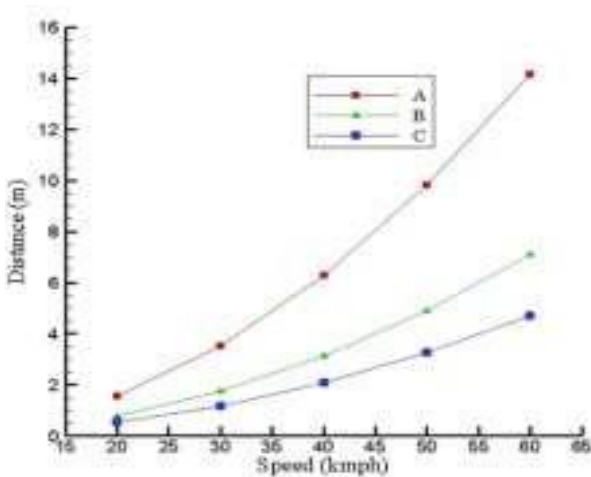
- An ultrasonic sensor, cheaper and less demanding of hardware than other types of sensors presently used.
- As ultrasonic sensors can detect any kind of obstacle, this system can also prevent collision of the vehicle with pedestrians, or can at least reduce the injuries occurring.
- This lower cost of ultrasonic sensors compared with other kinds of sensors, could facilitate the application and mounting of the system in many low-end vehicles, helping to improve comfort and safety and offer a hassle free driving experience at a reduced cost.
- As system does not take whole control from driver, the 'risk' factor due to false indication gets reduced.

When vehicle is in motion, different forces acts on it during braking of vehicle. i.e. Sum of all the static and dynamic forces comes in picture .To achieve safe and smooth braking operation we works on different parameters as follows.

**Discussions**

**4. Obstacle distance:**

We carried out experimentation of different obstacle distance from vehicle. In our prototype model we try to achieve safe anti-collision braking within 5 metre.

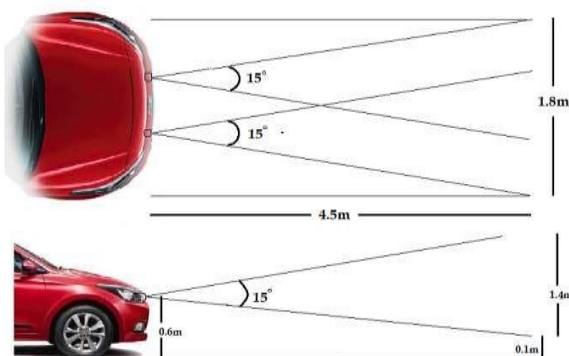


**Figure 3.2 Graph of Speed Vs Stopping distance**

**5. Current variation to actuator:**

Actuator we used is of variable actuator speed i.e. from 3mm/sec to 20mm/sec. We can achieve this variation with the help of different current rating (1amp to 3amp) during high speed condition and critical braking condition we have to apply brake immediately but without jerk.

**6. Ultrasonic Sensor position:**



**Figure 3.3 Ultrasonic sensor position**

To get maximum catchment area in front of the vehicle and to avoid false indication we have to adjust the sensor position. Also number of sensors use is crucial parameter because if one sensor faces the failure then other can do the work.

In the present work, a prototype of an ultrasonic distance measurement for stationary obstacle is obtained. And controlling the speed of vehicle accordingly to predetermined distance is shown. An ultrasonic sensor, cheaper and less demanding of hardware than other types of sensors presently used, such as the sensors based on computer vision or radar, is used to measure the distance between vehicle and the obstacle. The relative speed of the vehicle with respect to the obstacle is estimated using consecutive samples of the distance calculated. These two quantities are used by the control system to calculate the actions on both the accelerator and also the brake, thus to adjust the speed in order to maintain a safe distance to prevent accidents. As ultrasonic sensors can detect any kind of obstacle, this system can also prevent collision of the vehicle with pedestrians, or can at least reduce the injuries occurring. Since the control system does not use the absolute speed to calculate the safety distance as done by the currently existing systems, the interaction with automotive electronics is limited to actions on the accelerator and brake. This matter, coupled with the fact of lower cost of ultrasonic sensors compared with other kinds of sensors, could facilitate the application and mounting of the system in many low-end vehicles, helping to improve comfort and safety and offer a hassle free driving experience at a reduced cost.

**Conclusions**

In this report the innovative idea of implementing intelligent braking system is discussed and thereby analyzed its various parameters for regular realistic application. Intelligent braking is one of the smart options which can be implemented in various applications for stopping a moving body without jerky motion. The previous research study clearly explains that Ultrasonic sensor and microcontroller action plays vital role in determining intelligent braking torque generated by brake actuation assembly. Design of intelligent brake applications basically depend upon effectiveness of Ultrasonic sensor and RPM counter. In the present work various experiments were conducted to check the effect



of various parameters such as obstacle distance, output current and sensor position on moving vehicle braking. The parameters were varied using different arrangements of sensors, varied amount of current which leads to various conclusions. In the present work, a prototype of an ultrasonic distance measurement for stationary obstacle is obtained. And controlling the speed of vehicle accordingly to predetermined distance is shown. An ultrasonic sensor, cheaper and less demanding of hardware than other types of sensors presently used, such as the sensors based on computer vision or radar, is used to measure the distance between vehicle and the obstacle. The speed of the vehicle is estimated using RPM counter. These two quantities are used by the control system to calculate the actions of the brake, thus to adjust the speed in order to maintain a safe distance to prevent accidents. As ultrasonic sensors can detect any kind of obstacle, this system can also prevent collision of the vehicle with pedestrians, or can at least reduce the injuries occurring. Since the control system does not use the absolute speed to calculate the safety distance as done by the currently existing systems, the interaction with automotive electronics is limited to actions on the accelerator and brake. This matter, coupled with the fact of lower cost of ultrasonic sensors compared with other kinds of sensors, could facilitate the application and mounting of the system in many low-end vehicles, helping to improve comfort and safety and offer a hassle free driving experience at a reduced cost. We have used the previous work on advance braking system and use that to define the

basic braking control problem and have developed intelligent control method for this system. Clearly the approaches and conclusions that we present are somewhat preliminary and are in need of further significant investigations. For instance, it would be useful to perform stable, hassle free braking and also help to evaluate this safety-critical automotive braking system. While the model that we have developed has proven to be quite adequate for the development of microcontroller system that has been evaluated on a vehicle, it would be valuable to evaluate the developed controllers in the field. This would force us to take a very careful look at the requirements for real-time implementations of the intelligent braking system. Our present work realized us that implementation of this smart system can be feasible and of real time use. Approaches and conclusions that we present are somewhat preliminary and are in need of further significant investigations. While car is taking a turn sensor can give the false indication of obstacle. To avoid this we will make an arrangement such that this system goes off while turn. This can be achieved by mounting sensors on car wheel that are capable of measuring wheel turning. At present, this system is readily suitable for automatic transmission. While making some changes we can use this on any available vehicle. Also improved and precise programming is necessary for real time operation. Application of intelligent braking system for critical dynamic condition need to be analysed.

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## OPTIMIZATION OF MACHINING PARAMETER OF NICKEL ALLOY FOR GREEN PRODUCTIVITY

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### ABSTRACT

*Machining of Iron-based Nickel super alloy material with existing method creates many difficulties like fast tool wear, large cutting force, and high surface roughness on the machined components. Various types of coolants were used to study the surface texture, tool wear, and chip morphology in turning of Iron-based Nickel A286 alloy. The machinability index for surface roughness and tool wear appreciably increased by minimum quantity cooling and lubrication (MCQL) (Seyed et al., 2018) method as compared to other methods. This result also discovered that the rake face of the cutting tool is affected by the built-up edge.*

**Keywords:** Ultrasonic Sensor, Intelligent Mechatronic system, RPM counter, Microcontroller

### Introduction

Machining of Iron-based Nickel super alloy material with existing method creates many difficulties like fast tool wear, large cutting force, and high surface roughness on the machined components. Various types of coolants were used to study the surface texture, tool wear, and chip morphology in turning of Iron-based Nickel A286 alloy. The machinability index for surface roughness and tool wear appreciably increased by minimum quantity cooling and lubrication (MCQL) (Seyed et al., 2018) method as compared to other methods. This result also discovered that the rake face of the cutting tool is affected by the built-up edge.

The effect of nano-particles (Musavi et al., 2019) permanence on machinability for surface quality and chip morphology with Nano-Copper oxide and nano-Silicon oxide with an addition of surfactants such as Sodium Dodecyl Sulphate (SDS) was studied. Machining was carried with Nano-fluid with the surfactant, Nano-fluid without surfactant, and conventional cutting fluid. The result indicated that surface roughness and chip formation morphology improved with blended Nano fluid considerably as compared with nano-fluid without surfactant and conventional fluid. Face-milling of Iron-based Nickel (Guoliang et al., 2017) at various machining process parameters was carried out to analyse the surface and fatigue properties. It was

observed that the machining process parameters can alter the surface texture and mechanical properties considerably. The investigations on the tool wear behaviour during machining of Nickel super alloy (Zhu et al., 2013) were carried out with bare Tungsten Carbide tools, coated Carbide tools, and Ceramic tools. Tool wear observed with resultant of mechanical and chemical reactions between the tool and work piece.

The machining performance characteristics in turning of Nickel 242 alloy (Habeeb et al., 2008) were carried out with coated tools. It was noticed that the flank wear was lower at cutting speed of 100 m/min and depth of cut of 0.4 mm. The highest flank wear results were recorded with an increase in depth of cut. The turning process was carried on Nickel 718 super alloy (Darwish, 2000) using Ceramic and CBN cutting tools under the dry condition and 0.5 mm constant nose radius. The surface roughness observed with the Ceramic tool was less when compared with CBN inserts at high and low feed rates. The feedrate was more influential amongst the other process parameters considered for roughness and the result indicated that lower surface quality occurs at higher feed rate.

Flooded and dry turning tests were carried on Inconel 718 superalloy (Devillez et al., 2011) at different speeds and other semi-finishing conditions. The test results confirmed that the coated Carbide tool directs to satisfactory

surface quality with residual stresses using dry machining. At the machining affected zone, the microhardness values were observed in dry machining, and these were similar order in those attained in wet machining under the optimized environments. A tool flank wear model was developed for Inconel 718 alloy. The study of modeling and simulation (Chen and Li, 2009) was carried with the proposed model and experimental results. The results of simulated flank wear results were closer to the results of models generated. The influence of the microstructure of two superalloys (Philipp et al., 2018) on the flank wear with bare Cemented Tungsten Carbide tools was observed. Tool life was evaluated during machining of 718 and Waspalloy alloys. The experimental tests on tool wear propagation and cutting forces dissimilarities with coated Carbide was studied on end milling of Inconel alloy 718 (Li et al., 2006). The results indicated that tool flank wear was the chief mode of tool failure influencing the life of the tool. The flank wear promulgation in the down milling process was less than that of up milling process. The assessment sustainability (Gyanendra Singh Goindi and Prabir Sarkar, 2017) of various machining processes was discussed and suggested dry machining process for sustainable machining with future directions.

Turning experiments were performed on Nickel based super alloy using dry machining (Thakur and Gangopadhyay, 2016) with PVD coated TiN/TiAlN tool and flooded, minimum quantity machining with uncoated tool. The results concluded that the performance of PVD coated tool under dry environment is good than uncoated tool under flooded, Minimum quantity machining. Therefore, the dry machining is considered as a justifiable approach for attaining green and a sustainable machining. The turning experiments were carried to evaluate sustainable aspects (Karmjit and Ibrahim, 2019) in terms of air pollution and energy consumption using CNC lathe on 6061-T6511 Aluminum alloy. The effect of process parameters on air pollution and energy consumption were studied and developed model to predict the air pollution and energy consumption to maintain and apply the sustainable machining conditions.

Various machining plans have been performed by several researchers during the machining of Nickel alloys, for instance, electro-discharge machining, hard turning, and the use of cutting fluids. Yet, the drawback of the above processes includes high tooling cost, reduced material removal rate, the requirement of a skilled operator, and environmental pollution. The complete elimination of cutting fluids in machining process is called as dry machining. The dry machining is also called as sustainable machining. In present days dry machining is became popular due to reduction of environmental pollution, health hazards on the operator such as cancers, respiratory infections, etc., cost of the machining and use of advanced cutting tools. The dry machining was successfully applied for certain materials by various researchers. Therefore, this research is aimed at the optimization of turning process parameters and appraises the performance of different cutting tool materials such as PVD coated and uncoated tools with sustainable dry machining of Iron-based Nickel A286 alloy. From the experimental results, best cutting tool materials can be evaluated to enhance the sustainable machinability of the Iron-based Nickel A286 alloy material for surface finish, tool wear, and chip morphology.

### Methodology

Work piece material: The work piece material used in the machining test was Inconel 718. The work pieces were cut off from a warm-rolled Inconel bar, and their surfaces were prepared through face milling to get rid of the original skin layer containing hard particles like oxides or carbides. The dimension of the work piece was 102 mm × 50 mm × 26 mm. The Inconel 718 contains a significant amount of iron, niobium, and molybdenum along with lesser amount of aluminium and titanium. Its chemical composition confirms to the following specification. The nominal ultimate tensile strength of the material is 1240 MPa, and the nominal hardness is 36 HRC (355 HV10). However, it is noted that the measured hardness of the work piece material was in a range from 433 HV10 to 560 HV10, where the variation of the hardness was up to roughly 30 %. This hardness variation might have been caused by the work hardening during the

surface preparation of face milling, or by the manufacturing process of the material.

**Cutting tool:** The cutting tool used in the machining test was a Mitsubishi BAE500R161S16 end milling cutter with a F7030 coated carbide insert. The tool diameter was 16 mm. Its axial rake was  $2^\circ$ , and its radial rake was  $-8^\circ$ . The insert had a cemented carbide substrate, with an inner coated layer of TiCN featuring spalling and wear resistance, a middle coated layer of  $Al_2O_3$  featuring thermal stability and wear resistance, and an outer coated layer of TiN featuring low friction and welding resistance. The insert had a flat rake face. Its nose radius was 0.8 mm. It covered a wide application range from ISO P10/M10 to ISO P30/M30.

**Machine tool:** The machine tool used in the cutting test was a 3-axis vertical milling machine tool with a PC-based NC controller. The machine table could be moved in Cartesian coordinates in x, y-, and z-direction. A Kistler Type 9254 quartz 3-component dynamometer was mounted on the machine table to measure the cutting forces. The work piece was mounted on the dynamometer through a specially designed fixture. The setup of the machining experiment is shown in Fig. 1.

### 1.2 Experimental Procedure

The machining tests were carried out in two types of end milling operations, i.e., down milling and up milling operations. The axial depth of cut diameter was 1.2 mm. The width of cut  $w$  was 2 mm. The feed per tooth  $f_t$  was 0.03 mm. The cutting speeds were 30 m/min (spindle speed  $n$  was 600 rpm) and 45 m/min (spindle speed  $n$  was 900 rpm). The feed direction of the work piece was along the negative x-axis as shown in Fig. 1, and the work piece length in the feed direction  $L$  was 50 mm. Dry cutting was used for the experiment. Therefore, the machining tests were divided into four groups: down milling with the spindle speed of 600 rpm, up milling with the spindle speed of 600 rpm, down milling with the spindle speed of 900 rpm, and up milling with the spindle speed of 900 rpm. In each group, two inserts were used to cut the work piece in succession, and the flank wear of the inserts was measured after each cutting pass using a LEICA MZ12 microscopy system. The cutting forces were recorded down through

a PC208AX Sony data recorder. In down milling, maximum chip thickness occurs close to the point where the cutting tooth contacts the work piece. As shown in Fig. 2, the entry angle of the tooth in the machining test of down milling operations, starting from the negative y-axis, should be  $4 = \phi - \alpha = \phi + \beta = \phi + 138.59$  (1) The tooth exits the cutting at an exit angle approximately as  $= 180^\circ - \phi$  exit, and the chip thickness is zero at the exit point. For up milling operation as shown in Fig. 3, the entry angle of the tooth is approximately  $= 0^\circ + \phi$  entry. The chip is very thin at the beginning where the tooth first contacts the work, and increases in thickness as the cutter rotates. It reaches the maximum when the tooth leaves the work piece, where the exit angle is  $= \phi - \alpha = \phi + \beta = 41.41$  (2) Under the specified cutting condition, regardless down milling or up milling operations, the cutter starts cutting when it reaches a position where the distance from its centre to the work piece edge perpendicular to the feeding direction is:  $L_1 = r - r - w = - = (mm)$  (3) It ends the cutting when its centre reaches the position of the other work piece edge perpendicular to the feeding direction. Hence the machined length (ML) in one pass is  $50.529$  ML = L +  $L_1 = + = (mm)$  (4) The number of impacts (cutting cycles) that an insert is subjected to in one cutting pass is  $1843.03$  = = =  $t_{imp} = f \cdot ML / N$  (5) When using the spindle speed 600 rpm, the cutting time in one cutting path is  $184.3$  = = =  $t = n \cdot f \cdot ML / t$  (s) (6) Similarly, for the spindle speed 900 rpm, the cutting time in one cutting path is  $122.9$  = = =  $t = n \cdot f \cdot ML / t$  (s) (7) During the machining tests, the instantaneous cutting force components in the x, y, and z directions,  $F_x$ ,  $F_y$ , and  $F_z$  as shown in Fig. 1, were measured using the three-component 5 piezo dynamometer. The measured force components can be converted to the instantaneous cutting force components in the tangential, radial, and axial directions, i.e.,  $F_t$ ,  $F_r$ ,  $F_a$ , using the following equations:  $F_t = F_x \cos \phi + F_y \sin \phi$  (8)  $F_r = F_x \sin \phi - F_y \cos \phi$  (9)  $F_a = F_z$  (10),

### 3.1 Propagation of Flank Wear

The experimental results showed that the dominant tool wear and damage were flank wear and chipping. Damage observed on the rake surface, such as crater wear, was quite limited. The development of the flank wear of the coated carbide inserts used for both the down milling and the up milling under the spindle speed of 600 rpm is shown in Fig. 4. There were six cutting passes performed for the down milling cases and four cutting passes performed for the up milling cases. Within these cutting passes performed, the wear propagation was almost linearly related to the cutting time for both the down milling and the up milling. For the cases of down milling, the width of flank wear was about 0.1 mm after the first cutting pass where the number of impacts for the insert was about 1843. After the sixth cutting path, the width of flank wear was about 0.3 mm, as shown in Fig. 5. It can be seen from Fig. 5 that the worn surface was smooth. For up milling, the development of tool wear was more rapid compared with that for down milling. The width of flank wear was over 0.2 mm even after the first cutting pass. After the fourth cutting pass, it reached as high as 0.5 mm, compared with the width of flank wear of only 0.19 mm – 0.25 mm for the down milling cases after the same cutting pass. Fig. 6 shows a photograph of the flank wear after the fourth cutting pass of the up milling. It can be seen that the flank wear was quite severe, and there was also an obvious chipping mark on the flank face. Fig. 7 shows the development of the flank wear of the coated carbide inserts under the spindle speed of 900 rpm for both the down milling and the up milling operations. Seven cutting passes were performed for the down milling cases and five cutting passes were performed for the up milling cases. For the down milling cases, the width of flank wear was about 0.1 – 0.16 mm after the first cutting pass, and up to 0.4 mm after the seventh cutting pass. For the up milling cases, the width of flank wear was about 0.23 mm after the first cutting pass. It kept growing and reached 0.45 mm after the fifth cutting pass, whereas the width of flank wear in the down milling was only 0.37 mm after the same cutting pass. The wear propagation was also

almost linearly related to the cutting time for both the down milling and the up milling within the cutting passes performed. The development of the flank wear in the up milling was also more rapid than that in the down milling. However, comparing with Fig. 4, it was noted that for the down milling cases, the wear propagation was quicker under the spindle speed of 900 rpm than that of 600 rpm, whereas for the up milling cases, the wear propagation was a bit slower under the spindle speed of 900 rpm than that of 600 rpm. Fig. 8 shows a photograph of the flank wear after the seventh cutting pass of the down milling, and Fig. 9 shows a photograph of the flank wear after the fifth cutting pass of the up milling. Chipping marks in the flank face can be found in both Fig. 8 and Fig. 9. From the experimental results, it can be seen that the development of the flank tool wear was relatively rapid in general, and it was even worse for up milling. It is well known [12] that the curves that describe the flank wear versus the cutting time can be divided into three different regions as shown in Fig. 10. The first region is for the break-in-period where the flank wear initially increases rapidly and later on gradually reduces to a constant rate. During this period, the wear behaves in the form of an exponential curve. The second region is the steady state wear region in which the wear curve can be regarded as linear to the cutting time. The third region is the failure region in which different wear curves can be observed when different groups of tool-workpiece materials are machined. In the end milling of Inconel 718 with coated carbide inserts studied here, the break-in-period was not explicit in the curve of flank wear versus cutting time. It can be concluded that this period was very short and occurred in the early phase of the first cutting pass for each new insert. The flank wear curves as shown in Fig. 4 and Fig. 7 can be regarded as falling into the second region. The wear rate was almost constant until a total tool failure was reached, and there was no obvious transition from the second region to the third region. Milling is characterised with an interrupted cutting action where each tooth produces a chip of variable thickness. The cutting circumstances are more adverse than that in turning. Since Nickel alloys work

harden rapidly, once the milling cutter starts cutting, it will become more and more difficult for further machining due to the hardening effect. When the cutting edge is not sharp enough, the metal is pushed instead of cut. This will result in higher cutting force and higher temperature. For the coated carbide insert in the milling cutter, although the multiple coating layers can improve wear resistance significantly, it is still hard to bear the high load impacts and high temperature. Actually the coated layer cannot stand for long before it is worn. This will result in severe tool wear and short tool life. In the up milling operations, the cutter encounters minimum chip thickness as it enters the work piece. This approximating rubbing at the beginning of the cut will cause an excessively work hardened layer in the work piece, therefore higher cutting forces, higher tool wear rate and shorter tool life than those in down milling were observed. It is recommended that down milling operations be used as far as possible.

### 3.2 Cutting Force Variation

The cutting force waveforms in the first cutting pass of down milling under the spindle speed of 600 rpm are shown in Fig. 11. The major cutting force component was in the positive Y direction, while the peak cutting force component in the negative X direction was less than half of that in the Y direction. At the initial stage when the cutter was fully engaged in cutting, there were peak cutting force components in both positive and negative Z directions. Along with the progress in the cutting pass, there was a significant increase of the peak force component in the positive Z direction, which was from 80 N to 7 218 N. On the other hand, the peak force component in the negative Z direction decreased to a very low level. The peak force components in the negative X and the positive Y directions also underwent slight hikes. The cutting force waveforms in the second and the sixth cutting pass of down milling under the spindle speed of 600 rpm are shown in Fig. 12 and Fig. 13 respectively. Fig. 14 illustrates the variation of the peak cutting force components in the three directions for the six cutting passes. The maximum peak value, the minimum peak value, as well as the mean peak value for each

cutting pass was designated in the figure. It is clear that for each pass, the peak values kept up a steady increase within a certain range. There existed overlaps of the force variation ranges between successive cutting passes. Along with the tool wear propagation, increasing of the mean peak values in the X, Y, and Z directions was a general trend. Nevertheless, it was also noted from the comparison between the fifth cutting pass and the sixth cutting pass that although the mean peak continued to increase in the X direction, the mean peak decreased slightly in the Y and Z directions in the sixth cutting pass. The cutting force waveforms in the first cutting pass of up milling under the spindle speed of 600 rpm are shown in Fig. 15. The waveform pattern shows significant difference compared with that of down milling in Fig. 11. The major cutting force component was in the positive X direction, with a peak value of about 400 N. The axial cutting force component was in the positive Z direction with close amplitude as in the X direction. The peak force component in the negative Y direction was about 270 N, nearly two third of the peak value in the X direction. It can be seen that the resultant cutting force in up milling was larger than that in down milling. During one cutting pass, the peak force in the Z direction went through constant increasing, and the peak force in the X direction also increased slightly. However, the variation of the peak force in the negative Y direction was not so regular. Both increasing and decreasing were observed in the same pass. The cutting force waveforms in the second cutting pass and the fourth cutting pass of up milling under the spindle speed of 600 rpm are shown in Fig. 16 and Fig. 17 respectively. Fig. 18 summarises the variation of the peak cutting force components in the three directions for the four cutting passes. It was found that along with the development of the tool wear, there were irregular variation trends of the cutting force peaks during one cutting pass, especially for the fourth cutting pass as in Fig. 17. Nevertheless, the overall trend of the mean peak values in the X, Y, and Z directions was a steady increase along with the tool wear propagation in successive cutting passes. Fig. 19 and Fig. 20 show the variation of the peak cutting force components in the three directions along with the cutting passes

for the down and up milling operations respectively under the spindle speed of 900 rpm. It is evident that the overall trend of the mean force peak value in Fig. 19 for down milling under 900 rpm is similar to that in Fig. 14 for down milling under 600 rpm, and the variation of peak cutting force in Fig. 20 for up milling under 900 rpm is also similar to that of Fig. 18 for up milling under 600 rpm. The variation of the peak cutting force components could be attributed to a number of possible factors, such as the development of the tool wear, the work harden of the 8 work piece material, the temperature change in the tool-work piece interface, and the thermal expansion of the cutting tool and work piece. It is believed that the thermal effects could be a significant cause for the peak force variation within a single cutting pass, and that the tool wear propagation was the major reason for the gradual increase of the mean peak force in successive cutting passes. In the on-line tool condition monitoring, although the peak force component in the X and Y directions could be used as the main tool wear indicator, attention must be paid to the wide variation range of the peak force components during one cutting pass.

### Conclusions

- (1) The experimental study of end milling Inconel 718 using coated carbide inserts under dry cutting conditions showed that significant flank wear was the predominant failure mode affecting tool performance and tool life. The tool flank wear propagation in the up milling operations was more rapid than that in the down milling operations.
- (2) The variation of the peak cutting force components was analysed. It was found that for each cutting pass, the peak values of the cutting force components showed a steady increase within a certain range. The force variation ranges overlapped between successive cutting passes. Along with the tool wear propagation in successive cutting passes, the overall trend of the mean peak values in the X, Y, and Z directions for both the down and up milling operations was in a gradual increase.
- (3) The variation of the peak cutting force components could be attributed to a number of possible factors. It is believed that the thermal effects could be a significant cause for the peak force variation within a single cutting pass, while the tool wear propagation was the major reason for the gradual increase of the mean peak force in successive cutting passes. The relationship between tool wear propagation and cutting force variation can be used to develop effective tool condition monitoring strategies.

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**ELECTRIC VEHICLE CHARGING STATION AND AUTOMATIC BILLING SYSTEM****Nishant Firake<sup>1</sup>, Prathamesh Chopade<sup>2</sup>, Dnyaneshwar Lahare<sup>3</sup>, Saurabh Bharule<sup>4</sup>**<sup>1,2,3,4</sup> SIEM, Nashik, IndiaEmail: <sup>1</sup>nishant51098@gmail.com, <sup>2</sup>prathameshchopade9@gmail.com,  
<sup>3</sup>dnyaneshwarlahare96570@gmail.com, <sup>4</sup>saurabhbharule44@gmail.com**ABSTRACT**

Electric vehicles are widely used due to their advantages over combustion engine (ICE) vehicle like low emission and environment friendly. One of the weaknesses of electric vehicles is the limited availability of charger stations. The conventional vehicle drivers are still unwilling in using such a replacement technology, mainly due to the time duration (4-8 hours) required to charge the electrical vehicle batteries with the currently existing normal charging station. For this reason, fast-charging stations capable of reducing the charging duration to 20-30 minutes are being designed and developed. The present thesis focuses on the planning of a fast-charging station for electric vehicle. This research proposes the planning and prototyping of low-cost charger station. The charging station equipped with keypad to input what proportion power which will be purchased and an LCD to watch the status. This station can be used to charge electric car and electric motorcycle/ bicycle. Power electronic converters used for the interface of the energy sources with the charging stations are designed. The design development also focuses on the energy management which will minimize the battery charging time. Prototype has been built and tested to charge Plug-in Hybrid Electric Vehicle (PHEV) car both for normal charging and fast charging with satisfactory results.

**Keywords:** billing, charging station, electric vehicle, hybrid vehicle

**Introduction**

Electricity generation and transportation account for over 60% of global primary energy demand [1]. The growth of vehicles within the world is increasing rapidly in order that it impacts on the increasing use of petroleum for fuel. The use of petroleum for transportation from year to year has increased, and in 2018 it ranks in the second place after power generation [2]. If this is not addressed, it will have an impact on the energy crisis and environmental pollution from burning. Therefore, many companies are making vehicles with zero emission, namely electric cars, even the Indian government is also aggressively launching electric car technology. The development of the electric vehicle (EV) industry is an important thing to reduce greenhouse gas emissions and reduce dependence on fossil fuel [3].

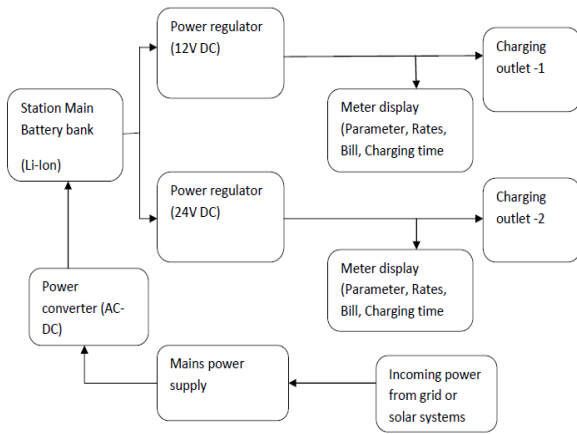
Recharging of the EV is that the bone of contention within the electric world. The charging infrastructure has developed dramatically, and enhancements have seen to scale back charging time. There are various options available for the buyer to charge their battery starting from slow to rapid charging. The supporting infrastructure is out there domestically with a single-phase slow or fast

charger. EV infrastructures have four main components, namely spare parts, electric motors, batteries, and charging stations. The main limitation for enormous deployments of EVs is the small amount of charging points. In this research, low cost charging station design and prototype is proposed. Low-cost charging station is expected to drive the growth of electric vehicles.

**System Design**

Generally, there are three ways of charging which is conductive charging, inductive charging, and swap battery. Conductive charging is a charging system where there is direct contact between the power supply and the vehicle through the charger [4]. Inductive charging known as wireless charging is charging method which utilizing varying magnetic fields. Swapping battery is a scheme where user can swap their empty battery with a fully charged in battery swapping station [5]. In this research, conductive charging is chosen because it offers lowest cost system.

The system design consists of an incoming power supply from grid or solar system, station main power supply, power converters, station battery bank, power regulator meter display and charging outlets.



**Fig. 1 Block Diagram of System**

The fig.1 shows the block diagram of electric vehicle charging station.

**1. Incoming Power Supply: -**

It is the main source of energy in this system. The charging station receives power from main grid as well as renewable energy sources (RES) such as solar and wind. Use of multiple sources reduces the cost of energy as well as increases the reliability.

**2. Main Power Supply: -**

The main power supply receives power from either grid or RES. It consists of protective system for the incoming supply as well as the charging station.

**3. Power Converter(AC to DC): -**

The Power converter can convert AC supply to DC supply with the help of SMPS. The SMPS Convert 230V AC to 12V DC. The main feature of this system is it doesn't include transformer. Internal impedance of the transformer is high which affect the performance of the station. Also, overall size and cost of station increases. The station is controlled using the switched mode power supply which is less costly and easy to control.

**4. Station Battery Bank: -**

The battery is used for supplying power to the vehicle in any emergency condition such as power failure from grid and no output from RES. Another purpose of the use of battery is to store the energy from RES when available so that cost of energy will be reduced. During peak period also vehicle charging can be done through batteries so that overall load factor can be maintained.

**5. Power Regulator: -**

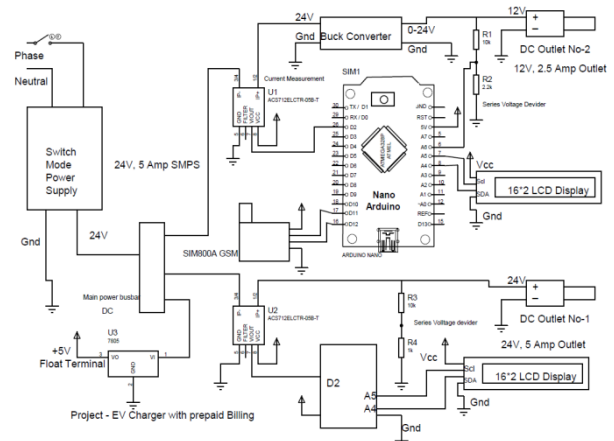
The power regulator is used to maintain constant voltage. The station is provided with overvoltage and under voltage protections. This will help to reduce losses in the station which results in increased efficiency. Numbers of regulators are depending upon the number of outgoing channels such as two-wheeler or four-wheeler charging socket.

**6. LCD Display: -**

All the parameters such as Rate, charging time, Billing unit and time required to charge are displayed using LCD display. There are separate display units for two-wheeler and four-wheeler charging sockets. The payment can be done using QR code which is given on the station by using UPI or other payment methods.

**7. Charging Outlet: -**

This charging station consists of charging outlet for two-wheeler as well as four-wheeler. In this demo model the charging outlet-1 is designed for voltage of 12V DC with 2.5A current rating. Another charging outlet charging outlet-2 is designed for the voltage of 24V DC with 5A current rating. In this charging station two different rating connectors are used for charging of two-wheeler and four-wheeler separately.



**Fig. 2 Circuit Diagram of the proposed charging station**

The Fig.2 shows the circuit diagram of proposed electric vehicle charging station and automatic billing system. In which the 230V, 16A, MCB is provided for controlling the switching of charging station as well as

protection of it. The SMPS is used for step down the voltage as per requirement and for maintain constant output voltage of 24V DC. From the bus bar outgoing lines are taken for normal charging and fast charging. The ACS712 hall effect current sensor is used to sense the current. The controller used to calculate power required for charging the vehicle based on voltage and current data, and from this the cost of energy required for charging the vehicle is calculated. Real time clock is used for digital clock reference. Current sensor is used to measure the charging current and power is calculated from eq. (1). The GSM module is introduced for prepaid billing. The Buck converter is used to reduce the voltage to 12V for two-wheeler charging outlet. The Arduino Nano is used for interfacing and controlling the system and the results of data is stored in the microcontroller board. The LCD display is used to display the status of energy consumed, charging time required and the cost of energy required for charging. Arduino output is connected to the relay and then to the controller which has functions to cut off charging when the amount of electric power supplied matches the input power that has been purchased. Meanwhile, if the vehicle battery is full before the amount of power purchased is met, the charging current will be zero and the charging system is turned off.

**Fig. 3 Flow Chart of the System**

Fig. 3 directs towards illustration of charging algorithm of model. We start the algorithm with initiation of system and detect the battery current by ACS712 Sensor to move further process.

Display shows the time based per unit charges of charging then the permission is asked to user to start charging. The payment method QR code/UPI method is used, once amount is paid by user using QR code, message is sent to the sim card, which is used in GSM module. Microcontroller compares the previous amount and time and unit-based amount displayed by the LCD display to the paid amount from bank message. Amount will be displayed until full amount gets equal to paid amount. Once amount get confirmed solid state relays get operated to start the charging. Until battery charging or selected time interval completes, The ACS712 Monitors the both side current and gives feedback to microcontroller after every 10 second. Arduino output is connected to the relay and then to the controller which has functions to cut off charging when the amount of electric power supplied matches the input power that has been purchased. Meanwhile, if the vehicle battery is full before the amount of power purchased is met, the charging current will be zero and the charging system is turned off. If no current is existing for 30s then the relay is off and it asked the customer to quite the session. There is also voltage sensor used to indicate voltage in total charging interval.

The energy required for charging is calculated as follows,

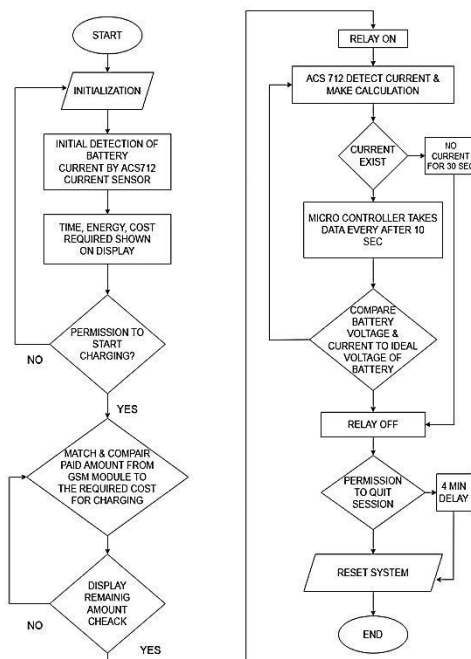
$$E [KWh] = Pt = VI(t) \tag{1}$$

Authors have tried to prove this concept through prototype. Fast charging, easy method of billing and monitoring will encourage and increase the purchase ratio of EV in India. System consists of main equipment's like LCD, Microcontroller, relays and GSM module to complete the system of billing and charging.

**Testing And Result**

Tests were carried out for charging the sample battery unit under two conditions, normal charging and fast charging as shown in the fig. 4. For fast charging, the electric current taken by battery is 5 A or twice from normal charging. It can be observed that fast charging

**Project Implementation**

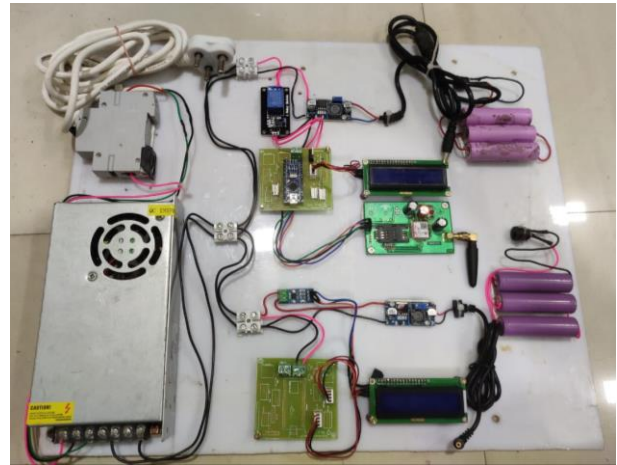


takes less than half of time than normal charging. Fast charging mode is suitable for application on charging stations in public places that require shorter waiting times.

The main feature of this proposed charging station prepaid method billing. This is used to avoid any post payment theft & any miss behaviour of user regarding to payment. In the proposed charging station auto-billing is implemented using GSM module, QR code and unified payment interface (UPI) gate way which makes the billing process fast & secured way.

#### Features of the System: -

- Charging process is managed and controlled to optimize use of grid and available source of electrical energy.
- Provides a cost-effective solution.
- Auto billing which prevents theft of energy.
- Easy to install in public places.
- Indirectly provides eco-friendly alternative



**Fig. 4 Hardware Design**

#### Conclusion

The design and prototyping of low-cost battery charging station was done. The prototype was installed and tested to charge sample battery unit with good result. It can accommodate both normal charging and fast charging. This charging station has two kinds of plug for electric car and for electric two wheeler and can calculate the energy consumed based on time and the fee or tax base on energy price per kWh on the given time slot.

Future research, this charging station can be developed with Internet of Things (IoT) which inform the user the charging status in real time..

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**A REVIEW PAPER ON NUMBER PLATE RECOGNITION BY USING MATLAB****Pritee Vijaykumar Bandal<sup>1</sup>, M. G. Nakrani<sup>2</sup>, Dr.U.B.Shinde<sup>3</sup>**

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**ABSTRACT**

*Automatic Vehicle Plate Recognition (AVPR) is the extraction of vehicle license plate information from an image or sequence of images. From the past thirty years, AVPR is becoming the challenging and interesting area of research. AVPR systems include a wide range of applications. Numerous real-world applications such as electronic toll collection, automatic parking management, access control, radar-based speed-control, border control, criminal pursuit, traffic law enforcement, etc. have been benefited from it. A lot of commercial AVPR systems are available today and yet there are many challenges and issues in accurate recognition of license plates. In India, number plate standards are rarely practiced. License plates recognition has many problems like unnecessary text, different font size and font type, blur, skew, environmental factors etc. The variations of the license plate types or environments cause challenges in the recognition of number license plates. The major objective of this thesis is to develop a robust, accurate and reliable automatic vehicle license plate recognition system. Our suggested approach is performed in three phases: In the first phase, the input image is pre-processed. Character regions are extracted in the second phase, and in the third phase, recognition of extracted characters is performed. The present work has been performed to recognize Indian license plates.*

**Keywords:** Vehicle Number Plate Detection, Segmentation, Dilation, Template Matching

**Introduction**

Number plates are used for identification of vehicles all over the nations. Vehicles are identifying either manually or automatically. Automatic vehicle identification is an image processing technique of identify vehicles by their number plates. Automatic vehicle identification systems are used for the purpose of effective traffic control and security applications such as access control to restricted areas and tracking of wanted vehicles. Number plate recognition (NPR) is easier method for Vehicle identification. NPR system for Indian license plate is difficult compared to the foreign license plate as there is no standard followed for the aspect ratio of license plate. The identification task is challenging because of the nature of the light.

Experimentation of number plate detection has been conducted from many years; it is still a challenging task. Number plate detection system investigates an input image to identify some local patches containing license plates. Since a plate can exist anywhere in an image with various sizes, it is infeasible to check every pixel of the image to locate it. In parking,

number plates are used to calculate duration of the parking. When a vehicle enters an input gate, number plate is automatically recognized and stored in database.

In NPR system spectral analysis approach is used were acquiring the image, extract the region of interest, character segmentation using SVM feature extraction techniques. The advantage of this approach is success full recognition of a moving vehicle [1].

It is difficult to detect the boundary of the Number plate from the input car images in outdoors scene due to colour of characters of the number plate and Background of the Number plate the gradients of the original image is adopted to detect candidate number plate regions[2]. There are also algorithms which are based on a combination of morphological operation, segmentation and Canny edge detector. License plate location algorithm consist of steps like as Edge Detection, Morphological operation like dilation and erosion, Smoothing, segmentation of characters and recognition of plate characters are described in [3][4][5][6]. Number plate extraction is hotspot research

area in the field of image processing. Many of automated system have been developed but each has its advantages and disadvantages. It is assumed that this algorithm worked on images which have been captured from fixed angle parallel to horizon in different luminance conditions. It is also assumed the vehicle is stationary and images are captured at fixed distance.

An automated system is developed using MATLAB in which image is captured from camera and converted in Gray scale image for pre processing. After conversion, dilation process is applied on image and unwanted holes in image have been filled. After dilation, horizontal and vertical edge processing of has been done and passed these histograms through low pass filters. Low pass filters filter out unwanted regions or unwanted noise from image. After this filtering, image is segmented and region of interest is extracted and image is converted into binary form. Binary images are easily processed as compared to coloured images. After Binarization, each alphanumeric character on number plate is extracted and then recognized with the help of template images of alphanumeric characters. After this, each alphanumeric character is stored in file and whole number plate is extracted successfully.

### 1.1 Objective of Automatic Vehicle Plate Recognition (AVPR):

#### 1.1.1 Traffic surveillance:

Traffic surveillance system is an active research topic in computer vision that tries to detect, recognize and track vehicles over a sequence of images and it also makes an attempt to understand and describe object behaviour, vehicle activity by replacing the aging old traditional method of monitoring cameras by human operators. These systems are proving to be ineffective for busy large places as the number of cameras exceeds the capability of human experts. Such systems are in widespread across the world. Lower level of video processing is used in these systems.

The ANPR system's most necessary portion is package model. It uses series of image process techniques that square measure enforced in MATLAB. The ANPR system is split into following parts:

#### Capture Image

- Pre-Processing
- Extraction of Plate Region
- Character Segmentation
- Character Recognition
- Comparison with Database
- Result

The flow chart of the ANPR system implemented in this work is shown in figure

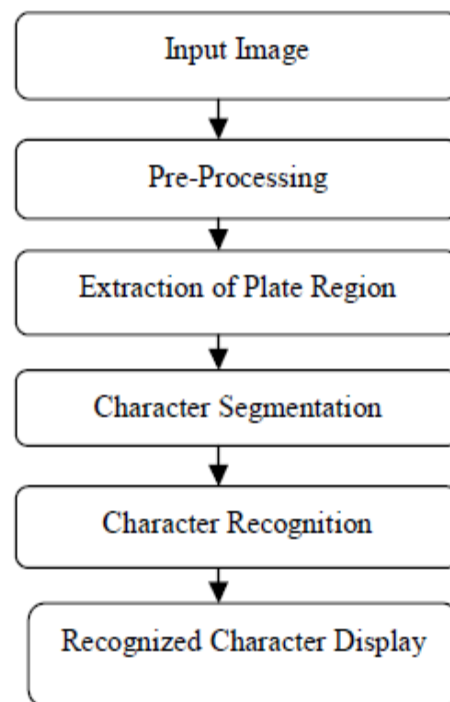


Figure 1: Flow diagram of ANPR System

#### Literature Review

**Prof. Pradnya Randive et. al. (2016)** the author stated the opinion about the automatic license plate recognition (ALPR) is the technique of extracting the information from an image or a sequence of images of Vehicle's Number Plate. They were studied the different paper and got the idea about the ALPR system also Studied and resolving all the issues regarding algorithms used for ALPR in previous few years<sup>[1]</sup>.

**Aniruddh Puranic et.al. (2016)**, In this paper they studied on existing methodologies and algorithms proposed in literature for Vehicle and Number Plate recognition. Due to the unavailability of such an ANPR system off the shelf in tune with their requirements, they

understand the template matching was implemented on number plates obtained from static images and an average accuracy of 80.8% was obtained. This accuracy can be improved greatly by positioning the camera suitably to capture the best frame and using two layers of neural networks. The implementation of the proposed system can be extended for the recognition of number plates of multiple vehicles in a single image frame by using multi-level genetic algorithms<sup>[2]</sup>.

**Khushboo Chhikara & Dr.Pankaj Tomar (2016)** they prepared this paper for to design a system which will be captures the good quality of image of the number plate of a vehicle using raspberry pi camera and the details are being retrieved using the character segmentation which is done by optical character algorithm. They were chosen an embedded platform leads to the automation in the field of electronics and they set the objective is to represent a system by using number plate of a vehicle for various application such as inventory control, border checkpoints, highly restricted area (supreme court, military base),etc. the authors developed the system is executed on raspberry pi micro controller and imitated in MATLAB because the experimental result shows that the system is fast enough in capturing images, recognition of algorithm and data streaming<sup>[3]</sup>.

**Bhawna et. al. (2016)** according to this paper the worked on automatic number plate recognition is a mass surveillance method that uses optical character recognition on images to read the number plates on vehicles by using matlab. They studied the existing closed-circuit television or road-rule enforcement cameras, or specifically designed systems can be used for the task and concluded that this system is very helpful for traffic police to find the details of a car violating the traffic rules. Their application also includes Automatic toll collection system and car parking systems. They also stated that, In high security areas where parking space is reserved for VIP vehicle owners only, the parking gate will be opened after number recognition. In areas where parking space is allotted to a particular vehicle, wrong vehicle parked can be recognized. ANPR can be used to store the images captured by the cameras and the text from the number plate. Systems

use infrared lighting to allow the camera to take the picture at any time of day. A powerful flash can also included in cameras, to both illuminate the picture and make the offender aware of his mistake. Due to plate variation from place to place ANPR technology tends to be region specific<sup>[4]</sup>.

**Soma Mukherjee et. al. (2015)** as the literature says that the there's huge need of number plan recognition by using MATLAB. In this paper the author also worked on the ANPR (Automatic Number plate Recognition) system is based on image processing technology. According to them it is one of the necessary systems designed to detect the vehicle number plate. In today's world with the increasing number of vehicle day by day it's not possible to manually keep a record of the entire vehicle. With the development of this system it becomes easy to keep a record and use it whenever required. The main objective here is to design an efficient automatic vehicle identification system by using vehicle number plate. The system first would capture the vehicles image as soon as the vehicle reaches the security checking area. The captured images are then extracted by using the segmentation process. Optical character recognition is used to identify the characters. The obtained data is then compared with the data stored in their database. The system is implemented and simulated on MATLAB and performance is tested on real images. This type of system is widely used in Traffic control areas, tolling, parking area.etc. This system is mainly designed for the purpose of security system<sup>[5]</sup>.

**Ragini Bhat et. al. (2015)** according to this paper the authors are working on the recognition of vehicle number plate using matlab and they worked on various processes which is very important to the number plate detection. The author stated that video surveillance system is used for security purpose as well as monitoring systems. But Detection of moving object is a challenging part of video surveillance. Video surveillance system is used for Home security, Military applications, Banking /ATM security, Traffic monitoring etc. according to the paper now a day's due to decreasing costs of high-quality video surveillance systems, human activity



detection and tracking has become increasingly in practical. Accordingly, automated systems have been designed for numerous detection tasks, but the task of detecting illegally parked vehicles has been left largely to the human operators of surveillance systems. The detection of Indian vehicles by their number plates is the most interesting and challenging research topic from past few years. It is observed that the number plates of vehicles are in different shape and size and also have different colour in various countries. In their work proposes a method for the detection and identification of vehicle number plate that will help in the detection of number plates of authorized and unauthorized vehicles. This paper presents an approach based on simple but efficient morphological operation and Sobel edge detection method. This approach is simplified to segmented all the letters and numbers used in the number plate by using bounding box method. After segmentation of numbers and characters present on number plate, template matching approach is used to recognition of numbers and characters. The concentrate is given to locate the number plate region properly to segment all the number and letters to identify each number separately<sup>[6]</sup>.

**P.Sai Krishna (2015)** the author worked on the text found on the vehicle plates is detected from the input image and that requires the localization of number plate area in order to identify the characters present on it. He worked simple colour conversion edge detection and removal of noise with the application of median filter as one of the operators was attempted. So according to his work presents an approach using simple but efficient morphological operations, filtering and finding connected components for localization of Indian number plates the reason behind this topic it proposes the identification of stolen car. The author made an algorithm and he has been tested on 20 samples, so he found to extract both alphabets and numbers from vehicle license plates images with an accuracy of 90% for four wheeler license plates<sup>[7]</sup>.

**Manisha Rathore et. al (2014)** worked on tracking number plate from vehicle using matlab in which they had survey by using various literature survey and the they decided this system is very helpful for number plate

detection for parking and other purpose. For this work they made algorithm by using matlab software. They had shown that this system gives about 90% of efficiency and has been tested with nearly 40 vehicles<sup>[8]</sup>.

**Cosmo H.Munuo et. al. (2014)** had referred nineteen various journals papers for to review and then made a case study on Vehicle Number Plates Detection and Recognition using improved Algorithms. According to them the NPR is very important for security purpose, they used the MATLAB R2012b is employed in these processes. The input incorporated includes front and rear photographic images of vehicles, for proximity and simulation purposes the ample angle of image is 90 degree +-15. The captured image is converted to gray scale, binarized and edge detection algorithms are used to enhance edges<sup>[9]</sup>.

**Mohit Kumar Pandey (2014)** as this paper author worked on vehicle registration plate recognition system by using computing techniques like matlab software in which he developed algorithm which used for output base on automatic detection in that he said a novel and straightforward approach for discernible fusion of several recognition methods and few novelties for recognition of Registration Plate (R.P.).According to his system works on most generic images and used snapshots captured in very realistic situations. The proposed method uses Sobel edge detection and Otsu's Method for thresholding in order to localize the plate. This step is followed by border removal, noise removal, character extraction and separation and finally template matching to recognize the characters. The algorithm is successfully experimented on variety of real images and shown in the paper<sup>[10]</sup>.

**Dhiraj Y. Gaikwad et. al. (2014)** in this paper authors reviewed various papers regarding the automatic number plate recognition by using various method and they understand processing techniques for identifying the vehicle from the database stored in the computer, and regarding the camera used in the system for such project is sensitive to vibration and fast changing targets due to the long shutter time. They also stated that the statistical analysis can also be used to define the probability of detection and recognition of the vehicle number plate. At

present there are certain limits on parameters like speed of the vehicle<sup>[11]</sup>.

**Bhavin A Patel et.al. (2014)**, they were studied the history of automatic number plate recognition (ANPR) system at the Police Scientific Development Branch in UK along with various application like road electronic toll assortment, automatic parking attendant e.g. in hotels, banks airports and fleet vehicle compounds, shopper identification enabling personalised service e.g. in leisure centres, gasoline station investigation, regulation group action and security. The authors developed the algorithm for automatic range plate recognition system using matlab, then the performance is tested on a true picture. The result shows that robustly detects and recognizes the vehicle using vehicle plate against different lighting condition and might be implemented on the doorway of highly restricted areas<sup>[12]</sup>.

**M.A. Massoud et. al. (2013)** In this paper the author has cover new technology for automated new license plate recognition in egypt, they worked on proposed technique consists of three major parts: extraction of plate region, recognition of plate characters, and database communication. A video stream was one of the most important advantages of this system. The real-time was capability, and that it did not require any additional sensor input such as infrared sensors. This approach provided a good direction and performance for Automated New License Plate Recognition in Egypt<sup>[13]</sup>.

**M. M. Rashid et. al. (2012)** This algorithm technology-based method for license plate extraction from car images followed by the segmentation of characters and reorganization and also develop electronics parking fee collection system based on number plate information<sup>[14]</sup>.

**Rana Gill and Navneet Kaur (2012)** was presented the method based upon edge detection with sobel operator, dilation and template matching process. This method has four main stages which are reprocessing, edge detection, dilation and lastly applied template matching. The proposed method was tested over real images and from the results it shows good performance in number plate detection for Indian vehicle<sup>[15]</sup>.

**Fikriye Ozturka et. al. (2011)** According to author a license plate recognition system

employs image processing techniques, to help to identify the vehicles through their plates. As they said license plate recognition is a process, where first the license plate region is localized in a car image supplied by one camera or by multiple cameras, and then the characters on the plate are identified by a character recognition system & there are many applications of the license plate recognition systems, both public and private. The algorithms, hardware and the network structure for recognition are designed according to the specific application. They used the advance technology to identify number plate by using the algorithm which is made in matlab software and hardware of higher quality have been designed, they had done recognition in three major steps: Localization of the plate, extraction of the plate characters, and recognition of the characters using a suitable identification method, an algorithm was designed that can recognize plates using the pictures taken at various angles, various distances and different times of the day, thus under various illumination conditions. The plate is localized using Otsu's thresholding method and the plate features. Vertical and horizontal histograms are used for character segmentation. and the conclude the character recognition done by Probabilistic Neural Networks. Simulation results are included and performance analyses are tabulated. MATLAB program is used in the simulations<sup>[16]</sup>.

### Conclusion

In this work the various existing methodologies and algorithms proposed in literature for Vehicle and Number Plate recognition were observed. From various papers we can say that the automatic number plate recognition system by using matlab software has different stages used like pre-processing, extraction of plate region, character segmentation, character recognition, comparison with database and result. This system uses for automatic number plate image processing techniques for identifying the vehicle from the database stored in the computer. The system works satisfactorily for wide variation of conditions and different types of number plates. The system is implemented and executed in matlab and performance is tested on genuine images.

The system works quite well however, there is still room for improvement. The camera used in the system for this project is sensitive to vibration and fast changing targets due to the long shutter time. The system speed can be

increase with high resolution camera. The implementation of the proposed system can be extended for the recognition of number plates of multiple vehicles in a single image frame by using multi-level genetic algorithms.

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**SOLUTION OF ONE DIMENSIONAL LINEAR CONVECTION EQUATION USING DIFFERENT FINITE DIFFERENCE SCHEMES USING MATLAB****Kiran D. More<sup>1</sup>, Sohail R. Tadavi<sup>2</sup>, Shreyas A. Tayde<sup>3</sup>, Rushikesh P. Zalke<sup>4</sup>, Swapnil S. Deshpande<sup>5</sup>**<sup>1</sup> Department of Mechanical Engineering, Sandip Institute of Engineering & Management, Nashik, Maharashtra, India<sup>2,3,4,5</sup> UG Student, Department of Mechanical Engineering, Sandip Institute of Engineering & Management, Nashik, Maharashtra, IndiaEmail: <sup>1</sup>kiran.more@siem.org.in, <sup>2</sup>tadavisohail@gmail.com, <sup>3</sup>taydeshreyas@gmail.com, <sup>4</sup>rushizalke@gmail.com, <sup>5</sup>swapnildeshpande199@gmail.com**ABSTRACT**

We discuss and explain the solution of elementary problems in solving partial differential equation, the kinds of problems that arise in various fields of sciences and engineering. This study aims to solve the wave equation in one dimensional using the Matlab. We followed the different finite differences schemes and found the suitable finite difference scheme which gives us a stable and accurate solution and also studied the effect of grid size & time step size on solution. Solving wave equation using Matlab is best in term of speed, accuracy and possibilities of prescribed shape for wave equation to the Matlab.

**Keywords:** Wave equation, Matlab, Solution

**Introduction**

Fluids are an essential part of our existence. From breathing air to drinking water, from Cricket to Football, from racing to air travel, our interaction with Fluids is inevitable for our living and survival. Therefore it is essential for us to understand how these fluids work and to be able to predict/simulate how they behave under concerning circumstances so that we can make them work to our advantage. That is where CFD comes into the picture. CFD is a tool that can help us simulate a fluid's behaviour by solving its governing equations numerically with the help of modern computation capabilities. As our machines are getting more advanced day by day, our reliance on computers is only increasing. And this is leading to the adoption of CFD by many industries. The problems that seemed impossible to solve are being solved using advanced computing capabilities. In the future, as technology becomes cheaper, CFD will surely be the most preferred testing method and will witness a big surge in its use.

This study we are dealing with wave equation using Matlab. The wave equation represents partial differential equation. Matlab is high performance language for technical computing.

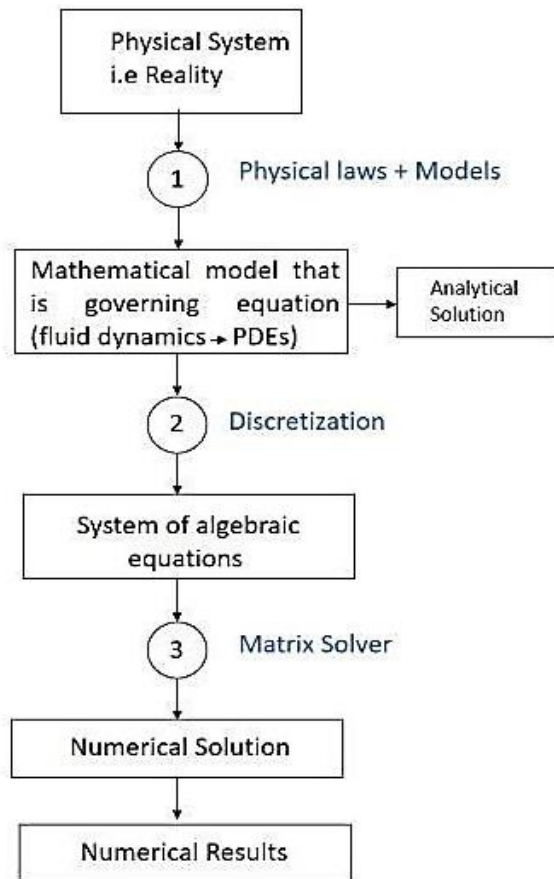
Matlab which is short for matrix laboratory in corporate numerical computation symbolic computation graphics and programming as the name suggests it is particularly oriented towards matrix computations and it provides both state of the art algorithms and a simple easy to learn interface for manipulating matrices. To study the solution of 1D linear convection equation using different finite difference schemes using Matlab. In this challenge, we will solve the one dimensional linear convection equation to observe the propagation of square wave with the time. The wave equation represents change in velocity with respect to time and space. The wave equation discretized using different finite difference schemes. After applying numerical schemes to the corresponding partial derivatives we obtain some numerical solution of the equation.

**Objectives:**

1. Studying the effect of different finite difference schemes on solution
2. Studying the effect of Time step-size on the solution of wave equation
- 3 Studying the effect of grid-size on the solution of wave equation

**Methodology**

Below chart showing numerical solution procedure:



**Solution of Wave Equation**

One dimensional linear convection equation is given by,

$$\frac{\partial u}{\partial t} + C \frac{\partial u}{\partial x} = 0$$

The equation represents the propagation of wave with respective time & space. In CFD, before computation we need to discretize the PDEs. Basically discretization is the process of conversion or transformation of partial differential equations into set of linear algebraic equations. There are different methods of discretization like Finite difference method (FDM), Finite volume method (FVM) and Finite element method (FEM). To solve the wave equation, we will use finite difference method (FDM).

**Finite difference method:** Here, we are replacing partial derivative with suitable algebraic difference quotient, which is finite

difference. Most common finite difference representations of derivatives are based on Taylor’s series expansion. Finite difference may be forward, backward, central. Also it may be 1st order, 2nd order, 3rd order, etc.

**By discretizing one dimensional wave equation using first order forward time and first order backward in space derivatives, we will get,**

Equating time and space discretized terms,

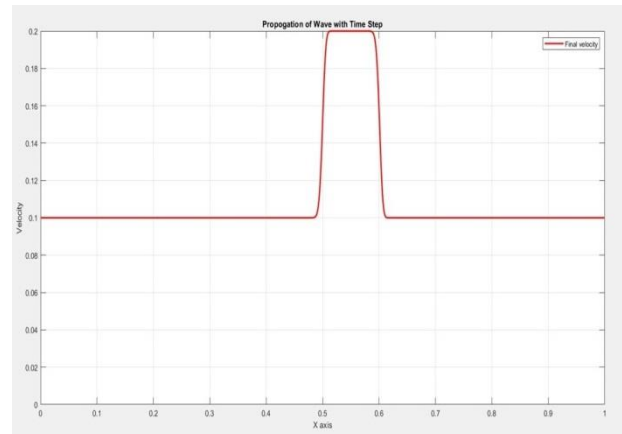
$$\frac{u_2^{n+1} - u_2^n}{\Delta t} + C \left( \frac{u_2^n - u_1^n}{\Delta x} \right) = 0$$

On simplifying and writing in terms of,

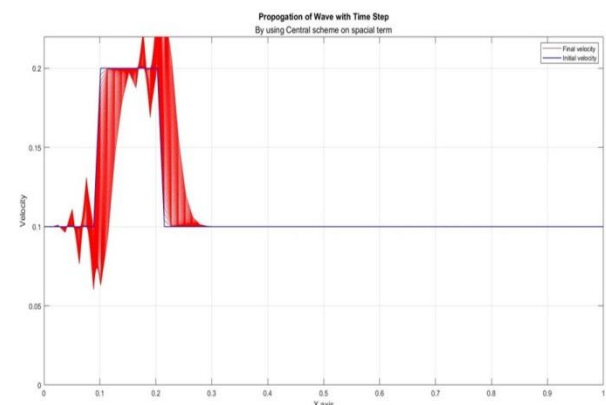
$$u_2^{n+1} = u_2^n - \left( \frac{C \Delta t}{\Delta x} \right) (u_2^n - u_1^n)$$

After applying Numerical schemes to the corresponding partial derivative we obtained the following explicit numerical solution of wave equation. Similar procedure we followed for further two finite difference scheme which are forward in space and central in space. Also we studied the effect of grid size and time step size on the solution.

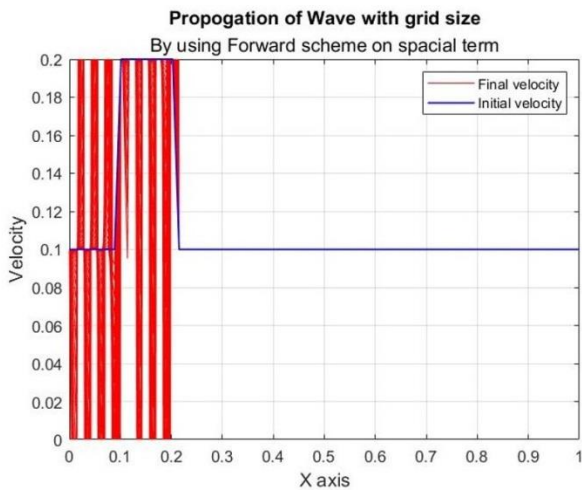
**Results**



**Figure 1 Wave plot using FTBS**

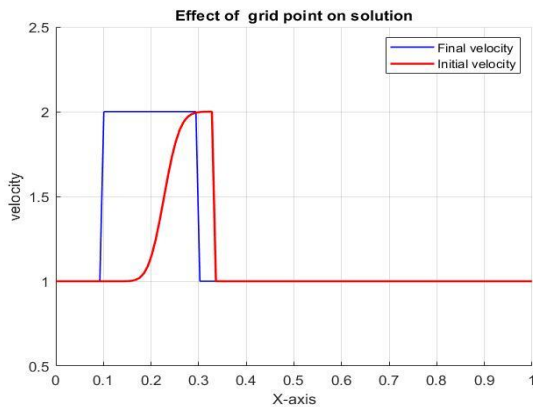


**Figure 2 Wave plot using FTCS**

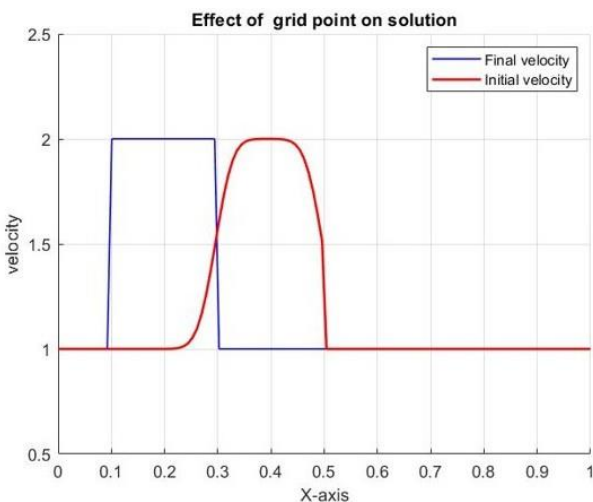


**Figure 3 Wave plot using FTFS**

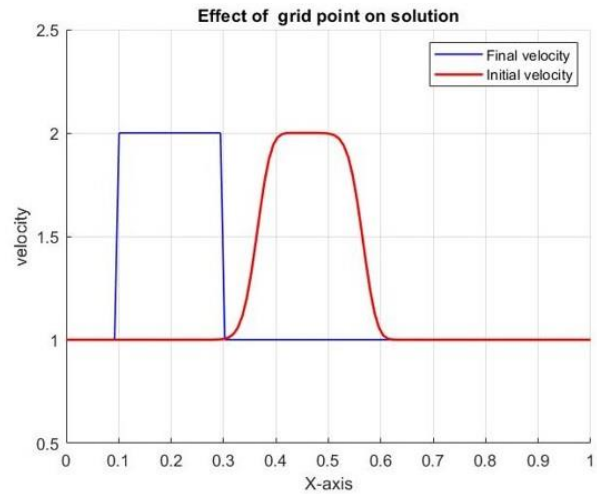
Following plots shows effect of grid size on solution:



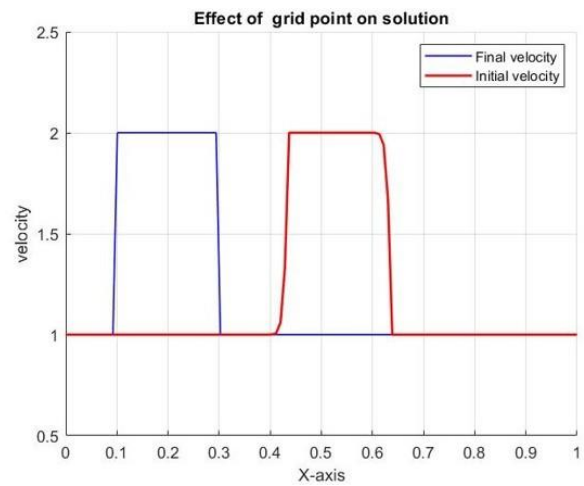
**Figure 4.1 For grid point 40**



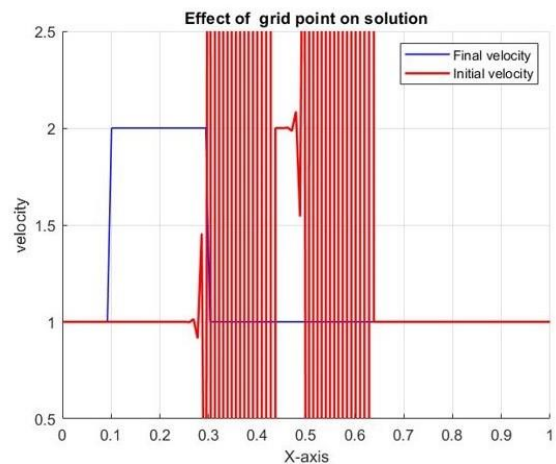
**Figure 4.2 For grid point 60**



**Figure 4.3 For grid point 80**



**Figure 4.4 For grid point 100**



**Figure 4.4 For grid point 120**

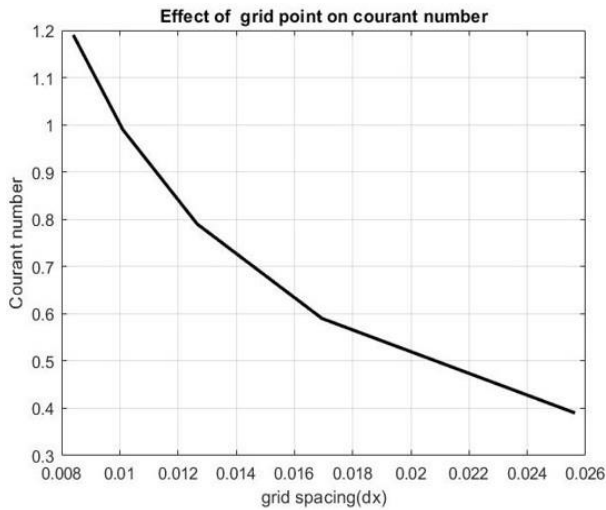


Figure 4.5 Courant number vs. grid size

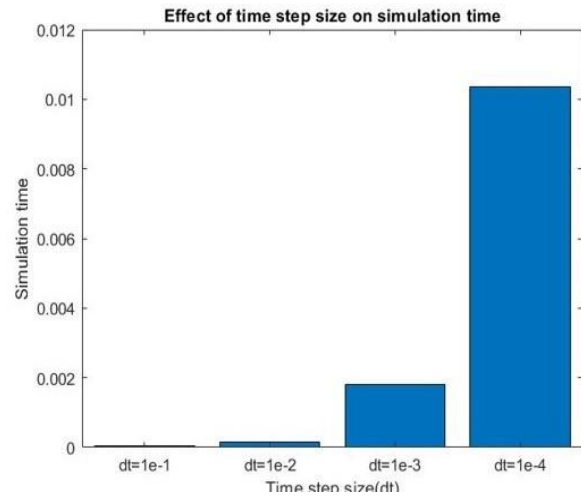


Figure 5.3 time step vs. simulation time

Following plots shows effect of time step size on solution:

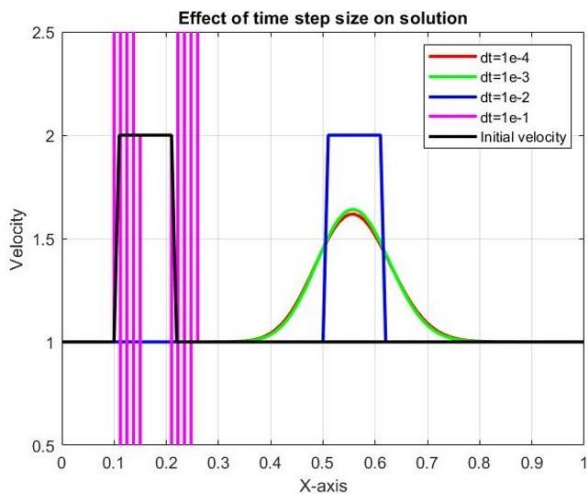


Figure 5 Effect of time step size (dt)

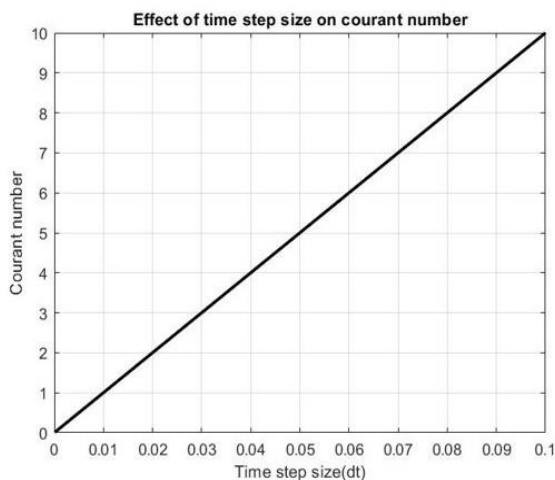


Figure 5.1 time step size vs. Courant number

**Conclusion**

- By Solving Wave equation using FTBS, we are getting result that wave is moving from left to right side. And we also observed that by increasing number of grid points, the shape of the wave is maintained. By decreasing number of grid points the wave loses its shape, due to presence of error is high there is numerical diffusion occurs.
- By observing the Results plots 2 & 3 the minimum velocity is less than the initial condition and also maximum velocity is higher than the initial condition that is what we are not expecting. That means our solution is not bounded, so this is called solution blowup. This occurring because here we are using 2<sup>nd</sup> order approximation central scheme & 1<sup>st</sup> order approximation forward scheme on special derivative but our scheme is not stable for this particular problem. So using a right scheme is very important for solving CFD problems.

From result plots 4.1 to 4.5 the following results.

As the special grid size decreases, the rate of decrease in peak velocity decreases result in more accurate solution further decreasing in grid size beyond a certain value results in solution blow up or unstable solution.

- We can clearly see that from fig 4.5 plot the decrease in special grid size results in increase in Courant number. As Courant number increases greater than 1 solution blows up.



- According to CFL stability criteria, the best solution is obtained is for 100 grid points. For solution to be stable. Time step (dt) must not be greater than spacial grid size (dx).

From plot 5.1 to 5.3 the following results.

7. Larger the value of time step lesser the accuracy of result causing errors.
8. Lower the value of time step shows the velocity profile moves closer to the initial profile in its shape and peak value of velocity but further decreases time step the solution is get unstable.
9.  $1e-2$  is most stable and less time consuming time step compared to others.
10. For a solution to be stable, time step (dt) must not be greater than special grid size (dx) according to stability criteria (CFL condition).

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**FOUR WHEEL STEERING SYSTEM ZERO RADIUS TURNING VEHICLE**

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**ABSTRACT**

*The project is about Four Wheel Steering System Zero Radius Turning Vehicle. This vehicle moves in the all direction. This makes the vehicle suitable for operation in the narrow paths & sharp corners. The normal wheel vehicles face lot of problem like parking, U turn & much more which consumes more time. So, Four Wheel Steering System Zero Radius Turning Vehicles designed to reduce & eliminate problems that occur when hulling material in the industries. in the this system, each of the 4 wheels has given drive with stepper motors, so it can rotate 360 degree. There are 4 Dc motors drive to move the vehicle in the forward & reverse directions. 360-degree rotating wheel is controlled by RF remote. Consequently, we can utilize this Four Wheel Steering System Zero Radius Turning Vehicle for various perspectives like to transport things overwhelming bags & furthermore in the vehicles, which will help in the decreasing rush hour gridlock & spare time.*

**Keywords:** Four Wheel, Steering, Zero Radius Turning, Vehicle

**Introduction**

The advanced new technology has led to various modifications in the the automobile sector. Out of these, Four wheel steering system zero radius turning vehicle which is being analyzed in the various vehicles e.g. hurricane jeep, JCB, Nano Pixel etc [1]. The turning circle of a vehicle is the diameter described by the outside wheels when turning on full lock. There is no hard & fast formula to calculate the turning circle but it can be calculated using this; Turning circle radius= (track/2) + (wheelbase/sin (average steer angle)) [2].

Four wheel steering system zero radius turning vehicle of a vehicle implies the vehicle rotating about an axis passing through the center of gravity of vehicle i.e. the vehicle turning at the same place, where it is st&ing.No extra space is required to turn the vehicle. So vehicle can be turned in the the space equal to the length of the vehicle itself. This technology exists in the heavy earth movers like excavator which consists of two parts i.e. the upper part cabin & lower part crawler chain. The upper part of excavator can rotate about its center, so that the direction of cabin can be changed without changing direction of lower part. Conventional

steering mechanism involves either the use of Ackerman or Davis steering systems.

The disadvantage associated with these systems is the minimum turning radius that is possible for the steering action. This difficulty that is associated with the conventional methods of steering is eliminated by employing a four wheel steering system. in the this system, the wheels connected to the front axles are turned opposite to each other, & so are the wheels connected to the rear axle. The wheels on the on left half vehicle rotate in the one direction & the ones on the right half of the vehicle rotate in the the opposite direction. This arrangement of the wheels enables the vehicle to turn 360 degrees, without moving from the spot, i.e. the vehicle has zero turning radius. This helps in the maneuvering the vehicle in the tight spaces such as parking lots & within small compounds

**Literature Review**

1] Arunkumar S M, Ch&an Kumar Sahu, Yubaraj G M, Jahangeer A B[18] Proposed a system of consist of steering, chain sprocket, DC motor, wheel, bearing, iron pipe, battery & chain drive. in the this system first vehicle is stopped & wheels are turned within required

direction with help of steering mechanism & DC motor. For forward & backward movement of vehicle, DC motors are used in the wheel & a battery is used to provide electrical energy for DC motor. It has turning radius nearly equivalent to negligible of length of vehicle itself. This arrangement is to be helpful in the hospitals, miniature industries & also on railway platforms.

[2] Sudip Kachhia Proposed idea of all electric concept of vehicle is that if it becomes a reality would prove to be a lot of fun to drive in the city. A vehicle works on 8 electric motors, four motors attached uniquely to each wheels & it can rotate 360 degrees. The wheels of car are magnetically coupled & it is controlled by magnetic fields. Hence car is rotate fastly & effectively

[3]. Jaishnu Moudgil 360 degree rotating car to beat matter of parking zone. car has Four wheel steering system zero radius turning vehicle of a vehicle implies the vehicle rotating about an axis passing through axis of gravity of vehicle i.e. a vehicle turning at similar place, where it's staying. No extra space is required to revolve vehicle. So vehicle is to be turned within space like to length of a vehicle itself. during presentation, so got idea of Four wheel steering system zero radius turning vehicle & have plane to make 360 degree wheel rotation load carry vehicle, vehicle is to be utilized in the different area like industries, hospital, railway platform, etc.

[4] K. Lohith Presented a four wheel steering mechanism for a car. in the four wheels steering the rear wheels revolve with the front wheels thus raising effectiveness of vehicle. A direction of steering the rear wheels comparative to front wheels depends on working circumstances. At low speed wheel movement is pronounced, in the order that rear wheels are steered within other way thereto of front wheels with utilization of DC motor to show left & right. during presentation, utilization of DC motor is to rotate wheels 90 degree left 90 degree right from original position.

[5] Er. Amitesh Kumar presented zero turn four wheel steering mechanism, a variety of functions of steering wheel are to manage the angular motion wheels, direction of motion of vehicle, to supply directional stability of

vehicle while going straight ahead, to facilitate straight ahead condition of vehicle after completing a turn, road irregularities must be damped to utmost possible extent. This project utilization of steering is to rotate front wheels.

[6] Mr. Sharad P. Mali Presented zero turn four wheel mechanisms, in the this project people have used DC motor & wheel to vehicle rotate 360 degree at a same position. So in the this task, initiative is to organize of DC motor & wheel.

### Problem Statement

A vehicle with higher turning radius face difficulty in the parking & low speed cornering due to its higher wheel base & track width, but the passenger prefer the vehicle to be higher wheelbase & track width as It gives good comfort while travelling. in the this scenario four wheel steering will be effective as the turning radius will be decreased for the same vehicle of higher wheel base. in the this project a benchmark vehicle is considered & four wheel steering is implemented without change in the dimension of the vehicle & reduction in the turning radius is achieved. The main problem associated in the city areas is traffic. This condition is very time consuming & also sometimes it is difficult to come out in the the emergency situations for example of hospital or fire safety conditions. Sometimes it is difficult to park a vehicle in the condition when two car parked one to another spaced between them. Thus this condition also consumes times for the life style. Also there may be chance of Sudden brakeage & chance of accident & damage for vehicle.

in the our day to day life while using 4 wheeler vehicles on heavy traffic roads & congested parking are we face problems associated with steering of wheels. Because of less space availability we become unable to turn our vehicle within available space. At present scenario minimum turning radius of commercial passenger car is 3.9m.

### Objectives

Behind developing the steering mechanism we have considered some objective main objective of this project is to bring certain solution in the steering methods. Present steering solutions have certain limits in the the steering radius.

- **To provide hassle free steering mechanism to achieve steering of vehicles with the minimum available space.**
- **Minimize wastages of fuel in the thesteering process.**
- **To overcome issues of parking spaces in the metro city& driving in the the heavy traffic roads & market places.**
- **To accommodate improved steering mechanism that gives easy & accurate steering mechanism.**

### Methodology

Now Let us know how project works.

For each wheel of robot we have provided separate motor & direction of rotation of wheels is controlled by electrical supply given through DPDT switch by operating switch we can run robot in the two &fro direction it means we can move robot in the forward & reverse direction.

Now turning direction angle can be controlled by controlling direction of rotation of high torque DC motor which is controlled by another Working

let us see working of project we have two switches on remote board one operates wheel driving motors & another one drives steering mechanism.

Condition -1 forward motion of wheels driving.Now we switch on & let press forward switch all wheel driving motors will rotate in the forward direction to run robot in the forward direction.

Condition -2 reverse motion of wheels driving.When we press reverse switch all wheels will reverse its rotation to move robot in the reverse direction.

Condition -3 Clock wise rotation of steering motor.When we press forward button on second switch high torque dc motor will start to rotate in the clockwise direction.

Condition -4 Anti Clock wise rotation of steering motor.When we press reverse button on second switch high torque dc motor will start to rotate in the anticlockwise direction.

Combined working conditions.Now I will press forward button of switch-1 gradually forward button of switch-2 it robot will start to move in the forward condition & towards left side. As much as we hold switch-2 robot will take turn

left side. when we press reverse button of switch-2 robot will turn towards right side.When we press reverse button of switch 1 robot will move in the reverse direction & when when we press forward button of switch-2 robot will turn towards left side & vice versa.

### Design



**Fig. 3D model of design**

### Motor calculation

Specification and calculation –

60 rpm – 12V – 18W

$$\begin{aligned} \text{Torque of motor: } \tau &= P \times 60 \div 2 \times 3.14 \\ &= 18 \times 60 \div 2 \times 3.14 \times N \\ &= 2.866 \text{ Nm} \end{aligned}$$

### Working

Base frame is manufactured as per dimensions. At corners of frame clamps are fixed with shafts mounted. Above shaft sprocket wheel setup is mounted. Totally four wheel sprocket are used in setup. Wheel sprockets are connected using a cycle chain. Using clamp dc motor are mounted in frame. wheels are connected to motor via shaft. A 12v 7amp/hr battery is placed in back of frame. Using wire connections motor is connected to battery. ESP wifi board is mounted on setup using a breadboard or card board. Relay boards are fixed in same place. ESP wifi board is programmed by interfacing with relay board. Interfaced electronic setup is connected to motor for controlling motor setup. All connections are made to connect to battery. With setup is assembled. Now power supply is given to all circuits motors. wifi board transmits signal to device could pair with it. Usually a mobile device is used to connect wifi board display web page that has remote

control functions. load is loaded in loading area. Using battery power supply motor starts to operate. motor operation is controlled by ESP wifi board. There are two types of key sets for controlling motor. first key set controls forward reverse operation of device. This is achieved by varying power supply to motors using relay board. Forward movement is achieved by giving positive supply reverse motion by reversing polarity. Second set of keys control directions of setup. 360\* rotation of the setup is achieved by this concept. same principle applied above is done here also. By these processes load is carried from one location to another without much disturbance. Due to 360\* rotation of wheels movement of setup is far more easy than conventional systems used. Usage of remote control for controlling movement of device ensures that human intervention for controlling it is reduced. Because of this human error that occur carelessly or out of consciousness is greatly reduced. Other cost for movement of resources is greatly reduced unnecessary usage of manpower is reduced. system increases working time of unit. Since humans get tired after some time of hard lifting works. Due to its compact structure device can enter all areas that are available with minimum spaces. operation area requirement is minimal in case



**Fig. Actual picture of Model**

### Components Used

**1 Steering** Steering is a part of Four wheel steering system zero radius turning vehicle. This part is used to provide the direction to the

front wheels by help sprocket & chain drive, which provides direction to front wheels clockwise or anticlockwise direction.

**2 Sprocket:** A sprocket is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain. The sprockets are used for the power transmission between steering & wheel through the roller chain drive. A sprocket is a profiled wheel with teeth that meshes with a chain, track or other perforated or indented material. Chain sprocket is a part this vehicle. Chain sprocket are used to provide the clockwise or anticlockwise direction to front wheel & rear wheel through the chain drive. Sprockets are used in the bicycles, motorcycles, cars, tracked vehicles, & other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc.

**3 Roller:** chain a roller chain is the type of chain driven most commonly used for transmission of mechanical power between two sprockets. It consists of a series of short cylindrical rollers held together by side links. It is driven by a toothed wheel called a sprocket. It is often used to convey power to the wheels of a vehicle, particularly bicycles & motorcycles. It is also used in the a wide variety of machines besides vehicles. in the this vehicle first chain drive connected with sprocket of front wheel & sprocket of steering & second chain drive is connected with sprocket of rear wheel.

**4 Wheel:** in the this vehicle wheels are made of plastic material. Wheel are connect with DC motor & front wheel rotate 360 degree by help of steering, chain sprocket, chain drive & bearing arrangement. The rear wheels rotate 90 degree left & 90 degree right from original position by help of DC motor, sprocket & chain driver arrangement, DC motor has given to each wheel to provide forward & backward movement of wheel.

**5 Iron pipe:** Iron pipe is a one of important parts of Four wheel steering system zero radius turning vehicle. It is made of mild steel. Which is used to connect bearing & DC motor of each wheel?

**6 DC motor:** in the this vehicle one DC motor are provide in the each wheel to move forward & backward direction. The specification of motor used is 12 V, with 60 rpm. When power

supply from battery to DC motor then DC motor rotate in the clockwise direction & when reverse current supply from battery to DC motor then DC motor will anticlockwise direction. Which will forward & backward movement of vehicle. An electric motor uses electrical energy to produce mechanical energy. In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, & to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North & South) polarities attract, while like polarities (North & North, South & South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor & an external magnetic field to generate rotational motion.

**7 Bearing:** In this vehicle bearing is used to move wheel from one direction to other direction, each bearing is connected with each wheel with the help of sprocket & iron pipe. A bearing is a machine element that constrains relative motion to only the desired motion, & reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction.

**8 Fixed frame:** The fixed frame forms the base of the four wheel steering system zero radius turning vehicle. This frame is made of Mild Steel (MS). It has four wheels attached to its two sides by sprocket bolt & iron pipe.

**9 Battery:** Battery is one of the important parts of four wheel steering system zero radius turning vehicle. Which is connected to DC motor by electric wire. It stores electrical energy & supplies to DC motor so vehicle will move forward & backward direction. Batteries operate by converting chemical energy into electrical energy through electrochemical discharge reactions. Batteries are composed of one or more cells, each containing a positive electrode, negative electrode, separator, &

electrolyte. Cells are to be divided into two major classes primary & secondary. Primary cells are not rechargeable & must be replaced once the reactants are depleted. Secondary cells are rechargeable & require a DC charging source to restore reactants to their fully charged state.

### Advantages

- By using 360° steering mechanism in commercial vehicles will make easy parking issue.
- It will become easy to drive on heavy traffic roads.
- As there is 4 wheel driving mechanism vehicle will be robust and reliable for remote and rough roads.
- Fuel consumption will be reduced that is wasted while parking and on heavy traffic roads.
- For electric cars this concept is fabulous
- By using 360° steering mechanism in commercial vehicles will make easy parking issue.
- It will become easy to drive on heavy traffic roads.
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- Fuel consumption will be reduced that is wasted while parking and on heavy traffic roads.
- For electric cars this concept is fabulous

### Applications

- It is used for moving material around the industry.
- It is used almost in all types of terrain.
- Movement in sharp and narrow areas.
- Project to use this in efficient way to control the movement of heavy loads in industry.

### Future Scope

As technology is improving day by day this concept is very fabulous to get implemented in the commercial vehicles like electric driven cars here we have to make changes such that steering angle should be controlled by electronic system so that there are no errors in

the angles of 4 different wheels to achieve efficient turning angle. If we control them electronically we can achieve perfect turning radius which will reduce wear& tear of wheels.

### Conclusion

As we studied&made prototype of Four Wheel Steering System Zero Radius Turning Vehicle it can be concluded that this type mechanism is very much useful for small passenger cars where we face problems due to less turning radius of presently available commercial cars. By using such mechanism it may cost

more&driving mechanisms become complex because we using 4 separate motors to drive robot.

Although we are getting accurate result on steering that is we are taking turns on the spot but need to check steering angle conditions & need to make improvements.

At the end of conclusion we can say that as a prototype this concept is working satisfactorily but need to make changes to achieve exact steering conditions.

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## POWER GENERATION ON HIGHWAYS USING VERTICAL AXIS WIND TURBINE AND SOLAR ENERGY

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### ABSTRACT

Renewable energy reliability has been the main agenda of the country nowadays, where the internet of things (IoT) and Industry 4.0 are crucial research ways with a lot of opportunities for improvement and challenging work. Data obtained from the Internet of Things is converted into meaningful information to improve and monitor wind turbine and solar performance, driving wind energy cost down and reducing risk. However, the actual implementation in the Internet of Things is a very challenging task because the wind turbine system level and component level need real-time control. So, this paper has been dedicated to investigating wind resource assessment and lifetime estimation of wind power modules using IoT. To illustrate this predicament, a model is built with sub-models of an aerodynamic rotor connected directly to a multi-pole variable speed permanent magnet synchronous generator (PMSG) with many various sensors for measurement of energy stored in the battery are integrated with IoT. Actual work is constructed with ESP32 Microcontroller and Google Cloud service. IoT has been proved to increase the reliability of measurement strategies, monitoring accuracy, and quality assurance.

**Keywords:** vertical Axis wind turbine, solar panel, Internet of Things

### Introduction

The Internet is a gigantic intercontinental network of networks. The nodes that comprise each one of these networks were classically used to be computers. Now, with the advent of the Internet of things (IoT), things of the IoT encompass any physical entity on earth. Therefore, the Internet is no longer a massive network of computers, but rather the Internet now interconnects heterogenous devices with the required interoperability. This makes these devices (or things) accessible from anywhere on the planet. The user can enjoy the services of various things remotely. Moreover, the operation of these devices will now be controlled remotely via the Internet. It is expected that soon, IoT will be so pervasive to cover every aspect of the human's life including renewable energy generation and management. The things in the IoT generates innumerable amounts of data. The nature of these data is in general unstructured data which need further processing painstakingly. Cloud services, provided by data centers, could be exploited to process such big data. However, this imposes several challenges in the case IoT and cloud computing are coupled directly to each other. An exigency shows up to provide a

seamless integration, and now comes the role of fog (aka edge) computing. The main purpose of the fog is to move the burden of dealing with vast amounts of data from the cloud to the edge of the IoT, near the end devices. In addition, fog computing is hoped to offer ameliorated security and privacy.

### Literature Survey

Smart Refrigerator Using Internet of Things (IOT), Gitesh K. Kakuste, M. K. Sangole, Bhushan S. Nasikkar, Dhananjay V. Kulkarni [1]. As we look around ourselves, we see evolution with superior technology, for example cell phones, kitchen, appliances and many more. It uses fast advance of computing technology and the wide use of the Internet; smart home is one of the most prominent areas of intelligent appliances. This system is best example to machine-to-machine communication which is the part of internet of things.

Adequate lighting in highways has been a prerequisite for the economic and social revolution in the developing countries because of their significant ratio (86%) in a comparative road accident study [4]. A research carried by New Zealand transport energy [5] also revealed that the largest night-

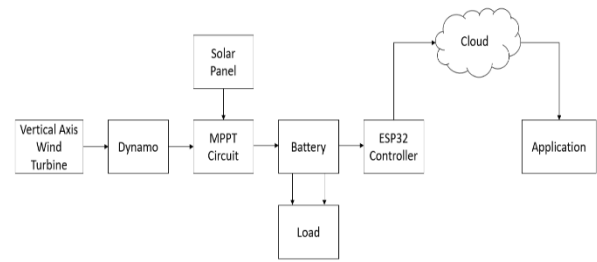


to-day crush ratio reductions attributable to road lighting on higher speed roads were 31%, 24% and 17% for motorways, divided highways and single carrying roads, respectively. Also, apart from the urban areas to many rural highways still need lighting to enable further safety for their users. However, the installation of lighting systems in the accident-prone stretches of remote highways is subjected to outrageous investment and maintenance cost. The cost of lighting services on highway can be momentarily impairing for a patchy budget. For example, 60% budget of European Commission was reported to be consumed only by their public lighting service [6]. Similarly, Australia has been spent more than \$125 million for their approximately 2.3 million lighting lamps in public lighting services [7]. Furthermore, about 30%-60% of their total carbon emission can be attributed to the energy consumption of these lighting services. For example, the United States generated 67% of their total electricity produced by fossil fuels contributing millions of metric tons of greenhouse gases in the air [8].

**Proposed Architecture**

When the vehicles passed on the highway it produces a considerable amount of air due to its speed. This air tangentially strikes on the blade of the vertical axis wind turbine, and it makes a rotation of the turbine in only one direction. The solar system is used to generate electrical energy and installed in a way that it diverts the vehicle air towards the turbine. The generator with the gear mechanism is connected to the shaft of vertical axis wind turbine to generate electricity. The electrical output of vertical axis wind turbine and the solar system are stored in a battery. This stored energy which can be further used for charging electric vehicles, street lighting, toll gates, etc. **ESP32 controller** with voltage and current sensors, monitors energy generation, battery status and send on cloud.

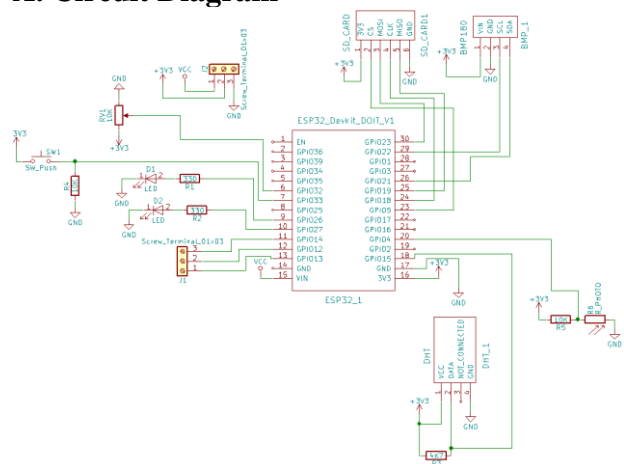
**Design**



**Fig. 1: Block Diagram Of VAWT**

**Implementation**

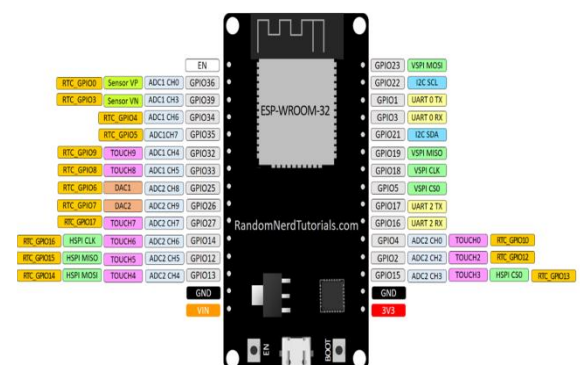
**A. Circuit Diagram**



**Figure 1 - Circuit Diagram**

**B. ESP32 Microcontroller**

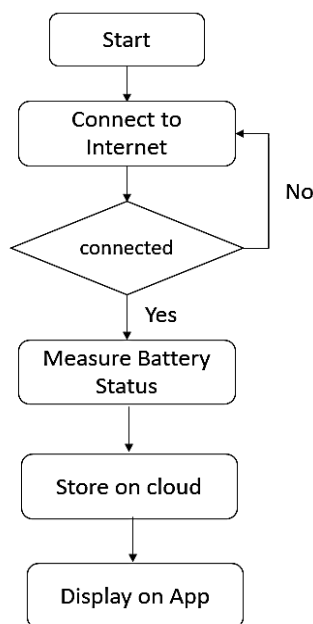
ESP32 is a single 2.4 GHz Wi-Fi and Bluetooth combo chip designed with the TSMC ultra-low power 40 nm technology. It is design to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios of ESP32 is designed for mobile, wearable electronics and Internet-of-Things (IoT) applications.



It features all the state of art characteristics of low-power chips, including fine-grained clock

gating, multiple power modes, and dynamic power scaling. For instance, in a low-power IoT sensor hub application scenario of ESP32 is woken up periodically and only when a specified condition is detected. Low-duty cycle is used to minimize the amount of energy that the chip expend. The output of the power amplifier is also adjustable, this contributing to an optimal trade-off between communication range, data rate and power consumption. ESP32 is a highly-integrated solution for Wi-Fi-and-Bluetooth IoT applications, with around 20 external components. ESP32 integrates an antenna switch, RF balun, power amplifier, low-noise receive amplifier, filters and power management modules. As such, the entire solution occupies minimum area on Printed Circuit Board (PCB). Role - In this project ESP32 used as a main control unit. ESP32 receives data from sensors and send it to the cloud.

### C. Flow chart

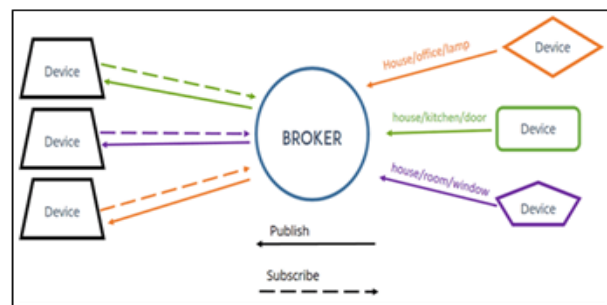


### Software Required

- Programming language – C++/Python
- Tool – PyCharm, Arduino IDE, Android Studio
- Protocol - MQTT
- Cloud – Amazon AWS
- Mobile Application – Android

### MQTT

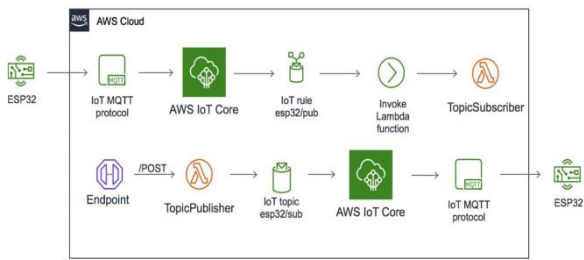
MQTT is a publish/subscribe protocol that allows edge-of-network devices to publish to a broker. Clients connect to this broker, which then mediates communication between the two devices. Each device can subscribe / register to particular topics. When another client publish a message on a subscribed topic, the broker forwards the message to any client that has subscribed.



MQTT is bidirectional, and maintains stateful session awareness. If an edge-of-network device loses connectivity, all subscribed clients will be notified with the “Last Will and Testament” feature of the MQTT server so that any authorized client in the system can publish a new value back to the edge-of-network device, maintaining bidirectional connectivity. The light weightness and efficiency of MQTT makes it possible to significantly increase the amount of data being monitored or controlled. Prior to the invention of MQTT, approximately 80 percent of data was being left at remote locations, even though various lines of business could have used this data to make smarter decisions. Now MQTT makes it possible to collect, transmit, and analyze more of. the data being collected.

### Amazon AWS

Amazon web services (aws) is amazon’s cloud web hosting platform that offers flexible, reliable, scalable, easy-to-use, and cost-effective solutions. This tutorial covers various significant topics illustrating how aws works and how it is beneficial to run your website on amazon web services.



## Conclusion

This paper has proposed an IoT-enabled hybrid energy driven system as an attempt to address the worldwide energy concern through a green energy solution. The novelty of this work is on combination of two renewable energy sources, namely solar and wind, which supplement each other under the supervision of IoT-driven

controller. Under some scenarios, this small-scale eco-friendly concept has been suitable not only for rural highway applications, but also for urban or suburban highways. To evaluate the performance and validate the feasibility of proposed system, we have performed a cost analysis and comparison study with a pure solar-based system. The proposed system has been shown to demand significantly less energy from the solar panel, reducing solar dependency for lighting up the highways. It is anticipated that this type of smart small-scale renewable energy solution for highway lighting can change the perspectives of relevant stakeholders and motivate researchers to develop better optimized versions.

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## A REVIEW PAPER ON DESIGN AND FABRICATION OF CHASSIS DYNAMOMETER FOR ELECTRIC TWO-WHEELER

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### ABSTRACT

The utilization of dynamometers (dyno for short) in transportation execution testing is the same old thing. Indeed, the soonest recorded creation and utilization of a dyno traces all the way back to 1828. In ongoing years, electric bikes are arising as one of the choices to work on the supportability of transportation energy and air quality, particularly in metropolitan regions. Albeit electric bike bikes are harmless to the ecosystem, they fail to meet expectations contrasted and gas bikes in numerous regards, especially in speed and voyage distance among refueling and re-energizing. Thusly, the motor advancement program should be possible with a dynamometer. Factors, for example, the state of force and force bends can be investigated. Henceforth, this venture is intended to foster a suspension dynamometer that can be utilized to gauge mechanical force, speed and force, and give a controllable burden to the electric bike being tried. Fundamental execution prerequisites of an electric bike which comprise of most extreme speed, driving reach and speed increase.

**Keywords:** chassis Dynamometer, Electric Two-wheeler

### Introduction

As we are finding in India that electric vehicle is arising because of rising cost of petroleum and diesel and it is likewise anticipated that up to 2045 motor-controlled vehicle will be total in the coming time so there is a need of progress from motor fueled vehicle to electric. So taking into account that there will be pattern of electric for transportation reason which additionally help in decreasing the contamination. As we realize that electric vehicle is natural agreeable yet they are under formed by motor vehicle in numerous perspectives. It is normal that the necessity of electric vehicle ought to be as indicated by the determination. Boundaries like battery life, power yield, least self-releasing of batteries and furthermore upkeep free ought to have been approved.

The improvement of the presentation of the vehicle is significant key so this need to dissect the different boundaries which are referenced over, this should be possible by planning a dynamometer. Ordinary dynamometer estimates the presentation of fuel vehicle as we do not have motor this had made our work simpler. In electric vehicle undercarriage dynamometer, we center around key

boundaries, for example, power yield, battery life and so forth

Dynamometer comprise of metallic design on which bicycle is put. Front wheel is fixed and clipped and the back tire lays on the roller which are permitted to pivot when the back tire turns. The primary parts of dynamometer is stage on which the vehicle rest, roller on which the back tire rests. The roller has two purposes, first to get the force that given by the haggles, to retain and store this energy in type of precise speed, is to say demonstrations of the inertial wheel. To accomplish ideal condition roller, inactivity and roller RPM should be at the pinnacle. By the by, the roller doesn't need to roll quicker than 5000 rpm because of mechanical impediments.

The principle point of our task is to plan and create a body dynamometer for electric vehicle which measure mechanical yield, speed and force during stacking just as dumping condition. This is done to copy greatest speed, execution, battery condition and speed increase.

### Literature Review

A. Juan, "Energies"(2016) stated that The energy consumption of an EV depends on the vehicle, driving habits and the weather (just

like with any other vehicle). A large family station wagon consumes much more electricity than a tiny EV, and commuting at the city center is much more efficient compared to driving at the highway with full speed. Changing seasons also have a high impact on the consumption, as the electricity consumption rises a lot on cold climate. Heating and cooling decrease the charge of a battery. [1]

**P. Lombardi,(2010)** “Battery powered vehicle” explained about . The battery set disconnected from the generator powered charging section, energizes a drive motor from which a vehicle is propelled at a speed determined by a motor speed controller. At a lower speed limit, a coast generator driven by a flywheel is enabled to begin charging of the motor energizing battery set under coasting conditions.[2]

**K. Aguirre,(2012)** A **DC motor** is any of a class of rotary electrical motor that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor[3].

**W. J. Requia,(2018)** “Environmental effect of Electric vehicle”. Reducing air emissions from transportation is the major goal of regulations promoting growth in electric vehicle market share. Because electric vehicles are promoted as a "green" technology, environmental effects of electric vehicle battery recycling will be closely scrutinized. The secondary lead recovery industry is already subject to stringent environmental regulations. Growth in lead production at secondary lead facilities has been steady, and lead-acid electric vehicle batteries may contribute slightly to this growth in the near future.

### Market Survey

Across the country there are wide range of electric vehicle having various specifications such as size, length ,width , weight, battery rating, range, power output, speed and many more so we have to design a ideal dynamometer which would be applicable to

each and every two wheeler electric vehicle. Collected data gives following specification

**Range:- 115km/charge.**

**Motor power:- 6000W.**

**Charging time:- 5.45 hours.**

**Max torque:- 26NM.**

Above specifications is of renowned electric two wheeler in india named as Ather 450X.

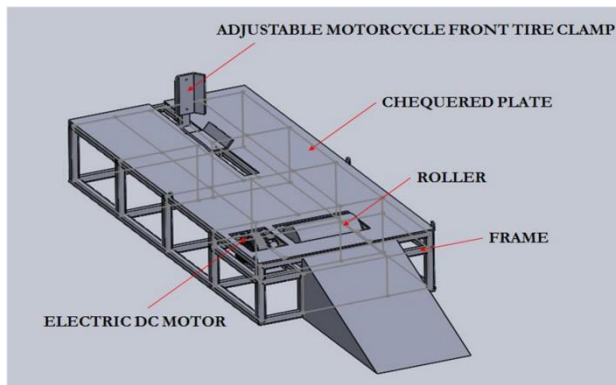
### Design of Chassis Dynamometer

According to the specification the frame of chassis dynamometer is fabricated so that it fits perfectly. The overall dimension of the frame is 900 mm x 2000 mm x 350 mm. Sheet fixed on the frame is chequered plate so that vehicle would not slip.

Afterwards knurled rollers are placed at the rear end in which the vehicles rear wheel rests. Roller design is the crucial part in the chassis dynamometer. The roller is a drum with huge inertia, thus is better to build a roller of great diameter and with mass moved away of the axis, nevertheless, due to wheel is directly traction on the roller, the angular velocity of the roller is a function of the diameter, if diameter is smaller than angular velocity is greater. The roller does not have to roll faster of 5000 rpm.

The front wheel locker is made in a frame of mild steel which is used to lock the front wheel of the vehicle. It is designed in such a way that it is easily detachable and can be adjusted according to the length of the vehicle. The frame with its two rods is drilled using a drill bit of 10 mm, 6 drills on each rod through which a rod of 9 or 10 mm can be passed easily.

Pedestal bearing are an important segment of the bearing holders. They offer large support and are therefore the optimal choice also for heavy loads.



**Fig 1. Chassis Dynamometer**

### Expected Outcomes

The project gives detail information about the speed, max torque, range of the vehicle, power output.

All the parameters are calculating in loading as well as unloading condition and after successfully carrying out the performance of

the vehicle it is measured with the standard specification provided by the manufacturer if the outcomes does not satisfy the standard necessary action is taken. Battery condition and motor used are most important components of the electric vehicle through this we focus on the both components and find the fault in the vehicle which is affecting the performance the vehicle.

### Conclusions

The chassis dynamometer is designed to test the performance of electric vehicle. This is to emulate the basic performance requirements of an electric motorcycle which consist of maximum speed, driving range and acceleration. This is done by running the vehicle at the top speed during loading and unloading condition.

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## A REVIEW ON EXPERIMENTAL INVESTIGATION OF MACHINING PARAMETER FOR TOOL WEAR AND TOOL LIFE OF TITANIUM ALLOY (Ti6AL4V) BY USING NO<sub>x</sub> COOLANT

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### ABSTRACT

*Titanium Alloy is a highly specific strength material, having excellent mechanical characteristics such as high stiffness, fracture resistance, and hardness at high temperature, so it is applied to various fields such as automotive, aerospace and bio-industry. The productivity and the quality of the machining products are the main important challenges of metal cutting or in production industry during turning processes. Due to which manufacturing industries are competing in the market field. This study represents optimization parameters such as cutting speed, depth of the cutting feed rate in the machining material and carbide tool. The design of experiment based on the Response Surface Methodology is performed to identify the effect of cutting parameters on the different response variables.*

**Keywords:** Titanium Alloy, Quality of the machining, Optimization parameter, Tool life

### Introduction

The high strength, low weight ratio and outstanding corrosion resistance which are natural in titanium and its alloys have brought about a wide range of successful applications requiring high levels of reliable performance in surgery and medicine as well as in aerospace, automotive, chemical plants and other major industries. In many of the engineering applications, titanium takes over heavier, less serviceable or less cost-effective materials. Designs created with the properties provided by titanium often produce dependable, economic and more durable systems and components. These titanium components often substantially surpass the performance and service life expectations at a lower overall cost. Titanium can be obtained in several different grades. Pure titanium is not as formidable as the different titanium alloys. Titanium (Ti-6Al-4V) alloy is one that is most extensively used. It has a credible machinability and excellent mechanical properties. For various weight reduction applications in aerospace, automotive and marine equipment, the alloy has the best overall performance. Because of their high

specific strength and exceptional corrosion resistance, titanium alloys are widely used.

### Literature Review

- **Ashutosh Khatri ET AL (Jan 2010)**, The objective of this study is to identify and explain tool wear mechanisms that dominate during machining of titanium alloy Ti-6Al-4V in dry, flood coolant, and minimum quantity lubrication (MQL) conditions. A series of experiments were conducted using end milling of Ti-6Al-4V by varying feed rate and depth of cut, while the cutting speed was kept constant at comparatively high cutting speed. Both uncoated and titanium aluminum nitride (TiAlN)-coated carbide tools were used for machining Ti-6Al-4V at the same settings of parameters. It was observed that abrasion was the most dominant tool wear mechanism for all dry, flood coolant and MQL machining conditions. [1]
- **J.Rajaparthiban ET AL (Nov 2010)**, The Taguchi method is a powerful tool in quality optimization. Optimization is carried out to utilize the available resources effectively to achieve better

results. The orthogonal array of twenty seven experiments in a particular order covers all factors. In this method, selected parameters are assumed to have influence on process results, which are located at different rows in a designed orthogonal array. With such an arrangement completely randomized experiments can be conducted. This method is useful for studying the interactions between the parameters, and also it is a powerful design of experiments tool, which provides a simple, efficient and systematic approach to determine optimal cutting parameters. Compared to the conventional approach of experimentation, this method reduces significantly the number of experiments that are required to model the response functions.[2]

- **M.Venkata Ramana ET AL (Mar 2011)** This paper deals with obtaining safe, environmental friendly and economically beneficial turning of titanium alloy using minimum quantity lubricant (MQL). In this work, Taguchi method is used for process optimization and the observations found are, the MQL shows better results than dry and flooded machining, tool wear shown in MQL is less than dry and flooded condition.[3]
- **Neeraj Sharma ET AL(Dec 2013)**, The present study is an investigation into the influence of different machining parameters (i.e., cutting speed ( $v$ ), feed rate ( $f$ ), depth of cut ( $d$ ), and cutting length ( $l$ )) on surface roughness ( $R_z$ ), flank wear ( $VB$ ), power consumption as well as material removal rate (MRR) when using high-speed turning Ti-6Al-4V alloy. A full factorial experimental design (L48OA) was used to carry out experiments. Such a multi-objective optimization technique is powerful and can offer a reliable solution and a balance among all included outputs. It also helps to provide different solutions that can offer enough flexibility for the decision maker to select the most appropriate cutting conditions based on the desired objectives.[4]
- **Tian-Syung Lan ET AL (Nov 2014)** Performed a experiment for tool wear optimization of general CNC turning using fuzzy deduction. In this paper depth of cut, speed, feed rate and nose runoff these machining parameters are considered under different levels to optimize the tool wear of CNC turning process using fuzzy deduction and Taguchi method. This paper proposes a fuzzy deduction general optimization approach along with orthogonal array and successfully results in improved tool wear performance.[5]
- **Prassan Shah ET AL (Mar 2016)** The need for developing sustainable manufacturing processes which should have a good balance between economic viability and environmental protection is one of the key challenges against manufacturers. The conventional carbon-based cutting fluids used in machining processes are found to be unsustainable in terms of a higher impact on ecology and hence it is required to develop alternative sustainable cutting fluid strategies[6]
- **Ibrahim Nouzil ET AL(Oct 2018)** The unique characteristics of titanium alloys such as, high thermal fatigue resistance, high erosion resistance and high melting temperature suit the purpose of many industrial applications. However, the disposal of the generated heat during the machining is not suitable due to the low heat conductivity of these alloys. The increase in machining generated heat over the critical limit leads to negative effects on the machined workpiece and the tool. In general, improper tool wear behavior and surface integrity are correlated with the machining of titanium alloys. The usage of cutting fluids during machining is mainly to take out the cutting generated heat.[7]
- **Yahya Isik ET AL(Mar 2020)** In metal cutting process, the condition of the cutting tools plays a significant role in achieving consistent quality and also for controlling the overall cost of manufacturing. The main problem caused during machining is due to the heat generation and the high temperature resulted from heat. The heat generation becomes more intensified in machining of hard materials because the machining process requires more energy than that in



cutting a low strength material. As a result, the cutting temperatures in the tool and the work-piece.

- **Nambi Muthukrishnan et. al. (Apr 2021)** Titanium alloys are now being constituted in modern aerospace, marine, automotive, atomic power plant reactor, medical instruments and chemical industry due to their strength to weight ratio that can be maintained at elevated temperatures, excellent corrosion and fracture resistance and low modulus of elasticity [3-5]. However, machining of titanium and its alloys can be considered very difficult to cut materials due to its highly chemical reactivity and tendency to weld to the cutting tool, which resulted in edge chipping and rapid tool failure[9]
- **R.Sulaiman ET AL (Sep 2021)**This paper deals with effect of cutting speed, feed ,and depth of cut on tool life by using Response surface method and find out optimum values of cutting parameters.[10].

## Conclusion

1. The coolant helps breaking up chips and removing them from the cutting area more efficiently, which means the cutting tool spent less time for breaking metal chips.
2. The cutting fluid has significantly reduced the amount of heat and friction at the point where a tool cuts into a metal workpiece.
3. For most tests, cutting speed did not show a significant effect on surface roughness for both dry and wet machining conditions. The effect of the cutting speed is negligible.
4. The results of the present work indicate substantial reduction in tool wear, which enhanced the tool life; this may be mainly attributed to reduction in cutting zone temperature and favorable change in the chip-tool interaction.
5. The cutting fluid enabled in reducing the main cutting force due to improved and intimate chip-tool interaction.
6. It provided more efficient chip removal and heat reduction.

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**A REVIEW ON DESIGN AND DEVELOPMENT OF HYBRID TWO-WHEELER****S.M.Mahajan<sup>1</sup>, Nikhil Pakhale<sup>2</sup>, Pankaj Lohar<sup>3</sup>, Tanmay Borse<sup>4</sup>, Ajinkya Bhagat<sup>5</sup>**

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**ABSTRACT**

*As the use of fuels like petrol/diesel are increasing day by day due to which the availability of fuels is decreasing. Because of excessive use of fuels the environment is getting more polluted. That's why our review is to focus on a two-wheeler Vehicle which will be hybrid; there will be electric drive as well as I.C. Engine. Hybrid-electric vehicle (HEV) combines the advantages of petrol engines and electric motors and may be configured to get different objectives, like improved fuel economy, increased power, and reduced emission leads to a green environment. In recent days, the availability of fuel sources is depleting day by day, and thanks to more consumption of fuel, environmental pollution is increasing. For bittng that issue, we have remodeled our bike as a hybrid bike which suggests the vehicle can use electrical power additionally for its working. Initially, the vehicle runs in fuel mode and after saving energy from this using regenerative microcontroller, electric mode starts, both engine and motor are utilized in case of high load carrying and quick travel. This lead the way of evolution of various alternative fuels and concepts, in this HEV system is one of the effective systems. The hybrid concept looks quite better as it not only decreases the per km cost of the consumer but also enhances the range of the drive.*

**Keywords:** Hybrid electrical vehicle (HEV), BLDC hub motor, Regenerative Microcontroller, Bidirectional converter, Internal combustion Engine (ICE)

**Introduction**

Hybrid vehicle' has been the foremost sorts after concept in today's industry. As a result of several pieces of research and over many decades, hybrid vehicles were realized. Initially and majorly, the concept of the hybrid was implemented in four-wheelers. The diesel-electric hybrid cars were revolutionary within the field. the main target slowly shifted towards the two-wheelers. The oil demand has increased significantly. Moreover, current automobiles utilize only 25% of the energy released from petroleum and therefore the rest is wasted within the atmosphere, making the vehicle inefficient also creating a hazardous environment. For the preservation of petrol for the longer term and increasing the efficiency of a vehicle, an electrical vehicle is often a serious breakthrough. an electrical vehicle is pollution-free and is efficient at low-speed conditions which are prevalent in high traffic areas. But battery charging is time-consuming. However, it cannot provide the high power required by drives during high-speed conditions or on slopes of hilly areas.

At Present condition, there is no hybrid two-wheeler commercially existing. But they exist

separately as fuel-powered or electrical power vehicles. during a fuel-based two-wheeler, an internal combustion engine is employed to drive the vehicle, and in an electrical-based vehicle, the electrical motor is employed to drive the vehicle which gets energy from a chargeable battery. Electric-based vehicles have zero emission but have less torque and power compared to petrol vehicles which produce more power and torque but also more emission. To beat this issue, we choose a hybrid two-wheeler which may produce good power and torque with low emission A hybrid two-wheeler solves these issues by combining the advantages of dual systems and uses one as well as other power sources at their efficient conditions. The goal of this project aims to better utilization of fuel energy and reduces dependence on non-renewable resources using the latest technology. Hybridization, especially in two-wheelers, is that the best approach to realize better fuel economy in automobiles without actually compromising on performance. Hybrid electric vehicle (HEV) technology has the potential to scale back urban emissions and overall petroleum consumption with proper implementation also

to scale back the fluctuating energy requirements of the interior combustion engine at different load conditions and ever-varying engine speed. The implementation involves the event of a Hybrid Electric Vehicle (HEV) that uses a motor that's traveled by A battery also as a petrol engine for the propulsion of a vehicle. Now there is a great need for the implementation of hybrid in two-wheelers. Two-wheelers are famous means of transportation in Asian countries and play a very important role in providing personal transportation in most cities in Asia. due to their small size and straightforward maneuverability In India, two-wheelers function as a primary transportation option that accounts for nearly two-thirds of the entire vehicle population and consumes quite 50% of petrol used. Statistics show that the two-wheeler population in India has grown very rapidly within the last decade and has tripled during this era. at the present, India has the second-highest two Wheeler density within the world. The expected high fuel consumption and emissions of two-wheelers in urban areas need to receive more attention to reinforce An improvement within the acceleration of the hybrid vehicle with good starting torque and helps tons in city traffic conditions. Reduction in Green House Gas (GHG) emissions, increase in oil prices, and dependency on foreign oil are major incentives to the event and deployment of Hybrid Electric Vehicles (HEV) and Plug-in Hybrid Electric Vehicles (PHEV). Compared with conventional vehicles, HEV and PHEV generate considerably low noise, greenhouse emissions, and ozone-precursor emissions. However, unlike HEV, PHEV offers the vehicle owner the pliability of charging the onboard battery. Therefore, it allows the combustion engine to figure within its optimal efficiency range for extended periods which reciprocally would increase fuel savings. A battery is capable of storing large amounts of energy (in order of 100Wh/kg) but isn't suitable for supplying an outsized amount of power during a very short time. a hybrid combines at least one Simple, inexpensive, faster, well tested, and reliable. They can weigh twice as much and have less torque than a geared Brushless direct current

hub motor with an internal combustion engine to move the two-wheeler, and its system recaptures energy (heat) via regenerative braking and converting its kinetic energy into either a braking action or by creating electrical energy to put back into the batteries. Regenerative DC Motor Controller an electronic device that reads the throttle setting of your e-bike and adjusts the current being supplied to the motor. Other functions usually include a low-voltage cut-off, a high-temperature shut-off, over-current shut-off. Regenerative controller work with in-built hall sensor mechanism. Hall-effect current sensor IC technology provides significant advantages in sensing both AC and DC currents in HEVs. Hall current sensors have inherent galvanic isolation for high side current sensing and offer low potential loss in high-efficiency HEV applications. The regenerative controller also has a brake cut-off to shut down the motor when the brake is applied. Infrequently the electric motor does all the work, every once in a while it's the petrol engine, and once and again they work together. The result is less petrol burned and, therefore, better fuel economy. Adding electric power can even boost performance in certain With all of them, electricity comes from a high-voltage Lithium-ion battery pack (Li-ion) is a type of rechargeable battery used in electric vehicles and several portable electronics. that's replenished by capturing energy from deceleration that's typically lost to the heat generated by the brakes in conventional two-wheelers. They have a greater energy density than classic lead-acid or nickel-cadmium rechargeable batteries. This means that the battery can reduce space, decreasing the allover size of the battery pack. Lithium is also the lightest of all metals. However, lithium-ion (Li-ion) batteries contain no lithium metal, they contain ions There also use of a Bi-directional dc-dc converter fed dc motor drive constant to electric vehicles (EVs) application allows a suitable control of both motoring and regenerative braking operations, and it can provide a significant increase in the drive system overall efficiency. Recently many Bi-directional dc-dc converter topologies have been reported with soft switching techniques to enlarge the transfer efficiency.

## Literature Review

**Pappuri Hazarathaiiah.** And His Team.,4 Nov 2019 [1] Perform an Experiment on Design and Fabrication of Hybrid Electric Bike at Department of Mechanical Engineering.. They Convert Their Bajaj Boxer Petrol Bike into The Hybrid Electric Vehicle They Conclude Above Lines Given In Bracket. According To Them EV Can't Sustain All the Power Conditions That's Why Hybrid Vehicle Is the Best Power Source Suitable for All Conditions

**Diego Sánchez-Repila,**23 March 2006 [2] Discuss the About History of HEV Concept of Hybrid Vehicle They Also Propose About Environment Effect Due to Use of Fossil Fuel, Global Warming Emission Legislation Their Graphs Health Effect and Then Briefly Explain About Component of Hybrid Vehicle and Details Survey and Uses. Finally They Conclude for Current Situation the HEV Is the Best Solution for Green Environment Just Because Of New Trend in HEV That Is Regenerative Braking It Will Help For Clean And Green Energy.

**Balasubramanian N1,** Mar 2018 [3] Conclude About Fabrication and Performance Analysis of Hybrid Two-Wheeler They Conclude That Gasoline Drive Is Most Proficient at High-Speed Drive. Hence HEV Both mode of operation happens At Their Most extreme productivity It Gives Twice the mileage Given by A Normal Vehicle.

**Toshali Mohanty,** may 2013 [4] describe about design of a hybrid electric vehicle In which they introduced cad model of vehicle and power trains of electric vehicle and with the help of Simulink the block diagram of hybrid electric vehicle is drawn The cad model of IC engine is also involved is this paper and in which overall simulation on ANSYS is done by them according author HEV is a vehicle Thus, HEV's both mode of transmission occurs at their maximum efficiency. But in petrol engine low speed operation is not efficient. Its high-speed mode is only efficient.so, it gives double the mileage given by a normal vehicle. This the main effective conclusion on HEV

**Prashanna Rangan R,** JAN 2017 [5] established Design and Fabrication of Hybrid Two-Wheeler.in which they introduced Sankey's diagram by which overall explanation

is given about petrol bike that is how much total petrol is actually converted to useful work. According to author the system will become bulky due to additional weight of battery to the bike that's why they have a lot future work in their model.

**Karan C. Prajapati,** DEC 2014 [6] introduced Hybrid Vehicle: A Study on Technology Author also introduced plug-in Hybrid Electric vehicle is also classified in two types 1) series plug in hybrid and 2) parallel / Blended plug-in hybrid future author introduced actual running model of plug-in hybrid. And conclusion is at lower speeds, no smog is emitted maintaining its sustainable advantage. Noise pollution and emission of CO<sub>2</sub> is considerably reduced

**Mohammad Kebriaci,**2015 [7] author to elaborate his paper main aspect is to focus on energy management system of HEV along with they compare between Electric Vehicle, Hybrid Electric Vehicle and Fuel Cell Vehicle. The comparison is on propulsion, energy storage sub system, characteristics, energy source infrastructure, major issue. according to above classification Hybrid Electric Vehicle is more powerful than electric vehicle and fuel cell vehicle. And Electric Vehicle is more stable than Hybrid electric vehicle also Fuel Cell Vehicle is more complex for fuel management because of hydrogen cell in it.

**Juan Jesús Castillo Aguilar,** 20 OCT 2017 [8] describe Regenerative Intelligent Brake Control for Electric Motorcycles Current regenerative systems in motorcycles are designed with a low fixed maximum regeneration rate in order not to cause the rear wheel to slip when braking with the regenerative brake no matter what the road condition is.And then finally conclude that for effective regenerative breaking the all consideration is necessary that is read parameters, adhesive coefficient. Just because of adhesiveness the ABS system is required that know as Anti break locking system.

**Saurabh Kadia,** MAY 2018 [9] introduced Improvisation and fabrication of Hybrid Motorcycle the author produced well developed model of hybrid electric vehicle. This project outlines the design, construction and testing of a conceptual motorcycle which club the two technologies, of an internal combustion engine with electric main drive. at

the last conclusion says about bulkiness of vehicle but its minor issue the main impact is to reduced the pollution due to traditional petrol bike

**A.K. Nachimuthu**, JUNE 2014 [10] perform design and fabrication of hybrid two-wheeler Component selection is the main part according to author because hub motor, dynamo, alternator, controller along with this battery. The perfect component will give us the maximum possibility of energy utilization Comparison is done according to the cost of component and its efficiency by observing comparison we can say cost of HEV is more than both EV and IC Engine bike, but HEV is more efficient than Both of them its required less money for 1km than both EV and IC engine bike, vehicle can be easily run by battery instead of by IC Engine, when high torque is required it can be changed to IC engine mode.

**D.RAJKUMAR**, 7 July 2018 Establish design and development of hybrid vehicle smart control system with solar charging. The design includes a solar panel and a generator (coupled with wheel) for charging the battery. The system has three modes of operation and it is more efficient than other normal automobiles towards conclusion the regenerative system will give support to the charging system of battery and will definitely give changes in system.

**Mr. Vidyadhar Gulhane**, 2016 [13] is perform A Scope for the Research and Development Activities on Electric Vehicle Technology The ever-increasing prices of fossil fuel products and serious environmental pollution problems have accelerated the development of non-polluting electric and hybrid vehicles during last few decades. Author Performs the library testing on Traction motors that will help to detect motor failure in various condition. However, customers are not satisfied with the operating performance.

**Ruthvik P. Sankar**, 6 June 2017 publish paper on Design and Development of Smart Hybrid

Two-Wheeler. The system reduces environmental pollution continuously by reducing the Carbon-di-oxide (CO<sub>2</sub>) emission and consuming less fuel At low speeds, the motor is highly efficient and the engine's efficiency is low besides liberates a lot of hazardous substances and producing noise pollution while idling and in slow moving traffics.

### Conclusion

The reduction of fossil fuel energy sources and the increase of the carbon emission force the technology to the systems which have renewable energy sources as a design philosophy. Among certain technologies, hybrid electric motorcycles are an important subject nowadays that has the advantages of less fuel consumption, lower operating costs, lower noise pollution, low emissions, smaller engine size, and long operating life. Hybrid electric motorcycle research is expected to be more famous in future years with the development of battery technology, control techniques, and government support to the automobile owners and manufacturers. This review has presented an overview of HEV with a focus on classification, selection of motor and battery, their benefits and future work, vehicle types, and energy management strategies. The investigational tests and theoretical calculations of the vehicle show that there is a good confirming result which satisfied the required torque and speed With the ever more tough restrictions on energy resources and environmental concerns, HEVs will attract more interest from the automotive industry and the consumer. No matter the market share is still meaningless today, it can be predicted that HEVs will gradually gain popularity in the market due to their superior fuel economy and vehicle performance. Finally, the overall review of studies in the literature helps to document present trends and explore future trends of HEV.

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|     | Professor | Y.Ashok         | Kumar     | Reddy    | M.Sreenivasulu | Professor : Design And              |
|     | Associate | Professor       | P.Vijaya  | Bhaskara |                | Fabrication Of Hybrid Electric Bike |

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**DESIGN OF AUTOMATIC HAND SANITIZER WITH TEMPERATURE SENSING****Ashwini Patil<sup>1</sup>, Shivani Patil<sup>2</sup>, Joyce Pathare<sup>3</sup>, Amit Kumar Mishra<sup>4</sup>, Dipak P Patil<sup>5</sup>,  
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**ABSTRACT**

Viruses such as COVID-19 are transferrable through touch and contact. There are WHO guidelines to clean or sanitize hands regularly to reduce the risk of infection. Dispensing of sanitizer from bottle and storage would require manual intervention. The design depicted shows the preventive measure that can be taken during the COVID-19 pandemic in the whole world. Sanitizers have become the most significant commodities right now. By the new rules and regulations given by WHO vigorous sanitization is needed to survive. The design gave the solution for the problem stated. The design introduces an automatic hand sanitizer and temperature sensing system, to keep the hand sanitized whenever a person wants to do it, without a contact with the sanitizing machine. The temperature sensor on touching gives the body temperature of the person.

**Keywords:** Automatic hand sanitizer, Arduino, temperature sensor, PIR sensors, TMP36, covid-19

**Introduction**

Since December 2019 the world is under tremendous tension, the numbers are increasing day by day, and till date no vaccine has been full proved against the pandemic agent. Yes it is COVID-19, it was unknown to the race before it out broke in Wuhan, China. Being from a large family, a continuous mutation is occurring, forbidding the researchers, microbiologist, and pharmaceuticals to draw the line of conclusion on the vaccine. Affecting the most prestigious countries in a chain; China, Italy, Spain , USA , India , Russia, [1] the virus has proved its strength and subservient a technologically enhanced race. The race of homo-sapiens. The policies taken worldwide has lesson its affect to some extent but could not eradicate it. Lockdown has economically weaken many nations, and testing of different medicines has also not proven to be satisfactory. The question now prevail is Life vs. Livelihood. The weaker section of the society is facing the hardship due to vigorous lockdown across the nations. Seeing the picture of India, one of the most promising countries in technology , the labourers are rushing for a little piece of grain.

The starving faces reveal the pain. Industries are in losses, workers are losing jobs, economic growth of the nation has taken a back seat , but it should be realized that a regular monitoring of body temperature and periodical hand sanitization can Prevent the spread of the pandemic to the masses. Keeping in mind, the situation worldwide, sanitization commodities should be installed in each and every corner of the sphere, be it an industry, a corporate office, an educational institute or an shopping mall.

In this research work, an automatic hand sanitizer with temperature sensing design prototype should made.

As there is an impact in using the hand wash sanitation by foot or by pressing the sanitizer bottle used to have a spread of the virus disease from one human to another. A long press is made with the footer, such that the mechanical forced to spray out the Sanitizer liquid. The human at aged people is unable to use this system as there is mechanical stress and there the corona virus disease is a major problem in the future is a sudden liquid force coming from the sanitizer bottle.



## Objectives

The purpose of this system work is to create awareness about public safety and solutions by ways of health monitoring system, which will measure successfully the body temperature along hand sanitization of a person and hence create a safer environment around.

The following line up as the main objective of the project:

1. Installation of LCD to display the sensed temperature.
2. Installation of spray pumps/submersible pumps.
3. Synchronizing all the sensors with Arduino UNO R3 microcontroller.

## Related Work

Implementing of Contactless Automatic Hand Wash Dispenser for Sanitation is efficient and the cost price is minimized. It works like the normal contactless automatic machine. The human gets the limited sanitizer liquid for sanitation in hand, to wash the hands and to protect themselves from the corona disease. This system can be utilized in malls, high populated areas. The economic cost of the system, it will be better quality when considering the life of the system and the seminar. The most goal of this seminar was to use current advanced technologies to develop an Automatic hand sanitizing machine to improve hygiene and prevent the infectious viruses entering our body. Automatic hand sanitizers are priced less when compared to any other hand sanitizing tools or dispensers. At the same time it is environment friendly as because the disposable wastage is very minimal, since it can be refilled easily without any technical assistance. These automatic hand sanitizer machines are developed keeping in mind about its affordability by underprivileged sections of the society as it can be purchased by lower income groups in pursuit of their well being and also they are easily available and can be used by everyone without any hassle[2].

### A. Novel design of automatic sanitizer dispenser machine based on ultrasonic sensor

The system consists of proximity sensor based on ultrasonic principle. The sensor used in the

system is SR04 to sense the hands are under the machine or not. The cabinet design was originally fabricated for water RO system and has been modified for the purpose of sanitizer dispensing action. The sanitizer storage section is on the front side upper region. Filters have been removed and the water dispensing tap has also been removed. Mist nozzle has been added at the bottom side of the cabinet. The pump is used to suck the sanitizer and pump it with a pressure to the nozzle. The solenoid valve has also been used to control the opening of nozzle and to facilitate to control the dispensing of liquid sanitizer. Pipes and attachments helped to make it easy to fabricate. As the controller receive High signal from the sensor module it triggers the pump to pull water from storage area and send to the nozzle in mist form. The program runs the pump for 3seconds. It has been seen during testing 3 seconds are sufficient to sanitize the hands with mistspray. Even we can change the time as per user need through program.

The machine is wall mount at entrance gates of society, schools, colleges or any commercial building. It can spray 40 times with 100 ml liquid and is effective in optimize use of liquid sanitizer. The machine is tested for 24hour operation for more than a week and is working fine. It helped to reduce the contact for getting sanitizer and also reduce man power employed to spray sanitizer with a spray bottle. The power consumption is very low. For each spray the maximum current consumption is 2 Ampere at 24 V. It consumes 48W if run continuously for 1 hour. The control circuit is small in size and low cost as compared to available controllers. The power consumption is low and the system can help to achieve contactless sanitizer dispenser. It reduces the risk of community transmission of the virus[3].

### B. Automatic Hand Sanitizer Container to Prevent the Spread of Corona Virus Disease

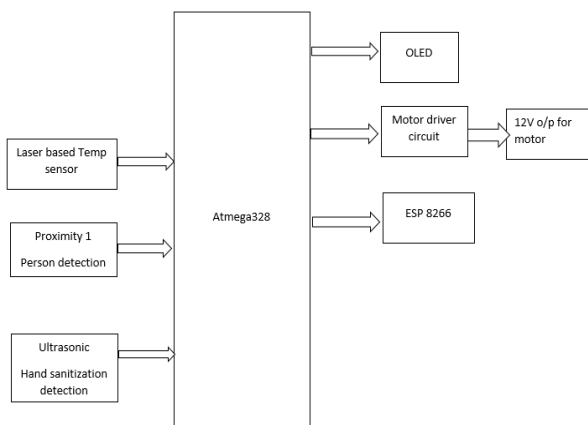
Most of the available hand sanitizers do not operate automatically. This aims to make an automatic hand sanitizer where soap and water can come out automatically. Besides that, automated hand sanitizer will make notification to the owner, if the liquid has run out to the Smart phone. The infrared (IR) will sense the presence of heat and motion of the object and

send data to the Arduino Uno so that it can activate the pump. If the water height is less than 10 cm, the ultrasonic sensor will send data to node ESC8266 as a Wifi microcontroller to the output devices such as smartphones or PC based on the Internet of Things (IoT) [18]. The results of the hand sanitizer testing that the system can run smoothly with a minimum detection error of transferring data. The automatic hand sanitizer testing can run smoothly with a minimum detection error of transferring data. Infrared can detect the motion up to 50mm and ultrasonic sensor can detect the level of water with the distance to the sensor 35 cm. Ultrasonic sensor can send data to the MCU and Blink server and send notification to the user. So that it can be concluded that the system can work smoothly that can prevent the spread of Covid-19[4].

### System Development

The system we designed known as the Automated Hand Sanitizer dispenser integrated with temperature sensing is mainly aimed at doing the temperature check, and dispensing the Sanitizer through dispenser as a single process through an integrated system there by reducing the complexity. There is mechanism used as listed in the below Block Diagram.

#### Block Diagram



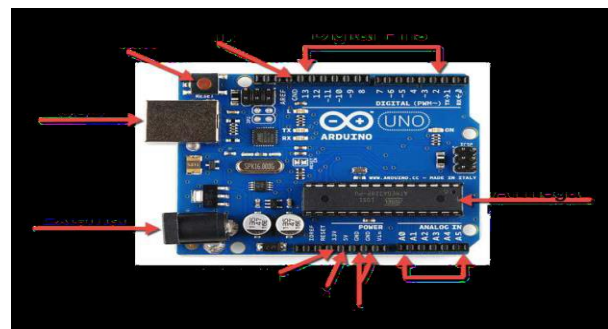
**Fig 4.1: Block Diagram**

#### Component Description

##### 1. Arduino Uno [18]

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets

of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB based Arduino boards;[3] it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases.[4] The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

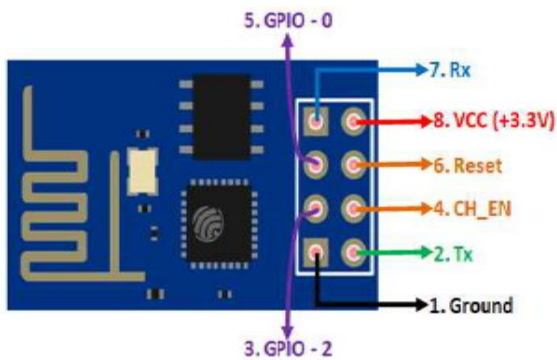


**Fig4.2: Arduino Uno**

##### 2. ESP8266 Wifi Module

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers (and that's just out of the box)! The ESP8266

module is an extremely cost effective board with a huge, and ever growing, community. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development upfront and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area.



**Fig4.3: ESP8266 Wifi Module**

**3. Proximity Sensor**

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive proximity sensor or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target.



**Fig4.4: Proximity Sensor**

**4. Ultrasonic Sensor**

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).



**Fig4.5: Ultrasonic Sensor**

**5. Motor Driver**

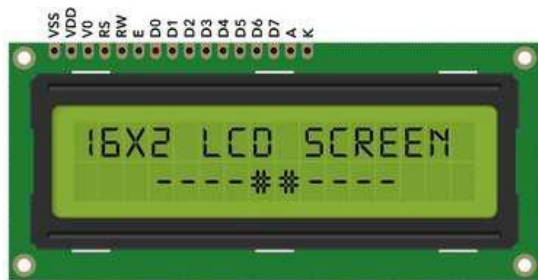
The L293D is a popular 16-Pin Motor Driver IC. As the name suggests it is mainly used to drive motors. A single L293D IC is capable of running two DC motors at the same time; also the direction of these two motors can be controlled independently. So if you have motors which has operating voltage less than 36V and operating current less than 600mA, which are to be controlled by digital circuits like Op-Amp, 555 timers, digital gates or even Micron rollers like Arduino, PIC,ARM etc.. this IC will be the right choice for us.



**Fig.4.6: Motor Driver**

### 6. 16\*2 LCD Display

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day to day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical.



**Fig.4.7: LCD Display**

### 7. DC Motor Pump

Micro DC 3-6V Micro Submersible Pump Mini water pump For Fountain Garden Mini water circulation System DIY project. This is a low cost, small size Submersible Pump Motor which can be operated from a 3 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the

motor. Dry run may damage the motor due to heating and it will also produce noise.



**Fig4.8: DC Motor Pump**

### 8. Temperature Sensor

LM35 is a precision Integrated circuit Temperature sensor, whose output voltage varies, based on the temperature around it. It is a small and cheap IC which can be used to measure temperature anywhere between  $-55^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ . It can easily be interfaced with any Microcontroller that has ADC function or any development platform like Arduino.

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes. There are many different types of temperature sensors. Some temperature sensors require direct contact with the physical object that is being monitored (contact temperature sensors), while others indirectly measure the temperature of an object (non-contact temperature sensors).



**Fig4.9: Temperature Sensor**

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**OPTIMIZATION AND TESTING OF SPOT WELDS ON MOPED STEEL WHEELS****S.M. Mahajan<sup>1</sup>, Akshay Patil<sup>2</sup>, Siddhant Pawar<sup>3</sup>, Rohit Parolekar<sup>4</sup>, Vishal Suraywanshi<sup>5</sup>**<sup>1</sup> Assistant Prof. Mechanical Engg. Dept. Sandip Institute of Engg. And Management, Nashik, India  
<sup>2,3,4,5</sup> Under Graduate Student Mechanical Engg. Dept, Sandip Institute of Engg. And Management, Nashik, IndiaEmail: <sup>1</sup>sunil.mahajan@siem.org.in, <sup>2</sup>akshay.patil0459@gmail.com, <sup>3</sup>siddhantpawar1998@gmail.com**ABSTRACT**

In this paper we are representing the work done on automotive wheel where optimization is done using multiple parameters and objectives. Main objective is to reduce spot welds on wheel so as to increase productivity. We used FEA method as optimization method. Also, for validation purpose we used Wheel method.

**Keywords:** Wheel, Analysis, Optimization

**Introduction**

Analysis of the wheels consists of numerically analyzing the stress levels that it experiences during operating conditions. These stress levels will then serve as input parameters for a fatigue analysis of the wheels to evaluate their respective fatigue life. Additionally, the load bearing capacity of the bolt pattern will be evaluated for conditions of severe loading. The finite element (FE) method is implemented for all wheel analysis. The reliability of FEA approach is based on their previous experience in fatigue analysis studies. The magnitude of the static load and pressure contributes to increasing the stresses on the wheel components. [2]

**Problem Definition**

Presently 24 spots are used to join disc and wheel on spot weld machine having 3 stations. One cycle of 3 spots requires 6-7 seconds. There are 8 cycles of welding and 7-time indexing. One indexing requires 4-5 seconds. Loading and unloading time is near about 3 seconds. So, for production of one wheel will require near about 94 seconds. Other operations need maximum 35 seconds. Now there is a bottle neck at this stage of production, in a shift with other operations 900

to 960 wheels are produced but at welding machine 300 to 306 wheels are produced. To cope up with this problem 2 Welding machines are installed still the maximum production of wheels is 612 wheels per shift. So, this thesis aims at optimizing the number of spot welds on the wheel which will increase the production rate.

**Parameters**

Parameters	1	2	3
Number of Spots	21	18	15
Diameter of Spots (in mm)	8.4	7.7	7.0
Plate thickness (in mm)	2.0	2.3	2.6

**Table: 3.1 Parameters considered**

The parameters for Experimentation are selected as follows,

Currently there are 24 spot welds on the wheel with plate thickness 2.3 mm and spot weld diameter 7.0 mm.

**Wheel Plan**

**Combining all parameters Experiment Plan is designed as follows:**

Expt. No.	Spot Number	Diameter Spot(mm)	Thk. Plate (mm)
1	S1=21	D1=8.4	T1=2.0
2	S1=21	D2=7.7	
3	S1=21	D3=7.0	

4	S2 =18	D1=8.4	
5	S2 =18	D2=7.7	
6	S2 =18	D3=7.0	
7	S3=15	D1=8.4	
8	S3=15	D2=7.7	
9	S3=15	D3=7.0	
10	S1=21	D1=8.4	
11	S1=21	D2=7.7	
12	S1=21	D3=7.0	
13	S2 =18	D1=8.4	
14	S2 =18	D2=7.7	
15	S2 =18	D3=7.0	
16	S3=15	D1=8.4	
17	S3=15	D2=7.7	
18	S3=15	D3=7.0	T2=2.3
19	S1=21	D1=8.4	
20	S1=21	D2=7.7	
21	S1=21	D3=7.0	
22	S2 =18	D1=8.4	
23	S2 =18	D2=7.7	
24	S2 =18	D3=7.0	
25	S3=15	D1=8.4	
26	S3=15	D2=7.7	
27	S3=15	D3=7.0	T2=2.6

**Table Wheel Plan**

**5. Steps for Work**

1. For optimization purpose first we will conduct the Weld Strength Test. Finite element analysis of wheel for Weld Strength Test, we will go for best combination of Thickness T1=2.0 mm.
2. Wheel with Weld Strength Test.
3. The FEA result of wheel is compare with Weld Strength Test result and validation is done.
4. The wheel which passes the weld strength test only will be considered for next step.
5. Finite element analysis of wheel for cornering fatigue test
6. Wheel- Cornering fatigue test.
7. The FEA result of wheel is compare with Cornering fatigue test result and validation is done.
8. The wheel which passes the Cornering fatigue test will be considered for next step.
9. The wheel which passes all the 3 tests are considered and the wheel with minimum spots will be the optimized wheel.

10. Finite element analysis of wheel for Radial fatigue test
11. Wheel- Radial fatigue test.
12. The FEA result of wheel is compare with Radial fatigue test result and validation is done.
13. The wheel which passes the Radial fatigue test test only will be considered for next step

**6. Weld Strength Test and Analysis**

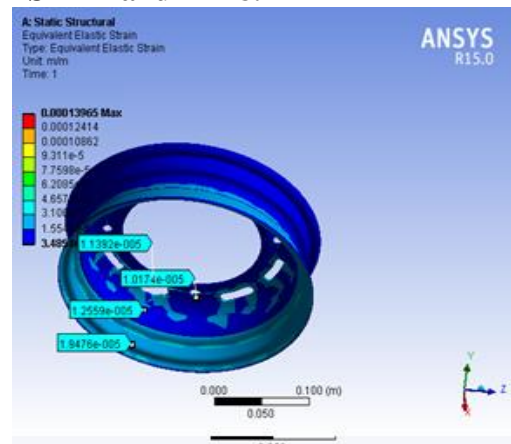
We will start Analyzing the Wheel for Weld strength at minimum thickness (T1=2.0 mm), Maximum thickness (D1 = 8.4 mm) and (Spots numbers=21). If this combination fails all the remaining for T1 will get fail because we are using maximum diameter and maximum number of spots so other combinations will be weaker than above used. So, we will directly take next thickness of wheel.

If passed we will go for the next combination.

**Force:** As in UTM a force of 237.5 kN is applied. (As specified by Manufacturer)

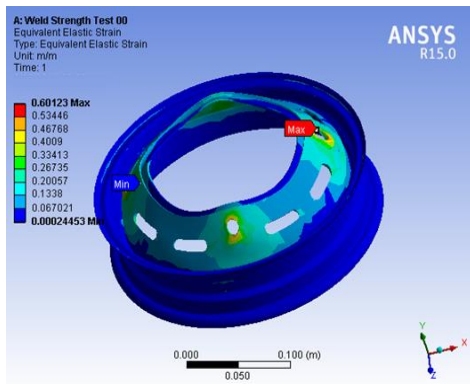
**7. Finite Element Analysis of Wheel for Dynamic Cornering Fatigue Test**

**Sample Experiment. Finite Element Analysis of Dynamic cornering fatigue test with S1=21 and D1=8.4 mm**

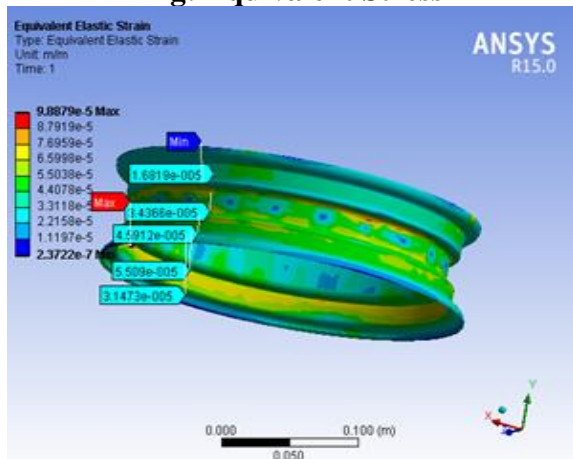


**Fig. Elastic Strain on Wheel 1**

**Sample Experiment No.1: With S1=21, D1=8.4 mm**



**Sample weld analysis: Experiment No.1.1:**  
**D1=8.4 mm; S1 = 21; T2=2.0 mm**  
**Fig: Equivalent Stress**



**Fig: Equivalent Strain**

**Optimized Result Level**

No.	Sp.No.	Sp.Dia	Thk	Weld	DCFT	RFT	Result
1.	S1	D1	T1	F	---	---	
2.	S1	D1		P	P	P	
3.	S1	D2		P	F	---	
4.	S1	D3		F	---	---	
5.	S2	D1	T2	P	P	P	OK
6.	S2	D2		P	F	---	
7.	S3	D1		F	---	---	

**Table. Optimize Result after Finite Element Analysis**

**So From Experimental and FEA results an Optimized level is Spot Numbers 18 and Spot Diameter 8.0 mm**

**Conclusions**

A Multi-objective analysis concept is carried out to optimize the number of spot weld on the

Wheel. Work is carried out in steps by step manner. We tried to minimize the number of experiments and levels. All experiments were considered at First Test, then proper Finite Element Analysis is done. Then Experimentation for the same test is done and compared. In this way a filter is applied to extensive Experimentation. For the safe combinations we carried DCFT with FEA as well as Experimentation. Then the best combinations were tested for RFT. Here we got the final optimize result. Experimental results were compared to finite element results for validating the methods adopted. The experimental results and the modifications and identification of the proper methods for applying the radial load, Comparisons of uniquely identified wheel geometries and the effects of inflation pressure on the state of stress, effect of moment on Wheel, effect of change in spot diameter and its number on Wheel is verified.

**The study is helpful towards:**

1. Reducing spots weld in wheel provided, spot weld number optimized from 24 to 18.
2. **Saving of Time:** As the spot weld is optimized at 18 numbers 2 cycles of Indexing (5 seconds per cycles) and 2 cycles of spot welding (7 seconds/cycle) are saved. i.e., total saving of 24 seconds per wheel.
3. As 24 seconds are saved per wheel, production rate is increased from 306 to 411 on one machine, or 612 to 822 on two machines. In this way the rate of production is increased,
4. Providing the useful database for the product development.
5. Could leads to robustness in design with high accuracy.
6. Providing the interface for stress analysis, useful for confirmation of new set up of testing rig or after calibration.

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**A SAMPLE PAPER ON NEED OF U-LOOP TRAFFIC SYSTEM****V.B.Shinde<sup>1</sup>, Viraj Navandar<sup>2</sup>, Anuj Nagare<sup>3</sup>, Hemangi Sonawane<sup>4</sup>, Tanmay Avhad<sup>5</sup>**<sup>1</sup> Professor, Civil Engg. Dept., Sandip Institute of Engg. and Management, Nashik, India  
<sup>2,3,4,5</sup> Under Graduate Student Civil Engg. Dept., Nashik, India**ABSTRACT**

Vehicle is the main constituent of the transportation system. Vehicle is used for convenience and for time saving purpose. Therefore vehicles are increasing day by day in number because of communication social purpose also. Our Nashik city in Maharashtra is fastly growing city among the country as well as world and it is declared as metro city before some years. And like kumbhmela sudden increase in traffic in kumbhmela period. So need the management of traffic and supporting the safe driving and to solve the problem of traffic. This paper reviews on need of u-loop traffic system at Bombay Naka for controlling traffic.

**Keywords:** Transportation Management, U-Loop, Traffic Signals

**Introduction**

In order to facilitate the assessment of present and future traffic demands, for the development of need based infrastructure accurate information and continuous monitoring of traffic by appropriate methods is necessary. Implementing authorities must therefore ensure that sufficient and appropriate data is available to undertake

necessary planning, design, construction and maintenance of the country's road network, which is aimed at meeting the prevailing traffic flow, future traffic growth and loading without considerable deterioration in the quality of service. This guideline has therefore been prepared with the main aim being to provide basic information, concept and principles with respect to traffic data collection and analysis. There are various methods of data collection available and used by different organisations/institutions. This guideline, therefore, is only intended to provide guidance in respect of data collection and analysis, and allows for variation in the methodologies adopted by different users, planners, developers, funding authorities, etc. The beneficiaries of this guideline are Roads Department, other Ministries/Departments, local authorities, educational institutions.

Vehicle is the main constituent of the transportation system. Vehicle is used for convenience and for time saving purpose. Therefore vehicles are increasing day by day in number because of communication social purpose also. Our Nashik city in Maharashtra

is fastly growing city among the country as well as world and it is declared as metro city before some years. The present situation bans the BS-3 engines increased sudden traffic. And like kumbhmela sudden increase in traffic in kumbhmela period. So need the management of traffic and supporting the safe driving and to solve the problem of traffic.

In India, the traffic lights for vehicles commonly have three main lights, a red light that means stop, a green light That mean go and yellow that means ready to go. the pedestrians, there have only two lights, a red light and a green light that mean go and stop respectively. Besides reducing the number of accidents, it made the traffic flow smoothly and possibly could save people time.

**1.1. Objective**

1. To control traffic volume at Bombay naka.
2. Planning design and regulation of traffic at Bombay naka
3. Planning and design of new street and flyover at Bombay naka.
4. Established properties and schedule for traffic improvements.
5. To developed transport system.
6. To control the local traffic at Bombay naka.



## 1.2. Scope of Project work

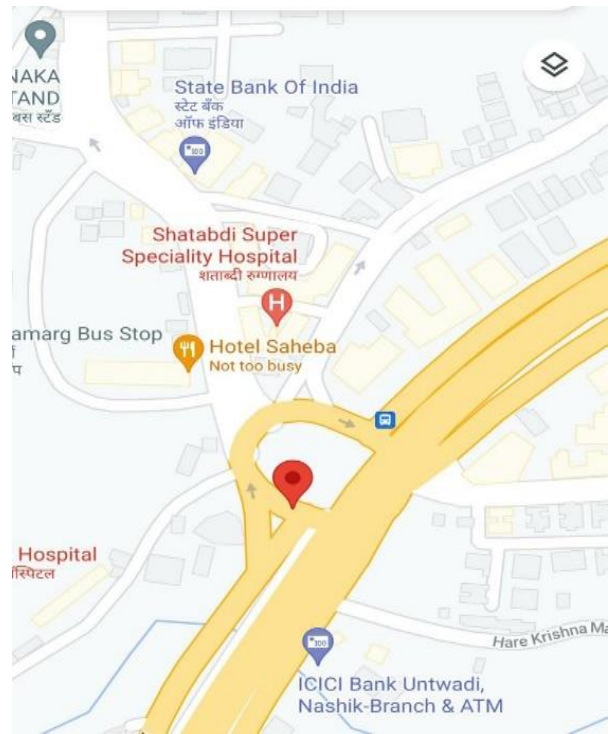
The In order to facilitate the assessment of present and future traffic demands, for the development of need based infrastructure accurate information and continuous monitoring of traffic by appropriate methods is necessary. Implementing authorities must therefore ensure that sufficient and appropriate data is available to undertake necessary planning, design, construction and maintenance of the country's road network, which is aimed at meeting the prevailing traffic flow, future traffic growth and loading without considerable deterioration in the quality of service.

The scope of study was limited to following There is need to conduct survey on the traffic flow of vehicles on the study area to determine the number of vehicles moving in a given interval of time. The major objective involved preparation of replica of proposed Intelligent Transportation System along with an algorithm suitable for the same framework that could be easily implemented on station area and could be replicated on other Streets of Bombay naka, Nashik city.

## 1.3. Methodology

The study will follows following steps.

1. The first step is to study and identification of study area location.
2. Various literature research paper, book, thesis report, related to study are referred.
3. Study area profile give existing situation of Bombay naka w.r.t study corridor.
4. Portion of road is selected to suggest U-loop traffic design system.



## Literature Review

- [1] The 5th International Conference of Euro Asia Civil Engineering Forum (EACEF-5) Traffic performance analysis of u-turn and fly over u-turn scenario; a case study at Soekarno Hatta Road, Palembang, Indonesia Rhapyalyani H. Dellaa\*, Hanafiaha , Joni Arliansyaha , Riga Artiansyaha  
Literally, U-turn is turning round facilities for manuevers of vehicle performing which is implanted by U shaped driving that aims to travel to the opposite lane (Rohani, 2010). In Indonesia, median opening which can be used as a U-turn, the regulations about road and highway facilities in Indonesia issued by Public Works Departement, U-turn facilities regulations issues only find in: x Regulation of Median Opening Planning (Tata Cara Perencanaan Pemisah), No. 014/T/BNTK/1990 x Specification of Road Median Opening (Spesifikasi Bukaan Pemisah Jalur), SKSNIS-04-1990-F x U-turn Planning Module (Pedoman Perencanaan Putaran Balik (U-turn)), No.06/BM/2005 The procedures of designing a U-turn from Regulation of Median Opening Planning
- [2] TU Chowdhury, Shahriar Mohammad Raihan, Abrar Fahim, MA Afrahim Bhuiyan International Conference on, Civil Engineering (ACEE-16), 61-65, 2016

These Intersection is a composite region of a road section where vehicles can resolve to divergent directions. Traffic flow at any intersection of an urban road has always been an entangled nonlinear process.

[3] Research On Unsignalized Intersection With Left And Right U-turn

NEERAJ AGARWAL

The objective of this study is to determine the safety and operational effect of U-turns at unsignalized median openings. This paper addresses research results on access management strategies that increase U-turn volumes at unsignalized median openings that can be used safely and efficiently.

[4] Performance Evaluation of Median U-Turn Intersection for Alleviating Traffic Congestion: An Agent-Based Simulation Study Md Mamunur Rahman, Yuan Zhou, Jamie Rogers Department of Industrial, Manufacturing and Systems Engineering The University of Texas at Arlington TX 76019, USA

In this article, we studied the performance of Median U-Turn (MUT) intersection, a nonconventional low-cost design, as an alternative to the traditional four-way intersection. A high-fidelity simulation model was developed using the Agent-Based Modeling (ABM) approach to mimic the traffic flow of one of the busiest intersections in Dhaka city

[5] Can U-loop bridges be the low-cost solution for jam free intersections along national highways of Bangladesh? M.N. Murshed, M. Hadiuzzaman, T.R. Hossain & B. Ahmed Bangladesh University of Engineering and Technology, Dhaka 1000, Bangladesh

The focus of this study was to evaluate U-loops or U-turn bridges as a potential cost-effective and less space-restrained solution to this problem. The outcome of this research is quite

impressive and promising. Implementation of the proposed U-loops showed significant improvement in traffic operating conditions- an 86.9 % increase in average speed, 62% decrease in average delay per vehicle and 73% decrease in total stopped delay.

### Conclusion

After a detailed study of Nashik city it is found that for sustainable development of city, Nashik needs integrated transportation management plan. With the aim of promoting sustainable transport in Nashik, it is necessary for the transportation point of view to regulate the heavy traffic smoothly by the way to facilitate compact, pedestrian friendly development along the city's planned hence we have design U-Loop traffic design to improve transportation and to minimize accidents. Nashik has a good potential to develop as a smart city.



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## FUTURE AND USABILITY OF ELECTRIC BIKE

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Vipul Girase<sup>5</sup>, Pravin Gopal<sup>6</sup>**

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### ABSTRACT

*The primary objective of this project is to analyse and find the flaws in the electric motorcycle market in India and to provide feasible solutions to it by understanding the customers perspective. India is a growing automotive market and it is now moving towards the EV market, but still people are afraid of buying electric motorcycles due to various reasons. This report is to provide detailed analysis of the market of electric motorcycles and to present the customer's side about what they expect from the electric Vehicles. The main aim of the study is to explore the requirements at the customers end for the startups to provide optimum required specifications of the vehicles to achieve customer satisfaction which will eventually result in enhancement and expansion of the EV market in India. This can be achieved by the combined efforts of the government and private sector.*

**Keywords:** electric motorcycle, EV Market

### Introduction

The world is going electric and there is just so much talk about electric that if you want to do a start-up right now.

The concept of electric scooters still makes sense as an electric vehicle for commuting seems like a great idea, low running cost and the scooter itself is quite a practical vehicle. But in India, the problem is completely different, acquisition cost is much more important than running costs, at least in the case of commuter 2-wheelers.

If you are buying a motorcycle to travel extensively, you don't want to have range anxiety, and if you are touring then an electric motorcycle just doesn't fulfil your needs.

But the problem is bigger which EV start-ups fail to understand. They just go on with the techy features to offer and resulting in the higher price of the vehicles which leads to customer hesitation. All the EV startups are just making the feature list longer and not focusing on the product specifications that are actually the requirements of the customers.

In India people just want reliability of the product and service on offer for the price. No one wants to think about the charging and range of the vehicle while commuting. Startups and government should change their approach towards the EV market and should focus on creating a proper infrastructure for the EV

market for changing and service. In this report we have researched and observed some various aspects of the EV market which could be better.

### Literature Review

**[1]In 1994 Morchin, William C.** The usual battery powered electric bicycle has a conventional bicycle-frame, pedals, cranks, chain and freewheel assembly. Electric propulsion replaces or supplements muscle power. An electric motor, gear reducer, battery and power controls were added. Average travel William C. Morchin, President Electric Bicycle Company speed compared to pedaled bicycles can be increased the order of 8 to 10 km/h (5 mph). Regenerative braking which in automobiles would capture the potential energy of descending slopes is not required. Bicyclist rarely uses brakes while coasting down paved hills. E-bikes powered with today's nickel-metal hydride batteries give a 100-km range between recharges and have a potential of 300 km when polymer batteries become available. The electric bicycle normally will not require registration, license or operator qualification. Unlike the gasoline powered bicycle it can be used to travel trails

**[2]In 2002 Lomonova, E. A.** The paper discusses the generic mechanical,

electromechanical, electromagnetic, control design and test approaches leading to the system integration, design solutions and physical implementation of electrically assisted bicycle as a result of the cooperative research work done by the Dutch Company ID Bike and Technical University of Eindhoven.

**[3] In 2016 Dumitrache, Florin, Marius Catalin Carp, and Gheorghe Pana** said that, The electric vehicles industry is continuously evolving. A such electric vehicle is the electric bicycle (e-bike). Electric bicycles, like another electric vehicles, implement a BLDC motor (Brushless Direct Current Motor). This paper presents a way of designing and using an electronic module for an e-Bike. The paper shows how a low power, 8-bit microcontroller can be used to drive such a motor and also manage other useful functions on an e-bike.

### Case Study

**3.1 History of electric motorcycles :** It sounds like a recent product when we talk about the electric motorcycle. But as start researching we see that the concept of electric motorcycle is nearly as old as the IC engine bike. On 19 September 1895, a patent application for an "electrical bicycle" was filed by Ogden Bolton Jr. of Canton Ohio. Also in the same year on November 8 another patent application was filed by Hosea W. Libbey of Boston 12. As look further at stanley cycle show a electric tandem bicycle was exhibited in 1896 in London by a bicycle manufacturer named Humber. In 1911 an electric bike was also introduced with a claimed range of 120km per charge. In 1919 Ransoms, Sims and Jefferies registered an electric bike for road use but it never went past the trial stage .fuel cell/Nickel-cadmium battery hybrid electric motorcycle was made by Karl Kordesh who was working in Union Carbide in 1967. During the same year an Indian motorcycle company made , a prototype electric motorcycle called the Papoose under the guidance of Flyod Clymer. In 2019 an Indian startup named Revolt launched its first two electric vehicles called as RV400 & RV300 the founder of the revolt

brand is Mr. Rahul Sharma. He is also the co founder of Indian smartphone brand micromax.

Timeline	
1895	Earliest known electric motorcycle patent.
1911	Popular Mechanics article introduces an electric motorcycle.
1919	Ransomes, Sims & Jefferies make an electric motorcycle prototype.
1936	Socovel electric motorcycle company founded.
1940	Norwegian motorcycle company "Tempo" produced the Tempo Electro Transportsykkel
1946	Marketeer company founded, based on an electric motorcycle made by Merle Williams.
1967	Karl Kordesch makes an hydrazine fuel cell motorcycle
1974	Mike Corbin's motorcycle Quick Silver sets electric motorcycle speed record of 165.387 mph (266.165 km/h)
1996	First mass-produced electric scooter, Peugeot Scoot'Elec, released
2011	Chip Yates sets Guinness record of fastest electric motorcycle with 316.899 km/h (196.912 mph)
2013	First FIM eRoad Racing World Cup

**3.2 Current market of electric vehicles :** Electric two wheeler market is not that big in India, but still there are more than twenty brands in

the current market. If we look at the statistics, nearly 152 thousand units of electric motorcycles and scooters were sold in the country in 2019, with a 20.6% annual growth rate from 2014. A total of 6,059 units of electric two-wheelers were sold in February 2021 against 2,243 units sold during the same month last year.

There are many government initiatives being taken to increase the sales of electric motorcycles. As the fuel prices and price of IC engine bikes is also increasing, people are moving towards the electric bike increasing the growth rate of EVs.

Along with the present brands there are many new brands coming to the two wheeler electric mobility segment.

**In 2020,** Ola Electric Mobility, a division of Ola Cabs, planned to construct world's largest electric scooter factory near Bangalore, Karnataka, India, 371 The company aims to produce 10 million vehicles annually.

The sales rate of the present brands have increased as compared to last year's sales number. Hero electric is the leading segment with 2201 vehicles sold in Feb 21 as compared to the 614 units in Feb 20. There is also growth in others brands sales report comparing the unit sales in Feb 20 and Feb 21.

**In 2020**, Ola Electric Mobility, a division of Ola Cabs, planned to construct world's largest electric scooter factory near Bangalore, Karnataka, India, 371 The company aims to produce 10 million vehicles annually.

**In 2020**, Juan Ayala, an urban planning design professor at Rutgers University, invented smartphone app based rentable e-scooter systems.

**In 2021**, VinFast of VinGroup from Vietnam introduced 2 new models: VinFast Theon and VinFast

Feliz

However the Lockdown due to the Covid-19 pandemic affected a lot in the production schedule of electric bikes. Recent surge in the number of cases in China in June has led to uncertainty in terms of resuming the manufacturing operations. China is the biggest manufacturer of lithium ion batteries and this pandemic situation hindered the production of the EV components primarily batteries coupled with a just-in-time production approach is likely to impact the OEM profitability.

But Indian electric two wheeler sector was not that impacted as the demand in indian two wheeler market for electric motorcycles is not that big currently.

**In June 19, 2021**, The Central Government has decided to increase the subsidy to electric two-wheelers by revising the existing FAME-2 scheme to boost the electric vehicle segment in the country. A notification to this effect was issued by the Heavy Industries Department on Friday last week. Accordingly, in order to increase the use of electric vehicles, the existing FAME-2 scheme has been amended to increase the subsidy given to vehicles. The subsidy for electric two-wheelers has been increased to Rs 15,000 per KWh.

**3.3 Future Of Electric Bikes:** Pune, India, April 06, 2021 (GLOBE NEWSWIRE) -- According to the report, Electric Bike Market size is projected to reach USD 10.90 Billion value by 2027, exhibiting a CAGR of 8.4%.

The Electric Bike Industry was valued at USD 10.05 billion in 2019. Geographically, in 2019, Asia Pacific held USD 8.47 billion in terms of revenue. The region is set to dominate throughout the forthcoming years on account of the major contribution of China.

The electric bikes market in India is estimated to reach a value of INR 17.43 Bn by FY 2024, from INR 2.92 Bn in FY 2019, expanding at a compound annual growth rate (CAGR) of -42.95%, during the FY 2020-FY 2024 period. Electric bikes have already set a prominent footprint in the states of Uttar Pradesh, West Bengal, Gujarat, Tamil Nadu and Maharashtra. With further development in charging infrastructures, the adoption of electric bikes is likely to increase in other parts of the country as well.

In FY 2020, India electric two-wheeler market stood around 152 thousand units in volume terms. The Government of India is continuously emphasising on increasing the sales of clean energy vehicles in the country. According to WHO, air pollution is becoming one of the leading causes of death in developing countries with deteriorating air quality. As a result of which, the county's government is offering subsidies on the purchase of electric two wheeler by introducing

No	Electric 2Wheeler	Feb-21	Feb-20	Diff	Growth %	Share % Feb 21
1	Hero Electric	2,201	614	1,587	258.47	36.33
2	Okinawa	1,059	664	395	59.49	17.48
3	Ampere	800	286	514	179.72	13.20
4	Ather Energy	624	369	255	69.11	10.30
5	PureEV	404	0	404	-	6.67
6	Benling	254	5	249	4980.00	4.19
7	TVS	208	0	208	-	3.43
8	Jitendra New EV	124	5	119	2380.00	2.05
9	Bajaj	111	25	86	344.00	1.83
10	MEW Electricals	80	0	80	-	1.32
11	Revolt	70	155	-85	-54.84	1.16
12	Goreen E-mobility	45	2	43	2150.00	0.74
13	Ira Edutech	11	3	8	266.67	0.18
14	M2GO Electric	6	0	6	-	0.10
15	NDS Eco Motors	5	51	-46	-90.20	0.08
16	Odysse Electric	5	0	5	-	0.08
17	Supereco Auto	4	0	4	-	0.07
18	Avan Motors	3	22	-19	-86.36	0.05
19	SBTEK E Moto	2	0	2	-	0.03
20	Others	43	42	1	2.38	0.71
-	<b>Total</b>	6,059	2,243	3,816	170.13	100.00



schemes like Fame-1 and Fame-2. Furthermore, low speed electric two-wheelers does not require any registration from transport authority of the country, which is anticipated to positively influence the growth in the India electric two-wheeler market during the forecast period.

**3.3.1 Market Insight :** Electric two wheelers are poised to be the game-changer for the two-wheelers industry. Although electric bikes comprised a minimal share (~0.6%) of the total two-wheelers sales in India in FY 2019, its sales with respect to the previous year have increased by about 129. This growth can be attributed to the government's initiatives towards the electrification of bikes. Other factors that have influenced the adoption of electric bikes are rising concern over air pollution and the lower ownership and maintenance costs of electric bikes. The cost of running electric bikes is about INR 10 for 70 Km, whereas the same distance can be covered by a conventional counterpart at a minimum cost of INR 102.

**3.3.2 Government Initiatives :** In February 2018, the government's policy think tank, Niti Aayog proposed and mandated the electrification of all two wheelers with a displacement capacity of below 150 cc by March 2025. With the policy mandate, the automobile industry is likely to experience a rapid transition towards electric mobility. Such initiatives were taken to curb pollution and reduce the country's Import bills by INR-1200 Bn by 2025: The Department of Heavy Industry in association with Society of Indian Automobile Manufacturers implemented the schemes of FAME and FAME II. Under FAME and FAME II, the government outlined a budget of INR 107.95 Bn, directed towards the faster growth of electric vehicles.

**3.3.3 Competition Analysis :** The industry is dominated by new entrants in the market, such as Electrotherm (India) Limited, Hero Electric Vehicles Private Limited, Ampere Vehicles Private Limited and NDS Eco Motors Private Limited. Other market participants include Ather Energy Private Limited, Avon Cycles Limited, Lohia Auto Private Limited, Okinawa Autotech Private Limited, Tork Motors Private Limited

and Tunwal E-Bike India Private Limited. The market is currently Hefty weight.

Almost anyone who has ridden an e-bike will agree that a lot of them are heavier than standard bikes. Lead-acid battery-powered bikes often have this attribute, which takes a toll on speed and the bike's ability to conquer steeper roads and terrains. If the electric bike does not have speedboosting capabilities, then this can be a real problem. This is certainly another major problem that manufacturers are doing everything in their power to solve. The introduction of lightweight lithiumion batteries was one of the first steps companies made. Lighter materials that are also more durable are slowly being incorporated into the body of most e-bikes. dominated by niche players as they have already set up their operations with modern infrastructure, advanced technologies and in-house charging facilities. On the other hand, the well-established manufacturers of conventional two wheelers are yet to expand their footprint in this market. The entry of these established players is anticipated to create fierce competition within the market.

It is generally expected that a massive boost to research & development in the EVS sector will happen as more and more conventional car manufacturers work overtime to improvise their EV technology. The battery range issues needed for faster charging batteries as well as long-distance charging concerns need to be addressed fast with practical options.

Most R&D efforts in the automobile sector are therefore expected to focus on improving battery performance and reducing battery costs to make EVS more affordable. The Electric bikes space is also likely to witness greater churning and growth.

**3.3.4 People's Opinion About Electric motorcycles :**

To find the Indian customer's opinion about the electric vehicles we have researched the vehicle reviews to find out the Pros & Cons of the product, and to understand the customer's perspective about the requirements of the electric motorcycle.

To get the overall views of the customer opinion we choose some big electric motorcycle brands which sell their electric motorcycles in Indian market.

**[1] Revolt RV400**

The Revolt Motors RV 400 is one of the 2 different products from Revolt Motors on sale in India. There is only one version on sale and comes with a sticker price of Rs 103999. The Revolt Motors RV 400 generates a max power of NA along with a peak torque of 170 Nm and the engine is mated to a Automatic speed gearbox. Some of the main rivals include the White Carbon Motors GT5 and Revolt Motors RV 300.

### Revolt Motors RV 400 Specifications.

#### Fuel Type

Electric

#### Range

150 Km

#### Charging Time

### Revolt RV400 User Reviews

**4.1 / 5** ★

775 reviews

Mileage	4.1/5
Performance	4.1/5
Maintenance Cost	4.1/5
+ 2 more	

Preferred For : Daily Commute

60% of users have given a rating of 4.5 and above

0-75% in 3 Hours And 0-100% in 4.5 Hours

### [2] Hero electric flash

The Hero Electric Flash is one of the 5 different products from Hero Electric on sale in India. There is only one version on sale and comes with a sticker price of Rs 52990. The Hero Electric Flash generates a max power of NA and the engine is mated to a Automatic speed gearbox.

Some of the main rivals include the Hero Electric Dash and Avon E Star.

### Hero Electric Flash Specifications

#### Fuel Type

Electric

#### Range

50 km

#### Charging Time

8-10 hours

### Hero Electric Flash User Reviews

**3.4 / 5** ★

85 reviews

Mileage	3.5/5
Performance	3.2/5
Maintenance Cost	3.7/5
+ 2 more	

Preferred For : Daily Commute

34% of users have given a rating of 4.5 and above

### [3] Bajaj Chetak

The Bajaj Chetak is powered by 4080 W BLDC Motor. The Bajaj Chetak takes 5 Hours to get fully charged its 48 V, 60.3 Ah battery and has a claimed range of 85 km/charge . The Price of Bajaj Chetak starts at Rs 1 Lakh and goes up to Rs 1.15 Lakh (Ex-showroom, {city}). It is available in two variants, Urbane and Premium.

### Bajaj Chetak Specifications

#### Fuel Type.

Electric

#### Range

85-95 Km

#### Charging Time

5 hrs

### Bajaj Chetak User Reviews

**4.1 / 5** ★

241 reviews

Performance	4.1/5
Mileage	4.0/5
Comfort	4.2/5
+ 2 more	

Preferred For : Daily Commute

55% of users have given a rating of 4.5 and above

### [4] TVS iQube

The TVS iQube Electric is one of the 14 different products from TVS on sale in India. There is only one version on sale and comes with a sticker price of Rs 108012. The TVS iQube Electric generates a max power of NA along with a peak torque of 140 Nm and the engine is mated to a Automatic speed gearbox.

**TVS iQube specifications****Fuel Type**

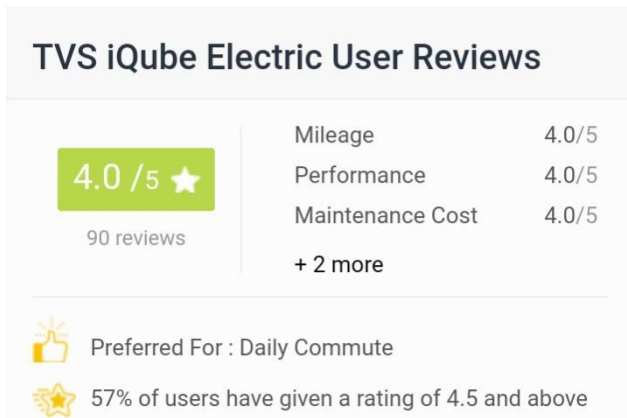
Electric

**Range**

75 km/charge

**Charging Time**

6 hours

**• Articles from ETAuto.in**

It is generally expected that a massive boost to research & development in the EVS sector will happen as more and more conventional car manufacturers work overtime to improvise their EV technology. The battery range issues needed for faster charging batteries as well as longdistance charging concerns need to be addressed fast with practical options. Jan, 08 2020 According to a report by Persistence Market Research, the global electric bikes market is projected to register a CAGR of 4.7% during the 2017-2022 period. Here again, China leads the globe with

the largest consumption of electric bikes. In Europe as well government subsidies and favorable policy measures are ushering in a highly impressive growth in e-bikes. For example, France registered a 90 per cent plus growth in e-bike sales in recent years, thanks to a government subsidy on its purchase.

The two-wheelers are picking up with a new array of models, evincing keen interest from a cross-section of customers, and a new radiant spike of electric cycles evoke customers interest in times of this pandemic This, in themselves, has pushed the electric vehicle revolution by at least half a decade.

So, driving an electric vehicle is still a challenge, especially going inter-city with

virtually no charging support and almost nil awareness about these new age vehicles. The experiential drive faces huge practical hurdles and might not be the death knell for conventional fuels and not persuade people to shun them altogether.

• **Problems to be overcome :** There are several reasons or we can say problems in the development of the EV market in India. Some are from the company side and some are from the government side. Below mentioned are some of them.

[1] In India the biggest problem occurring to the EV market expansion is the charging infrastructure, more than 50% of the people who want to buy an electric motorcycle are not buying it just because of the poor charging infrastructure.

[2] Low range of the electric motorcycle which are currently present in the Indian two wheeler market, people get limited because of the range and on the top of that there is barely any charging station on the highway.

[3] High charging time, people are used to instant refuelling on the petrol pumps and on the other hand EVs take time to charge actually a lot of time, and this leads to the resistance to prefer an electric motorcycle.

[4] In current market EVs are priced too high, their price is almost double of their ICE competitors, that's why customers hesitate to put that much money in the EVs even though they can get its ICE alternative at half of the price.

[5] EV range gets affected by the weather conditions, in winter and monsoon season its ranges very low, which increases the problem of the customers.

[6] Battery replacement charges are too high, these charges are almost half the price of the vehicle. And on an average the battery needs to be replaced after 4-5 years.

[7] People are not that aware about EVs, so they hesitate to shift to somewhat different kind of vehicle.

These are the most important problems the EV market needs to overcome to be successful. These are the major causes due to which EV market is not growing in India.

• **Possible solutions for the Above mentioned problems :** Following are the solutions provided for the problems which are

being the obstacles in the path of EV market development. Some of these are the required combined efforts of the government sector as well as the private or EV sector itself.

[1] For the problem of the charging infrastructure, the government should apply the compulsion of adding at least 1 fast charging point at every fuel pump, and should increase the number of charging points on every fuel pump according to the increase in EV sales.

[2] EV manufacturers should focus on the range issue, they should provide bigger batteries and cut off some rarely used features like fully coloured instrument cluster, traction control system as EVs speed is not that much it doesn't need these kind of features.

[3] R&D sector of EV market should work on the charging speed of the vehicles, they should provide some high power charging solution like today's smartphones.

[4] The high price is also the major issue, EV manufacturers should focus on this point and reduce the price of the vehicle, they can offer competitive price that can increase the EV market.

[5] As the battery gets affected by the low or high temperatures some special coating should

be provided to minimise the effect of low temperature, along with some ventilation to tackle the high temperature problem.

[6] The major contributor to the high price of the EV is the battery, there is a need to develop some new kind of cheap and long lasting batteries, to overcome the battery price issue.

[7] Some awareness camps, advertisements, workshops, etc needs to be done to make people aware of electric motorcycles.

### Conclusion

India is World's second largest automotive market, there are a lot of brands present in Indian market. Being a huge vehicle market there is also a pollution issue, and many other people's requirements that needs to be fulfilled. The Market needs to move towards the eco-friendly, economic and convenient market which is the electric motorcycle market and is moving towards it too, but at a very slow rate. This is done by the analysis of the market. This report shows some major issues which are slowing down the growth rate of EVs in India and gives some on the field solutions for a better EV future.

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**IOT BASED ELECTRICAL POLE SAFETY SYSTEM****Rahul Devendra Mashalkar<sup>1</sup>, Akshay Manoj Arsule<sup>2</sup>, Deep Manoj Chaudhari<sup>3</sup>, Swati Gade<sup>4</sup>**

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**ABSTRACT**

*Leakage current through the supporting structure of overhead transmission and distribution system causes accidents. Humans or animals passing close to the pole structure may be shocked, and if the leakage current is significant, it may result in death. Manually detecting the site of a fault has limitations in terms of accuracy, time, and expense. In this paper, a unique approach for automatically detecting the fault location is proposed. The system is equipped with the internet of things (IoT) technology, allowing it to instantly notify the fault and its location to the relevant authorities. It consists of a remote telemetry system in which IoT transceivers are used to detect electrical line breakage. The location of the line broken will be sent to the authorities using IoT technology. To enhance the safety of civilians and animals the system is password protected which is known to only the lineman of that area. The system is made fully automated by using switching relays and microcontrollers.*

**Keywords:** IoT, Live monitoring, Fault detection, Fault location, Linemen safety.

**Introduction**

Every year thousands of Indians are getting electrocuted in freak accidents on streets dotted with damaged power cables. In 2015 alone, 9,986 electrocution deaths were recorded across the country with Madhya Pradesh, Maharashtra and Rajasthan each witnessing over 1,000 casualties, according to the latest data available with the National Crime Records. Hence to solve this problem authors have introduced this system [1].

Electricity is one of the basic needs in every field. Electrical power system is non-linear and has a complex system which is very difficult to detect and monitor regarding electrical line breakage throughout the globe. Day by day the ratio of people who die due to Electrical accidents is increasing and that major reason is by unknowingly stepping on a broken electric line which is caused by natural calamities, accidents, etc.

Idea of the proposed system in module1 is that every pole is designed in such a way that it is connected to each other through wireless communication (IoT modules). Consider we are having one pole. If the pole is shorted with line the pole also carrying high voltage hence it is too dangers for public hence this system detects this [2], it will alert the public with a voice announcement so that anyone can get

information that some danger aroused. Once it acknowledges the breakage of the line occurred [3], it sends a message to the substation and also disconnects the power line automatically to ensure that no harm occurs to anyone [4]. Critical electrical accidents to line men are on the rise during electric line repair, due to lack of communication and coordination between the maintenance staff and electric substation staff [5]. The idea of the system in the module provides a solution that ensures the safety of maintenance staff, i.e., lineman lively monitor the status of line. Hence in this way this system not only reduces the time of repair but also informs the public about the fault in the local language [6].

**System Description**

Fig. 1 shows the block diagram of the IOT based electrical pole safety system. It consists of voltage sensors, current sensor atmega328 microcontroller, IOT node MCU, LCD display and voice module etc.

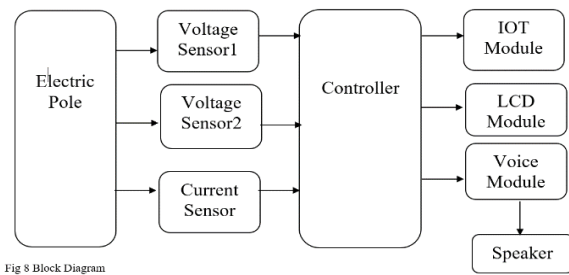


Fig 8 Block Diagram

**Fig. 1 Block diagram****Voltage sensor 1**

This sensor detects the voltage in the metal pole if there is any at the fault condition. And if the voltage is detected it sends a signal to the microcontroller.

**Voltage Sensor2**

This sensor is used to monitor voltage across the line. At the fault condition the sensor then sends the signal to the microcontroller.

**Current Sensor**

Current transformer is used to measure the line current. From Voltage sensor 2 and current sensor power transmitted by line can be calculated.

**Microcontroller**

The microcontroller atmega328 is the heart of the project. It controls the complete process. The analog signals sent by all the sensors converts into digital form. Actual values and the preset values are compared and the signal is given accordingly to the output devices.

**LCD Display**

The LCD display is one of the output device and is used to display the status of electric pole and all the parameters being observed by the sensors. It is located in the control room of the substation of that area.

**Voice module**

The voice module is also a output device and is used to announce the hazard at the fault condition. The message recorded in the voice module is in the local language as per the location of the pole. So, the civilians can understand the warning and be alert. This voice module is located at the pole.

**IoT module**

The IOT module is also one of the output devices and is used to send the message of pole fault with location to the control room of that area as well as to the line man of that pole.

**Working of System**

In this project the main part and heart of this circuit is atmega328 microcontroller which is used for controlling all the process and working of the system. This project can be divided into three parts as follows:

**A. Sensing circuit:**

It is the input circuit of the system. It senses the line parameter and gives input to the controller. Mainly three inputs are used 1) line voltage sensor 2) pole voltage sensor and 3) line current sensor. The line and pole voltage sensor are ideal however, they are placed at different location to sense line voltage and breakdown of the insulation of the pole respectively. Pole voltage sensor is connected to metal pole. In normal healthy condition the pole voltage is always zero whereas in case of pole insulation damage it shows some value which is harmful for the living things.

Current transformer is also the part of sensing circuit which is used to measure the line current of that line. The output of these sensor is analog which is converted into digital by ADC converter.

**B. Controlling circuit:**

Controlling circuit is the heart of the system and it consists of atmega328 microcontroller which is an AVR microcontroller based on RISC architecture. For programming is done using Arduino ide and the C language. The program is developed for several functions like voltage measurement, current measurement, calculating the power and detecting the status of pole and according to all these parameters, decide the output and then send it to the IOT module for remote monitoring.

**C. Indicating circuit:**

This circuit consists of all output devices such as LCD display, Voice module, and IoT module. 16x2 LCD display is used to show the status of the system and also power drawn through the pole it is located in the control room. Second output of the system is IoT module node MCU which is used to send the

status of pole to be monitored and in case of any abnormal condition, giving red color notification of pole to the lineman and authorities of that area. This will help the lineman to find the faulty pole in the area and within short time necessary action can be taken.

Another output device is the voice module which is used to notify and announce the emergency notice to the surrounding people of faulty poles to stay away from that pole. This information is recorded in the local language so that people can understand and be alert.

The step by step working of the project is as follows:

Step 1: The voltage sensors and current sensor senses the actual values of the quantity to be measured.

Step 2: The ADC converts these signals into digital signals.

Step 3: The actual parameters are compared with the preset value.

Step 4: If the values are not equal to the preset values, then a signal is sent to output devices for necessary action

Step 5: The voice module, announces this hazard in the local language.

Step 6: The IoT module sends a signal to the Wi-Fi module.

Step 7: The Wi-Fi module then sends the signal to the line man and authorities to report the fault.

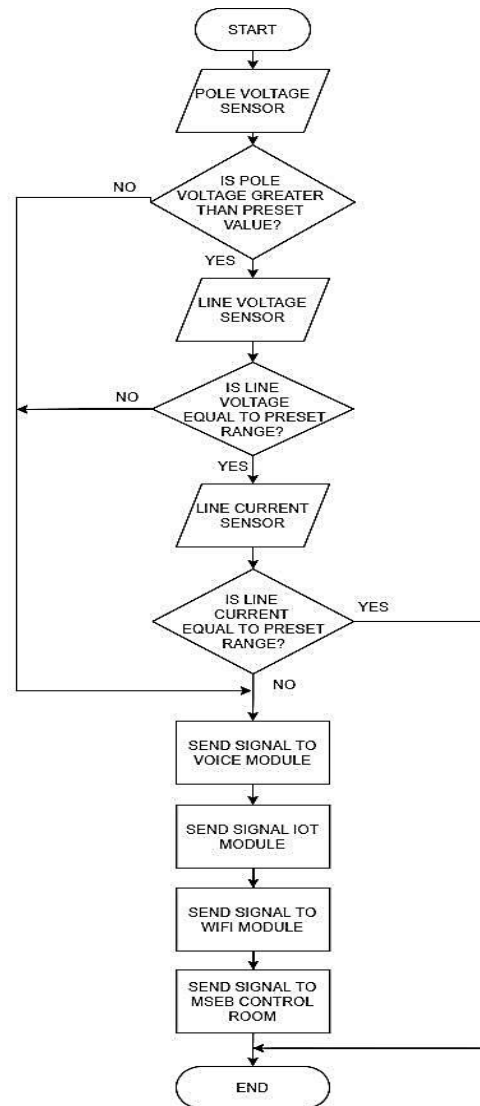


Fig 2 Flow chart of working of system

**Features of the System**

**Advantages**

- ✓ Allows faster fault detection. Live monitoring of line parameters.
- ✓ Smart fault detection.
- ✓ Voice module can announce the hazard in the local language to ensure the safety of the general public around the pole.
- ✓ Instantly notifies the electricity board hence allowing them to take action immediately.
- ✓ Improves the safety of the overall transmission system.

**Limitations**

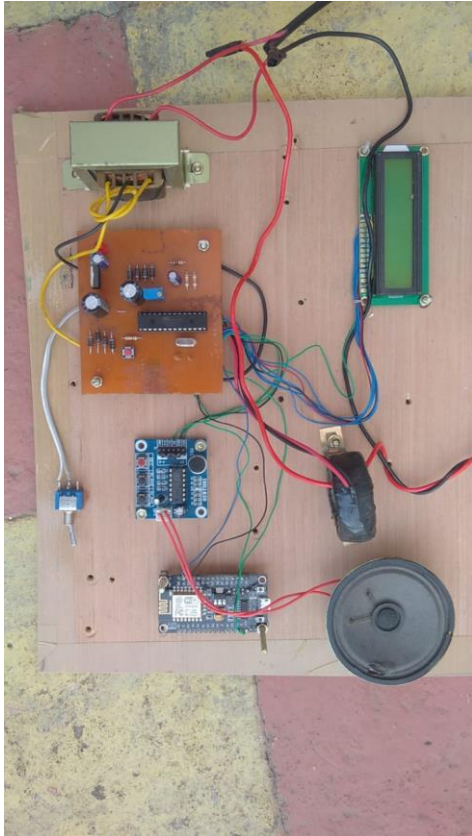
- ✓ Additional cost in the erection of transmission network.

**Features**

- ✓ Live monitoring of line parameters.

- ✓ Smart fault detection.
- ✓ Voice module can announce the hazard in local language to ensure the safety of the general public around the pole.
- ✓ Instant notification to the electricity board for faster fault clearing time.

### Images of the pole safety system



**Fig 3 Circuit of the system**



**Fig 4 Circuit of the system**

### Future Scope

This helps to protect linemen from getting shock due to miscommunication between lineman and the substation authority that monitors the power control of the electrical lines. The system also includes a password protected door lock technique which helps to safeguard the password based electrical line disconnection system from unauthorized people as well as the environmental hazards. As a future work, the system can be implemented such that we can send the location of the electrical broken line to an application instead of the web browser, for an easy accessing and recording regarding electrical line issues, to both authorities and lineman. Also, the authentication can be done using biometric method i.e., by using fingerprint sensor.

### Conclusion

The automatic detection of broken electrical lines of the electrical pole and also automatic power supply disconnection is very useful to avoid electrical shock hazards. Also, it is very easy to detect the location where the electrical lines are broken through a local network using Wi-Fi technology and also the wireless communication technology issued for the detection of broken electrical lines that can be used over years and years without any maintenance. If any malfunction occurs in the system and if automatic power supply disconnection is failed then we can use a password based electrical line disconnection system which is localized i.e., only authorized lineman who knows the password can disconnect the electrical line locally for certain number of poles without affecting the main station power supply.



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**AUTONOMOUS WASTE GARBAGE MANAGEMENT SYSTEM FOR SMART CITIES****Rohit Hitendra Sonawane<sup>1</sup>, Chetan Ravindra Milmile<sup>2</sup>, Divyani Yuvraj More<sup>3</sup>, Swati Gade<sup>4</sup>**

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**ABSTRACT**

*Improper garbage collection and disposal are creating the problem of ever-growing trash stocks. Many metro cities are facing major issue of garbage collection and disposal and required lots of manpower. This paper presents a system helps to collect garbage in metro cities to solve this problem. An autonomous trash collector vehicle which collects trash lying on ground in a trash-storage unit attached to it can be a feasible solution to the problem. In this system trash detection done via image processing and deep learning techniques. An ultrasonic sonar sensor on the robot detects object along the path and a camera module sends images of the trash to a controller for classification into trash or not trash. The main advantages of this garbage collection vehicle are low-cost and can detect a wide range of trash with high accuracy. Therefore, it has good environmental as well as economic impact.*

**Keywords:** Garbage robot, Trash detection, Deep Learning, ultrasonic Sensor, smart city.

**Introduction**

In today's era, collection of garbage and its management is the biggest problem due to rapid economic growth, overcrowding, poor urban planning, destructive corruption, and political dysfunction [1]. The present tried and tested strategies of trash collection have been proved ineffective. With the advancement in technology the world is looking IoT at smarter ways for overcoming the garbage assortment problem. People throw away plastic bags or other type of scraps often using instead of dumping them into dustbin. These trashes find their way in drains and from there to river and ocean [2]. Those that get buried in soil prevents trees from growing there naturally. In this paper collection of thrown away trash is of main concern. In the manual method of collection of garbage workers have to spend lots of time with all types of garbage. They live in the risk of health hazards such as breathing problem, skin problem, heart diseases, and metabolic syndrome. A smart wet disposal system can free these people off the burden. People throw away plastic bags or other type of scraps using instead of dumping them into dustbin. These trashes find their way in drains and from there to river and oceans. Those that get buried in soil prevents trees from growing there naturally. Collection of the own away trash is of main concern. People tend to throw wastes outside trash bin when it is full to its capacity.

Some work has been done to identify if a trash bin full or not depending on Stereoscopic camera System and image processing in Open CV [3]. In this a message is sent to trash collecting vehicle as soon as the bin is full to come and empty the trash bin. In the above-mentioned work, the trash bin is stationary and depends on disposal of trash in the bin. A mobile system that removes and collects trash has been worked on where a robot is used to clean the area around a dustbin using combination of Mobile Nets and Single Shot Detectors for fast, efficient deep learning-based object detection. Research has been done on autonomous robot which can collect any object in their path from ground, river and water ways with no flow but those are without the capability to separate trash from non-trash. Robots without trash identification capability can be harmful to wildlife.

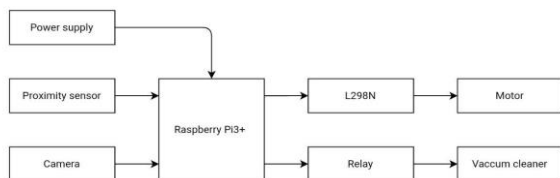
Object detection using image processing and deep learning is a rich field of research. Features can be extracted manually by image processing then a classifier is used to identify objects [4]. 87.69% mean accuracy in garbage detection on GINI dataset with Garb Net network [5]. Google Net is a classification architecture, which was similar to OverFeat model, to detect the target objects such as cigarette butts and leaves from a height of several meters [6]. Keras is used for object detection using python and Open CV [7]. No pre-trained model is used and the model's

created from scratch. The model is created using CNN and fully connected dense layer. In spite of having better performance, RNN is complex and has longer run time. CNN performs better in terms of real time simulation. As the robot needs to be agile, quick detection of trash is needed. Hence CNN is better choice. An autonomous system is built using raspberry pi, Raspberry Pi 3, servo motor, DC motor, proximity sensor and battery.

This paper is organized as follows. Section II describes the proposed system. Working of the garbage management system is explained in section III. Advantages, limitations and future scope is summarized in section IV. Concluding remarks are given in section V.

### System Description

The Fig. 1 shows the block diagram of the proposed garbage management system. It consists of camera, geared motor, proximity sensor, vacuum cleaner and the controller. In this system the main function of camera is to detect the garbage on the ground. Proximity sensor used to detect any physical object nearby without any contact. Vacuum cleaner used in the system to sucks up the detected waste.



**Fig. 1 Block diagram of smart dustbin**

#### ✓ Power supply

Power supply provides the power to controller, motor and vacuum cleaner. As per the requirement of the different components the power at different voltage levels is made available in this. Battery can be used as a source of energy which is charged by solar PV module.

#### ✓ Camera

Camera is the heart of this project. The 8MP Raspberry Pi Official Camera Module v2 in this project camera is also the input of this system when the signal comes from Raspberry pi then the pi camera module has captured the garbage. For actual implementation images

captured by the CCTV camera can be used as a input to the controller.

#### ✓ Proximity sensor: -

This is an input of the system by using this sensor this arm is run when any garbage or object sensing then this arm will stop the motor drive and give the signal to the camera module.

#### ✓ Raspberry pi: -

The whole process is controlled by raspberry pi. Its controls all the components such as gear motor, camera, vacuum cleaner etc. of this project. For this controller python language is used for developing the code for motor, and relay etc. When raspberry pi gives the command to the motor drive then this dustbin arm is moved towards the garbage or object then proximity sensor senses the garbage or wastes a stop motor drive and raspberry pi captured the image with help of the camera module and then comparing the image if the captured image is waste then rely on is executed collect garbage with the help of vacuum pump.

#### ✓ Gear motor drive: -

The project comprises of gear motor and for controlling it motor drive L298N is used. In this system four gear motors are used. At a time two motors are ON and therefore for controlling these motors drive plays very important role. So, this L298N is used to run the two-motor simultaneously.

#### ✓ Relay: -

Relay is used as a switch for vacuum cleaner. It is turned ON when the motor drive gets the signal for collection of the garbage.

#### ✓ Vacuum cleaner: -

In the complete process vacuum pump performs the main role. When the trash is detected, the vacuum pump pulls air in and the air sucks up the detected waste.

### Working of System

The Fig. 2 shows the flow chart of the working of the garbage management system. The complete process is divided into three parts 1) Object detection, 2) Trash identification and 3) Trash collection

### A. Object Detection:

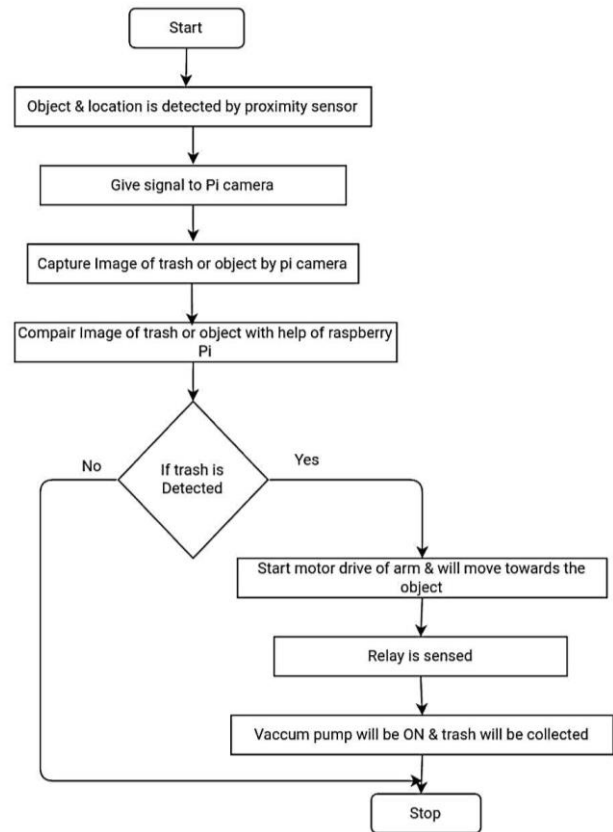
The trash collecting robot is mobile and it continues to run till the mounted sensor detect any object lying ahead of the robot. The sensor has been calibrated to detect object less than 30 cm and after detection the motor stops causing the robot halt and the robot takes pictures with pi-com mounted on the robot. The picture is then sent to the controller and trash detection via deep learning mechanism Starts.

### B. Trash identification:

After detecting object, it is necessary to identify it as a trash or not. At first, the captured images are reshaped into 64x64 pixels, after that, the dot has been split to 10 % for training, 10 % for validation and 20 % for testing. The network consists of one convolution 2D layer and two stacked dense layers. At first, the data is normalized. and fed into the convolution layer having filter numbers of 32, kernel size of (3,3) with ReLU activation function. The output of the first layer is fed into maxpool 2D layer with pool size of (2,2). After that it is fed into the dense layers having 128 and 2 neurons with ReLU and soft max activation respectively. The first layer extracts feature from the given image dataset of size 64x64x3 and the fully connected dense layers provides the output as a sequence of vectors of size 1x1. Batch size of 64 is used and for loss function, categorical cross entropy and for optimization, Adam optimizer with an initial learning rate of 0,01 is used.

### C. Trash Collection:

With deep learning algorithm if the detected object has been recognized as trash the raspberry pi send signal to the motor driver and motor driver starts to operate the motors at first the arm servo causes both arms of the robot to go down and often that the wrist servos rotate to gather the trash and the arm servos cause the arm to go upward and dispose the trash-to-trash container mounted over the robot. On the contrary if the object proves to be non-trash the robot drive around the object and continues to run for search of trash.



The working of the system is further explained considering following cases.

#### Case 1: When trash an object **Fig 2 Flow chart of working**

➤ is detected -

If any kind of trash and object is detected by proximity sensor then give the signal to the camera to capture the image of the trash or object, this captured image is compared with the help of Raspberry pi, if is this trash then our robotic arm moves towards the trash a relay is on a gives signal to a vacuum pump to collect the trash.

➤ Case 2: When non-trash in front of arm-

First of all, non-trash such as stone is detected by this robotic arm by the sensor, a location of the trash found is then given to pi-cam to the captured image and then next comparing the images by the Raspberry pi and give the signal to motor drive to stop the arm. So, this kind of non-trash is not collected.

➤ Case 3: when any person in front of this robotic arm-

If any person in front of this robotic arm is detected then the proximity sensor will give the signal to the pi camera to capture the image and send it to Raspberry pi then comparing the image between trash or any object. If this is not

any kind of trash then give the signal to L295N motor drive to the motors, so robot arm is stopped.

➤ Case 4: When any car in front of robotic arm-

At roads corner there is space for parking slots if any car or bikes are arising in front of this robotic arm what will be happening then after the check by proximity sensor then will capture the image and a compared by the Raspberry pi and give the command to motor drive and then stop the motor.

### Features of the System

Advantages, limitations and features, of the fully smart dustbin is as follows.

#### A. Advantages

- ✓ It is Portable machine.
- ✓ Reduce the risk of disease spread.
- ✓ Fast and accurate cleaning.
- ✓ Improve safety of worker from covid - 19.
- ✓ It is the good method to manage waste.
- ✓ Real time-based cleaning of cities.

#### B. Limitations

- ✓ High cost.
- ✓ Detection of garbage in dark needs high end cameras which increases cost of system

#### C. Features

- ✓ The garbage collection system is fully automatic.
- ✓ It can segregate the garbage Recyclable and Non- Recyclable.
- ✓ It is based on image processing and machine learning which is having high accuracy and efficacy.
- ✓ No manpower required so can be used in hazardous area for garbage collection.

#### D. Images of Smart Dustbin

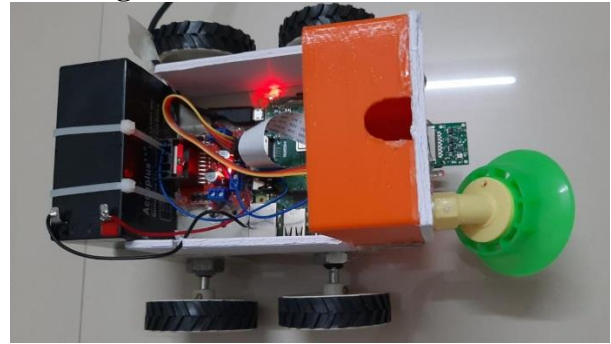


Fig 3 Circuit of smart dustbin

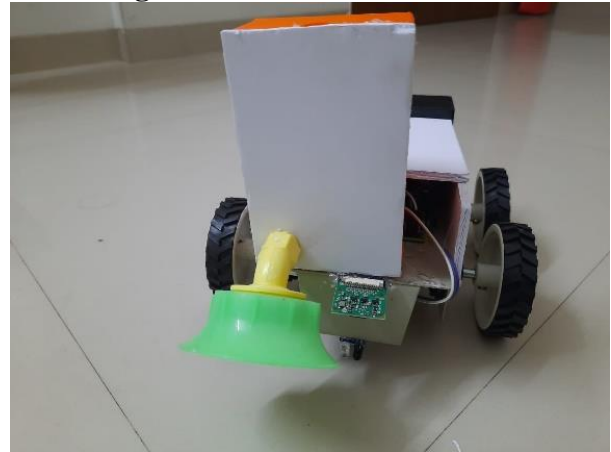


Fig 4 Prototype of smart dustbin

### Conclusion

The purpose is to build a stable system for collecting and depositing trash in the trash container mounted on a robot which runs on four wheels to move and collect trash. A simple and efficient object identifying algorithm from an image is designed with sensor. Our irresponsible behavior throwing trash here and there is creating problem of getting non-disposable materials into soil and water thus polluting them. Authors have tried to solve the problem by collecting thrown away trash and putting them in a place where those will be properly handled.

Hence this project will help in collecting garbage time to time specially now a days when human health and immunity is so much important.

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## A REVIEW ON OPTIMIZATION OF MACHINING PARAMETERS FOR SURFACE ROUGHNESS OF TITANIUM ALLOY (Ti-6Al-4V) FOR TURNING OPERATION BY USING NO<sub>x</sub> COOLANT

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### ABSTRACT

*Titanium Alloy is a highly specific strength material, having excellent mechanical characteristics such as high stiffness, fracture resistance, and hardness at high temperature, so it is applied to various fields such as automotive, aerospace and bio-industry. The productivity and the quality of the machining products are the main important challenges of metal cutting or in production industry during turning processes. Due to which manufacturing industries are competing in the market field. This review article summarize about optimization parameters such as cutting speed, depth of the cut and feed rate in the machining material and carbide tool.*

**Keywords:** Titanium Alloy, Turning Operation, Optimization Parameter, Surface Roughness, NO<sub>x</sub> Coolant

### Introduction

Titanium and its alloy are considered as important engineering materials for industrial applications because of inherent properties like, good strength to weight ratio, superior corrosion resistance and high temperature applicability. Titanium alloys have been widely used in the aerospace and aircraft industry due to their ability to maintain their high strength at elevated temperature, they minimize the aircraft weight and high resistance to corrosion. They are also being used increasingly in chemical process, automotive, biomedical and nuclear industry. Titanium alloys are very difficult to machined and so they have poor machinability.

Machinability of a material is usually determined based on criteria such as tool life, tool wear, cutting force, chip formation, cutting temperature, surface integrity and burr size. Titanium alloys are classified into three main groups as follows: (1) a; (2) near a; (3) ab. Some titanium alloys used in industry Alloys References Ti-64 Chen et al. , Che-Haron and Jawaid , Wang et al. , Nurul- Aminet al. , Sun et al. , Sun and Guo , Thomas et al. Ti- 6242S Ginting and Nouari , Ginting and Nouari , Che-

Haron et al. Ti-6246 Che-Haron Ti-834 Sridhar et al. , Thomas et al. Ti-45-2-2 Mantle and Aspinwall, Mantle and Aspinwall Ti-4.5Al-4.5Mn Zoya and Krishnamurthy Ti-6-6-2 Kitagawa et al. TA-48 Nabhani Ti-6Al-7Nb Cui et al. 2 S. A. Niknam et al. descriptions of titanium alloys and their properties in. In general, machining titanium alloys include milling, turning and drilling operations. However, most of the machining studies for titanium and its alloys have been focused on the turning process.

The surface integrity attributes of titanium alloys work parts are largely affected during machining operation . The main surface integrity concerns appear on ,

(a) topography characteristics such as textures, waviness and surface roughness

(b) mechanical properties affected such as residual stresses and hard-ness, and

(c) metallurgical states such as micro-structure, phase transformation, grain size and shape, inclusions, etc.

An extensive research work reported the surface integrity during machining titanium alloys. Generally low surface quality is resulted in titanium alloys, so post processing methods

such as laser shock peening and ball burnishing are required. In general, minimizing the surface roughness in machining titanium alloy is considered as a topic of current interest, and it has been received huge amount of interests. It has been found that the surface roughness in titanium work parts are widely affected by various phenomenon in machining operations, such as built up edge (BUE) formation, tool shape, geometry and tool wear, temperature, tool coating, feed rate, cutting speed and depth of cut. These effects mainly appear due to thermal and mechanical cycling, microstructural transformations, and mechanical and thermal deformations during machining processes.

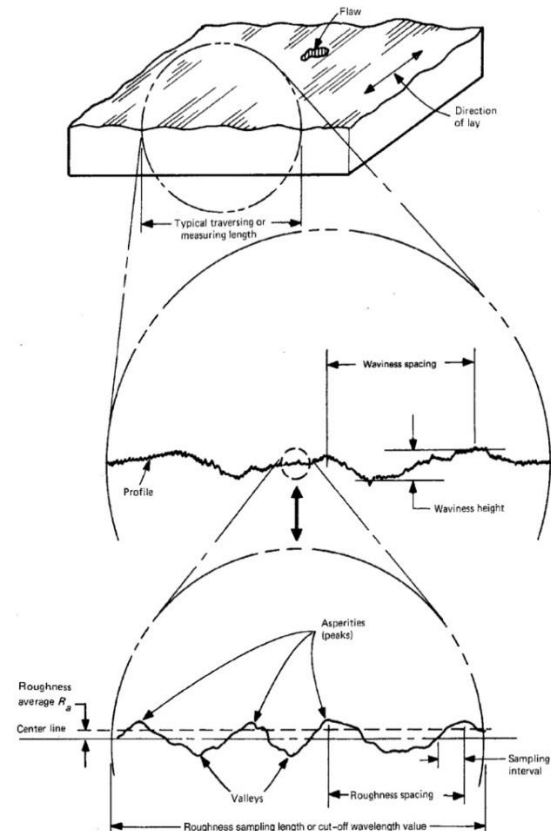
### Surface Roughness

Surface roughness is defined as the shorter frequency of real surface relative to the through. if you looked at the machined parts. You will notice that their surface embody a complex shape made of a series of peaks and through of varying heights, depths and spacing.

### Analysis of Surface Roughness

Surface texture is the repetitive or random deviation from the nominal surface that forms the three-dimensional topography of the surface. Surface texture includes

- (1) roughness (nano and microroughness),
- (2) waviness (macroroughness),
- (3) lay
- (4) flaws.



**Fig.1.1 Pictorial display of surface texture.**

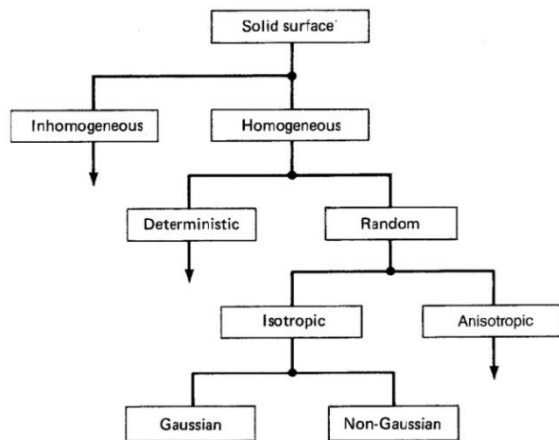
Figure 1.1 is a pictorial display of surface texture with unidirectional lay (Anonymous, 1985).

Nano- and micro roughness are formed by fluctuations in the surface of short wavelengths, character-sized by hills (asperities) (local maxima) and valleys (local minima) of varying amplitudes and spacing's. These are large compared to molecular dimensions. Asperities are referred to as peaks in a profile (two dimensions) and summits in a surface map (three dimensions). Nano- and micro roughness include those features intrinsic to the production process. These are considered to include traverse feed marks and other irregularities within the limits of the roughness sampling length. Waviness is the surface irregularity of longer wavelengths and is referred to as macro roughness.

Waviness may result from such factors as machine or workpiece deflections, vibration, chatter, heat treatment, or warping strains. Waviness includes all irregularities whose spacing is greater than the roughness sampling length and less than the waviness sampling length. Lay is the principal direction of the



predominant surface pattern, ordinarily determined by the production method. Flaws are unintentional, unexpected, and unwanted interruptions in the texture. In addition, the surface may contain gross deviations from nominal shape of very long wavelength, which is known as errors of form. They are not normally considered part of the surface texture. A question often asked is whether various geometrical features should be assessed together or separately. What features are included together depends on the applications. It is generally not possible to measure all features at the same time.

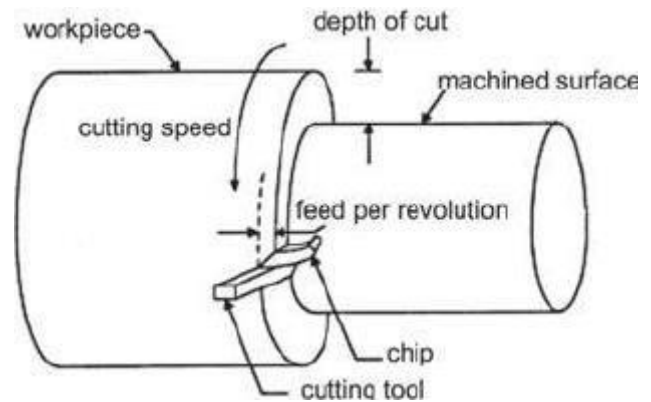


**Fig. 1.2 General typology of surfaces**

A very general typology of a solid surface is seen in Figure 1.2 Surface textures that are deterministic may be studied by relatively simple analytical and empirical methods; their detailed characterization is straightforward. However, the textures of most engineering surfaces are random, either isotropic or anisotropic, and either Gaussian or non-Gaussian. Whether the surface height distribution is isotropic or anisotropic and Gaussian or non-Gaussian depends upon the nature of the processing method. Surfaces that are formed by cumulative processes (such as peening, electropolishing, and lapping), in which the final shape of each region is the cumulative result of a large number of random discrete local events and irrespective of the distribution governing each individual event, will produce a cumulative effect that is governed by the Gaussian form. It is a direct consequence of the central limit theorem of statistical theory.

Single-point processes (such as turning and shaping) and extreme-value processes (such as grinding and milling) generally lead to anisotropic and non-Gaussian.

### Working Principle of Turning Operation



**Fig. 1 Basic Turning Operation.**

### Turning

Turning operation carried out on lathe and which can be manually or CNC operated. Turning is a material removing process in which a cutting tool, typically a non-rotary tool bit, describes a tool path by moving more or less linearly while the work piece rotates. The general process of turning involves rotation of work piece and single-point cutting tool is moved parallel to the axis of rotation. Turning can be done on the external surface as well as the internal surface of work piece. The turning processes requires fixture, lathe considered to be the oldest of machine tools, and can be of different types such as straight turning, taper turning, profiling. In general, simple single point cutting tool is used for machining but sometimes multi-point cutting tools are used. Each group of workpiece materials has an optimum set of tool angles that have been developed through the years.

### Literature Review

**Changliang zhang, et. al. (21 Jan /2000)** studied that If the process could be conducted under an open atmosphere, As shown in the state of the art, it is difficult to process Ti6Al4V by local shielding because of the high sensitivity to oxidation of the material. If the process can be carried out by local system for controlling gas atmosphere are no longer necessary. In addition, the processing time and reduced can be easily reduced.[1]

**Kassu silcha Silcha (2001)** studied that the research design is intended to provide and appropriate Framework for the study of very significant decisions in a research design process is the choice to be made in writing research approach since she's determined how relevant information for a study will be obtained.[2]

**Syed Mohd Fiddly Bin Syed (2005)** studied Taguchi orthogonal method design can be determine accurately by Matrix experiment by using this method the frequency of simulation test can be reduced and the experimental data can be obtained the present variation can be issued by signal to noise (S/N) response ratio in the taguchi method.[3]

**Pierre chevrier (October 2006)** studied that Quality of diamond layer for machining is highly related and process can be simply improved by selecting the right parameters changings parameter such as diamond seeding size, can enhance tool performance it has to be enlarged that these result are highly depends of carbide characteristics.[4]

**Xiaoping Yang et. al. (27 Apr 2007)** studied that Titanium and its alloys are attractive materials due to their unique high strength-weight ratio that is maintained at elevated temperatures and their exceptional corrosion resistance. The major application of titanium has been in the aerospace industry. However, the focus shift of market trends from military to commercial and aerospace to industry has also been reported.[5]

**Rahul Davis et. al. (2007)** studied Design of experiment is the technique used for guiding the choice of the experiment to be performed in an efficient way one of the most important purpose of the design sampling experiment that can productive and cost-effective and provide a sufficient data base in a qualitative sense the reason to be used is the implement valid and efficient experiment that will be produce quantitative results and support sound decision making.[6]

**Alokesh Pramanik (09 Feb 2015)** studied that in this project understanding in machining of titanium alloys with the industry based outputs and finds possible solutions to improve machining efficiency of titanium alloy Ti-6Al-4V. The machining outputs are explained based on different aspects of chip formation

mechanism and practical issues faced by industries during titanium machining. This study also analyzed and linked the methods that effectively improve the machinability of titanium alloys.[7]

**Andresa Baptista, et. al. (14 November 2018)** studied that pvd techniques are in constant evolution. Accompanying the appearance of new technologies that are adopted to process. They also increasing demands of the industry. Optimizing energy consumption of pvd process is an opportunity for improvement. It is in the deposition step that this improvement can be reflected, since it is in this step of process that pvd shows greater consumption.[8]

**RTI International Metals (Jan 2020)** It shows the various properties of titanium alloys and their uses of various process and how to use change their properties when works on various process and see the its alloy composition on [ASTM Grade] and its alloy description. Various Grades are present in titanium alloy composition.[9]

**Mehadi Mogyedian, et. al. (14 September 2020)** Studied that signal to noise ratio is a reduction of the noise based on different definition of quality characteristics. there are 3 type of quality characteristics for SM calculation namely, the smaller the better the nominal the best and the larger the better.[10]

**Van Canh Nguyen Thuy Duong Nguyen(2021)** studied that

In this research paper carried out a study research to apply a Multiple Criteria Decision Making (MCDM) approach for enhancing University accreditation process. The results showed that MCDM is suitable to solve multi response optimization problems. Taguchi-based techniques have been often used to solve MCDM problems with high accuracy.[11]

### Conclusion

From literature review lot of research mainly has been done on design of experiment. From literature survey it is observed that we need to design experiment based on Taguchi Method. Taguchi Method can give optimal results at low Number of trails. From literature survey we decided to conduct optimization of machining parameters upto 2 level. The surface roughness decreases with increased cutting

speed and nose radius, whereas the surface roughness increases with increased feed rate and depth of cut. The hardness is more at the surface level in dry lubrication due to large amount of heat generated. Most of the

investigations carried out on the machinability of titanium alloys were based on different cutting conditions, which make it difficult to compare results from different authors.

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## A CRITICAL ANALYSIS OF COMPENSATION MANAGEMENT'S IMPACT ON EMPLOYEE RETENTION OF LARGE SCALE INDUSTRIES IN NASIK

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### ABSTRACT

*The author of this research paper intends to investigate the impact of compensation systems on employee retention. The study focused on respondents' perceptions of the compensation system, as well as staff retention, as a result of the remuneration framework's impact on employee retention. Analysts utilized polls as technique for information assortment and examination instrument. An arbitrary examining strategy has been utilized to discover the populace test size of 70 employees of the referred to foundations. Measurable proof uncovered that there is a huge positive relationship demonstrating that Compensation framework impacts employee's fascination and maintenance. The findings revealed that there are positive and notable links between the remuneration structure and employee retention.. In this investigation, a few suggestions were additionally attracted organizations' administrators and specialists proposed regions of additional explores.*

**Keywords:** Compensation System, Employee Satisfaction, Employee Retention

### Introduction

Organization that has objectives to accomplish would require fulfilled and glad staff in their labor force. Significantly is the way that for any organization to take off and accomplish its essential objectives would unequivocally rely upon their ability to pull in, hold and keep up skilled and fulfilled staff into its work. Organization seeing enormous measure of changes and difficulties in contention among contenders, remuneration, globalization, frail monetary condition, changing socioeconomics and employee needs are expanding quickly along these lines organization should create extensive methodologies for work fulfillment, maintenance and serious edge.

Employees are committed to the organization and occupied with the work they do. The goal of an organization's employee benefits arrangements and practices is to provide a compelling and serious total pay package that attracts and retains top talent. Turnover of key representatives can have a disproportionately negative impact on the business, and the people who associations want to keep are probably the ones who are about to go. (Armstrong, 2006).

Turnover is a costly hierarchical result and organizations exhaust extensive time and assets in endeavors to diminish turn over especially useless turnover (Dalton & Todor, 1993).

It is caused essentially by helpless oversight, a helpless workplace and insufficient

remuneration (Hinkim et al, 2000). The foundation and execution of effective ideas, projects, and practices of worker pay are referred to as compensation management. It is essentially the application of a precise and rational approach for remunerating representatives in a reasonable, fair, and sensible manner for their work. Pay Management is worried about the remuneration to representatives for their work and commitment for achieving hierarchical objectives.

The impact of salary management on employee retention is the topic of this study. Because of the alarmingly high rate of staff turnover, the study is deemed required.

### Literature Review:

Each organization's human resources are vital, and they remain the foundation of each organization. Job contentment has become one of the most important aspects for certain organizations, today's globalised society necessitates the development of new technologies as it has a significant impact on corporate efficiency, employee execution, attrition, and absenteeism. When employees decide to stay with the company, they believe their skills and abilities are valued and rewarded fairly, with acknowledgment that feels like a sense of accomplishment for the rest of their lives.

### **Employee Retention:**

Employee maintenance refers to the methods and procedures employed by companies to keep critical employees from quitting. It entails taking steps to encourage representatives to stay with the organization for as long as possible. A first significant marker of worker maintenance is their authoritative responsibility (Curtis, 2001). This responsibility is affected by the organization's standards and practices, particularly the authoritative atmosphere (Kaliprasad, 2006). Prize experts can help with employee retention by making counter-offers, expanding fresh recruit offers, providing more regular exemptions for remuneration approaches and projects, and attempting to "bind" key employees to the organisation by offering investment opportunities and other projects that make it difficult for them to leave. (Scott et al, 2012).

While attempting to ensure employees' optimal execution and maintenance, businesses must consider a variety of appropriate compensation strategies in order to get the best results. (Falola H.

O., 2014). It has been suggested that how satisfied employees are with their work and how prepared they are to stay in an organization is a factor in the Organization's pay packages and prize system. (Osibanjo A.O., 2012). Workers' willingness to stay at work is heavily influenced by the company's remuneration packages. (Armstrong, 2003).

### **Compensation :**

A pay framework is a framework that is intended to decide measure of pay offered to a representative as a trade off for their commitment to creation (Erasmus, 2001). Pay assumes a significant function in deciding the responsibility levels of workers and their maintenance regardless of whether it is one of the critical issues similarly as pulling in and keeping ability in organization is concerned (Willis, 2000). Remuneration is a pivotal instrument for the fascination and maintenance of skilled representatives that are devoted to their duties inside the firm. Pay the executives means to advance the accomplishment of business objectives through drawing in,

propelling and holding hard working representatives (Shieh, 2008) (Peters, 2011).

In this review of related literature, pay packages are broken down into financial and non-financial components, as illustrated below..

### **Financial Compensation:**

Monetary pay/reward is one of the fundamental kinds of outward money related prizes which cover the essential necessities of pay to endure, a sensation of soundness and consistency, and acknowledgment (Smith, 2001). Money attracts workers to an organisation, and for firms with the goal of retaining their key employees, salary is a critical issue. (Brannick, 1999). Organization regularly offer significant compensation bundles for example investment opportunities, exceptional compensation, maintenance pay, pick up offer compensation, execution base compensation and reward and so on for fascination and maintenance of skilled workers of the market. Wages are a major determinant of employee interest and retention, and they play an important role in the enrollment process. (Williams, 1992)

### **Non-financial Compensation**

Non-monetary remuneration is otherwise called non-benefits rewards. These days, a ton of representatives don't look for monetary pay alone. They additionally incline toward non-monetary pay for instance, preparing openings, work difficulties, occasion to be advanced, acknowledgment and helpful workplace. (Sons, 2015). Non-monetary forms of pay can be motivating to employees and inspire them to enhance their performance. Using customised non-monetary awards strengthens positive behaviours and improves representative maintenance and implementation (Ryan, 2000). Subsequently, giving remuneration which incorporates monetary and non-monetary prizes is one approach to hold representatives in the organization. Most scientists concur that non-monetary remuneration can hold representatives despite the fact that it may not be the fundamental explanation behind the workers to remain (Tan, 2009).

### **Objectives:**

1. To determine how employees feel about compensation.
2. To investigate the connection between compensation and employee retention..

Particulars	Selected Sample
No. of Industries	05
No. of respondent	70

**Research Questions:**

To address the research purpose, the following research question was formulated:

- i. How important is compensation in retaining employees?

**Hypothesis:**

H<sub>0</sub>: Compensation and employee retention do not have a substantial link.

H<sub>1</sub>: Compensation and employee retention are linked in a substantial way.

**Research Design**

The type of examination was co relational which was conducted through Structured questionnaire. 05 industries from Nashik are chosen for research.

The following is a list of people that were eligible to help fill out the survey:

**Sources of Data Collection**

This study relied on primary sources for its data. Questionnaires were the primary source of data. The respondents were given a five-point liker rating to answer the questionnaire.. The scale ranges from (5) strongly Agree (SA), Agree (A) (4) can't say (C) (3) Disagree (D) (2) Strongly Disagree (SD) (1).

**Data Analysis**

This part utilized factual devices in summing up the highlights of the information gathered. The segment information gathered which include the sexual orientation, age gatherings, position, and number of years worked by the respondents was investigated and deciphered by the utilization of frequencies and rates. The theories were likewise tried for either acknowledgment or dismissal by the utilization relapse investigation and connections.

**Hypothesis Testing**

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
Employee Retention	70	0	70	1.000	4.833	3.474	1.252
Compensation	70	0	70	1.083	4.750	3.455	1.342

Correlation matrix:	
Compensation	Employee Retention
Compensation	1
Employee Retention	0.984
<b>Regression of variable Employee Retention:</b>	
Goodness of fit statistics (Employee Retention):	
Observations	70
Sum of weights	70
DF	68
R <sup>2</sup>	0.969
Adjusted R <sup>2</sup>	0.968
MSE	0.050
RMSE	0.224
MAPE	7.048
DW	0.258
Cp	2.000
AIC	-207.686

SBC	-203.189
PC	0.033

## Analysis of variance (Employee Retention):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	1	104.800	104.800	2094.661	<0.0001
Error	68	3.402	0.050		
Corrected Total	69	108.202			

Computed against model  $Y = \text{Mean}(Y)$

## Model parameters (Employee Retention):

Source	Value	Standard error	t	Pr >  t	Lower bound (95%)	Upper bound (95%)
Intercept	0.300	0.074	4.039	0.000	0.152	0.448
Compensation	0.919	0.020	45.767	<0.0001	0.879	0.959

## Equation of the model (Employee Retention):

Employee Retention = 0.300189481689298+0.918621928111988\*Compensation

## Standardized coefficients (Employee Retention):

Source	Value	Standard error	t	Pr >  t	Lower bound (95%)	Upper bound (95%)
Compensation	0.984	0.022	45.767	<0.0001	0.941	1.027

The null hypothesis of the study to be tested was —There is no significant relationship between compensation and employee retention. The statistical evidence shows that compensation and employee retention have a substantial link. As a result, the null hypothesis is dismissed and the alternative hypothesis is accepted.

**Conclusion:**

The overall goal was to investigate the connection between compensation and employee retention. Researchers claim that the remuneration structure plays an essential role in managing and retaining skilled personnel based on the findings. The study finds that, in order to limit employee movement, industry

should create, administrate, and implement excellent compensation policies that will allow them to keep their outstanding employees.

Employees that are happy with their jobs are more likely to stay with the company for a long time.

The compensations of workers should be changed on convenient premise, which won't just hold the current representatives yet will likewise draw in skillful and capable workers from different associations. Also, there is a requirement for associations to reexamine their advantages bundle by distinguishing those which have more impact on worker maintenance and supplant them with those that are not, at this point applicable.

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**A REVIEW ON AERATION SYSTEM DESIGN FOR OPTIMUM DO LEVEL****Shahu Zhalte<sup>1</sup>, Dr.Dnyandeo D.Shinde<sup>2</sup>**<sup>1</sup> Research Scholar, Department of Mechanical Engineering, SOET, Sandip University, Nashik, India<sup>2</sup> Professor, Department of Mechanical Engineering, SOET, Sandip University, Nashik, India**ABSTRACT**

*In the present paper some technical investigation done by selecting important research articles related to research work to formulate the problem definition. With the increase in food demand day by day there is rapid growth in the food production which leads to the innovation and development of new techniques in Agriculture, Horticulture, Apiculture, Aquaculture, etc. The Aquaculture is one of the food supply system in the form of fish meal. With the increasing demand of fish meal, the aquaculture system also needs to be updated and hence there are different techniques and methods are developed for making aquaculture profitable. One of the developed techniques is Biofloc system which is used to cultures the fish with zero or minimal water exchange. The major requirement of Biofloc system is maintain the optimum DO level in water and to keep the floc medium in suspension with water movement, but most of the Biofloc based system fails due to lack of requirements. Hence in order to provide the optimum DO level with sufficient water circulation the aeration system design is proposed with three set of nozzles fitted with aeration pipe and the optimum design is selected for benefits in aquaculture.*

**Keywords:** Aquaculture, Biofloc Based System, DO Level, Floc, Water Movement

**Introduction**

With almost seven billion people on earth, the demand for aquatic food carries on increasing and hence, expansion and intensification of aquaculture production are highly required. The prime goal of aquaculture expansion must be to produce more aquaculture products without significantly increasing the usage of the basic natural resources of water and land. The second goal is to develop sustainable aquaculture systems that will not damage the environment. The third goal is to build up systems providing an equitable cost/benefit ratio to support economic and social sustainability. All these three prerequisites for sustainable aquaculture development can be met by biofloc technology.

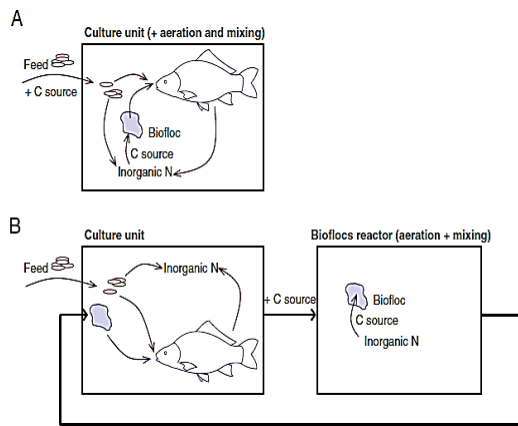
**1.1 Biofloc Technology**

If carbon and nitrogen are well balanced in the solution, ammonium in addition to organic nitrogenous waste will be converted into bacterial biomass. By adding carbohydrates to the pond, heterotrophic bacterial growth is stimulated and nitrogen uptake through the production of microbial proteins takes place. Biofloc technology is a technique of enhancing water quality through the addition of extra carbon to the aquaculture system, through an external carbon source or elevated carbon content of the feed (Figure. 1).

This promoted nitrogen uptake by bacterial growth decreases the ammonium concentration more rapidly than nitrification. Immobilization of ammonium by heterotrophic bacteria occurs much more rapidly because the growth rate and microbial biomass yield per unit substrate of heterotrophy are a factor 10 higher than that of nitrifying bacteria. The microbial biomass yield per unit substrate of heterotrophic bacteria is about 0.5 g biomass C/g substrate C used. Suspended growth in ponds consists of phytoplankton, bacteria, aggregates of living and dead particulate organic matter, and grazers of the bacteria. Typical flocs are irregular by shape, have a broad distribution of particle size, are fine, easily compressible, highly porous (up to more than 99% porosity) and are permeable to fluids.

Biofloc technology makes it possible to minimize water exchange and water usage in aquaculture systems through maintaining adequate water quality within the culture unit, while producing low cost bioflocs rich in protein, which in turn can serve as a feed for aquatic organisms. Compared to conventional water treatment technologies used in aquaculture, biofloc technology provides a more economical alternative (decrease of water treatment expenses in the order of 30%), and additionally, a potential gain on feed expenses (the efficiency of protein utilization is twice as

high in biofloc technology systems when compared to conventional ponds), making it a low-cost sustainable constituent to future aquaculture development.

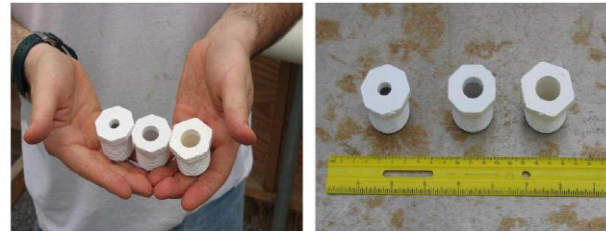


**Figure 1. Biofloc Concept**

Conventional technologies to manage and remove nitrogen compounds are based on either earthen treatment systems, or a combination of solids removal and nitrification reactors. These methods have the disadvantage of requiring frequent maintenance and in most instances the units can achieve only partial water purification. They generate secondary pollution and are often costly. Biofloc technology, on the other hand, is robust, economical technique and easy in operation. One important aspect of the technology to consider is the high concentration of total suspended solids present in the pond water. Suitable aeration and mixing needs to be sustained in order to keep particles in suspension and intervention through either water exchange or drainage of sludge might be needed when suspended solids concentrations become too high.



**Figure 2. Conventional Nozzle Used in Biofloc System**



**Figure 3. Conventional Nozzle Used in Biofloc System**

Although it is a critical aspect of biofloc technology, detailed knowledge about selection and placement of aerators is still lacking. Future research should address this issue and could also investigate new concepts, such as the integration of biofloc technology in raceways, which might prevent solids build up through its proper system configuration. Construction aspects for biofloc technology ponds merely deal with aeration. So improving and fine-tuning of the design of these ponds in terms of water mixing and sludge control is needed. Unlike the conventional techniques such as bio filters, biofloc technology supports nitrogen removal even when organic matter and biological oxygen demand of the system water is high. When establishing biofloc technology in aquaculture ponds, a certain start-up period is needed to obtain a well-functioning system with respect to controlling water quality and this will depend on the nitrogen and organic load of the culture water and thus the intensity of the system. Likewise, in order to establish the required microbial community in a bio filter one needs approximately 4 weeks, depending on nutrients, water flow rate and temperature. However, because heterotrophs grow at a rate that is 10 times higher than that of nitrifying bacteria in bio filters, bioflocs can usually be established much faster than conventional bio filters. To even further shorten the start-up period of biofloc technology, it might be interesting to investigate the effect of adding nucleation sites, such as clay, to the water at start-up, which will stimulate floc formation. Also the inoculation with water from existing good-performing biofloc ponds or with specific inocula might allow an accelerated startup. The strength of the biofloc technology lies in its 'cradle to cradle'- concept. Translated in

biofloc terms, 'waste'-nitrogen generated by uneaten feed and excreta from the cultured organisms is converted into proteinaceous feed available for those same organisms. Instead of 'down cycling', a phenomenon often found in an attempt to recycle, the technique actually 'up cycles' through closing the nutrient loop. Hence, the water exchange can be decreased without deterioration of water quality and, consequently, the total amount of nutrients discharged into adjacent water bodies may be decreased. In this context, biofloc technology can also be used in the specific case of maintaining appropriate water temperature, good water quality and high fish survival in low/no water exchange, greenhouse ponds to overcome periods of lower temperature during winter. Indeed, fish survival levels in overwintering tilapia cultured in greenhouse ponds with biofloc technology were excellent, being  $97\pm 6\%$  for 100 g fish and  $80\pm 4\%$  for 50 g fish. Moreover, at harvest, the condition of the fish was good in all ponds, with a fish condition factor of 2.1–2.3. Besides winter periods, we need to be aware of the fact that future impacts of climate change on fisheries and aquaculture are still poorly understood and colder periods might be more often an issue to deal with in the future. The key to minimizing possible negative impacts of climate change on aquaculture and maximizing opportunities will be through understanding and promoting a wide range of inventive adaptive new technologies, such as the biofloc technology combined with greenhouse ponds.

### Literature Review

Rodrigo A. Labatut, Michael B. Timmons, James M. Ebeling, Rajesh Bhaskaran, presented "Experimental Evaluation of the Effects of Nozzle Diameter and Effluent Withdrawal Strategy on Tank Hydrodynamics in a Large-Scale Mixed-Cell Raceway (MCR)" [1] in which A series of experimental trials were conducted in a large scale mixed-cell raceway (MCR) to evaluate the effect of nozzle diameter and the rate of bottom-center drain discharge on both the magnitude and uniformity of rotational velocities in the mixed-cell. Three nozzle diameters, 10, 15, and 20 mm, and three bottom-center flows, 0, 15, and 20%, were evaluated. Measurements of

rotational velocities in the mixed-cell were made at 5 cm from the bottom of the tank. While the nozzle diameter was found to have a highly significant influence ( $p < 0.01$ ) on the magnitude of the rotational velocities, the percentage of bottom flow did not ( $p > 0.05$ ). Also, results suggested that uniformity of rotational velocities in terms of the radial-wise profile is not affected by either the nozzle diameter or the percentage of bottom flow and concluded that the nozzle diameter has a significant influence on the magnitude of the rotational velocities; however, it was found that the percentage of bottom-center flow did not have significant effects on the magnitude of the rotational velocities. Also, no evident effects were observed as a result of increasing either the nozzle diameter or bottom-center flow on the uniformity of rotational velocities in the radial-wise velocity profile. While previous studies have established that the jet velocity influences rotational velocities almost linearly, it was found that this linearity remained as is, provided that the nozzle diameter was maintained constant. Also, the present study revealed that for a constant jet velocity, rotational velocities in the mixed-cells follow a logarithmic trend as a function of the nozzle diameter. By combining both the linear and logarithmic models, a set of iso-curves for prediction of rotational velocities as a function of the jet velocity and nozzle diameter was constructed. The iso-curves will facilitate the design of a mixed cell or circular tank where specific rotational velocities are required.

In 2012, Roselien Crab, Tom Defoirdt, Peter Bossier, Willy Verstraete reviewed and collected data on Biofloc technology in aquaculture: Beneficial effects and future challenges [2] and described As the human population continues to grow, food production industries such as aquaculture will need to expand as well. In order to preserve the environment and the natural resources, this expansion will need to take place in a sustainable way. Biofloc technology is a technique of enhancing water quality in aquaculture through balancing carbon and nitrogen in the system. The technology has recently gained attention as a sustainable method to control water quality, with the added value of producing proteinaceous feed in situ.

In this review, we will discuss the beneficial effects of the technology and identify some challenges for future research and concluded that Biofloc technology offers aquaculture a sustainable tool to simultaneously address its environmental, social and economical issues concurrent with its growth. Researchers are challenged to further develop this technique and farmers to implement it in their future aquaculture systems. The basics of the technology is there, but its further development, fine-tuning and implementation will need further research and development from the present and future generation of researchers, farmers and consumers to make this technique a keystone of future sustainable aquaculture.

In 2018, Mohammad Tanveer, Subha M Roy, M Vikneswaran, P Renganathan and S Balasubramanian presented A review on "Surface aeration systems for application in aquaculture" [3] in which Surface aeration systems viz., paddle wheel and spiral aerators are the most commonly used aeration systems in intensive aquaculture practices. Use of aerators in intensive aquaculture is important for ensuring better survival, optimal oxygen supply, higher production, and disease free environment. Hence, selection of properly designed and high efficient aerators is necessary to maintain adequate and continuous supply of dissolve oxygen (DO) in semi-intensive and intensive aquaculture and keep the energy consumption (operating cost) to minimum. Paddle wheel and spiral aeration systems have advantage of cost effectiveness, low maintenance and easy availability. In the present study a review on previous studies related to standard aeration efficiency (SAE) and standard oxygen transfer rate (SOTR) of paddle wheel and spiral aeration systems has been discussed and concluded a comprehensive review has been carried out on paddle wheel and spiral aerators. Paddle wheel aerator is found to be the best due to its low cost, low maintenance, ease in operation and high SOTR as well as SAE in intensive pond culture systems. Thus, it can be concluded that properly operated aeration system will help to mitigate the environmental hazard in the intensive culture and also reduction energy cost. Hence, judiciously selected aeration

system will contribute towards profit of the farmers. It is found that few literatures are available in spiral aerators. Therefore, more study about design and performance characteristics of spiral aerators could be carried out in future. By using computational fluid dynamics, different types of sturdy and shrewd aeration mechanism can be designed and its mixing characteristics and flow pattern can also be studied. It will reduce the design and testing cost.

In 2019, J.M.R. Gorle, B.F. Terjesen, S.T. Summer felt presented work Hydrodynamics of Atlantic salmon culture tank Effect of inlet nozzle angle on the velocity field [4] in which a full-scale computational fluid dynamics (CFD) model of an existing culture tank of 788 m<sup>3</sup> size was developed, based on time-dependent incompressible unsteady Reynolds averaged Navier-Stokes (URANS) formulation with the realizable k- $\epsilon$  viscous model. The tank has two inlet pipes, placed closed to side walls of the tank. Each pipe has 11 inlet nozzles, which introduce the flow into the tank parallel to the walls. This base case was validated against the experimental velocity measurements using Acoustic Doppler Velocimetry (ADV) at predefined locations across the central vertical plane of the tank. Turbulence characteristics and hence the hydrodynamic performance of the tank are influenced by inflow characteristics. To conclude this, two redesigns were developed and contrasted with the base design for various flow parameters from the viewpoint of the tank's performance. Redesign 1 has the nozzles turned towards the centre by 42°, while Redesign 2 has bottom 5 nozzles directing the flow towards the centre with the rest injecting the flow parallel to the wall. Distribution of turbulence parameters and vortices reveal that the inflow with a radial component improves the mixing and flow uniformity characteristics of the tank and concluded that the inclusion of a radial orientation in the lower flow inlet nozzles would improve the overall hydrodynamic performance of the tank also Flow physics behind such complex phenomena are highly influenced by the hydraulic boundary conditions. Commercial facilities use the standard practice of inlet and outlet locations in the circular tanks. Flow pattern can

be changed in a positive way for better mixing and improved uniformity if the flow boundaries are rightly modified.

One of the developed techniques is Biofloc system which is used to cultures the fish with zero or minimal water exchange. The major requirement of Biofloc system is maintain the optimum DO level in water and to keep the floc medium in suspension with water movement, but most of the Biofloc based system fails due to lack of requirements. Hence in order to provide the optimum DO level with sufficient water circulation the aeration system design is proposed with three set of nozzles fitted with aeration pipe and the optimum design is selected for benefits in aquaculture.

### Conclusion

One of the developed techniques is Biofloc system which is used to cultures the fish with zero or minimal water exchange. The major requirement of Biofloc system is maintain the optimum DO level in water and to keep the floc medium in suspension with water movement, but most of the Biofloc based system fails due to lack of requirements. Hence in order to provide the optimum DO level with sufficient water circulation the aeration system design is proposed with three set of nozzles fitted with aeration pipe and the optimum design is selected for benefits in aquaculture.

### Acknowledgment

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## DEVELOPMENT OF PIPE INSPECTION ROBOT

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### ABSTRACT

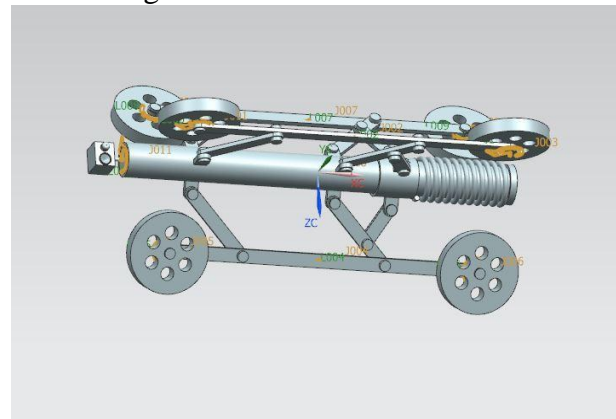
In the present work Pipe inspection robot is developed and simulated for an autonomous in-pipe inspection. The mechanism used involves a central rod upon which a translational element is fitted which in turn is connected to three frames of links and wheels. DC motors are attached to the wheels to achieve the drive required. The mechanism allows for small accommodation in pipe diameters. An electronic circuit consisting of three relay switches is used to control the entire circuitry of DC motors, camera and translational element. The camera is mounted on the top of the assembly, which in itself can be rotated thus giving a wide field of view in the pipe. The robot allows for detection of cracks, buckle, corrosions, pitting and many others. In the present paper development and simulation of the present set up is explained which is useful for the actual manufacturing of Pipe Inspection Robot.

**Keywords:** DC motor, Defects, In-pipe inspection, Links, Robot

### Introduction

Pipelines are proven to be the safest way to transport and distribute gases and liquids. Periodic inspection is required to maintain that status. Pipeline systems deteriorate progressively over time through various means. Robotics is one of the fastest growing engineering fields of today. Robots are designed to remove the human factor from labor intensive or dangerous work environments and also to act in inaccessible environment. The use of robots is more common today than ever and it is no longer exclusively used by the heavy production industrial plants. The specific operations such as inspection, maintenance, cleaning etc. are expensive. Thus, the application of the robots appears to be an attractive solution. The project aims to create a robotic inspection technology. It is beneficial to have a robot with adaptable structure to the pipe diameter, which possesses enhanced dexterity, maneuverability and capability to operate under hostile conditions. Wheeled robots are simple, energy efficient and have a great potential for long range usage. A multi – frame robot as shown in fig. 1 offers few advantages in maneuverability with the ability to adapt to in-pipe unevenness, move vertically in pipes, and stay stable without slipping in pipes. This type of robot also has

the advantage of easier miniaturization. A challenge in its design and implementation consists in combining the mobility with that of autonomy and low weight. Major design objectives are represented by the adaptability of the robot to the inner diameters of the pipes and making the machine autonomous.



**Fig. 1: Pipe inspection robot**

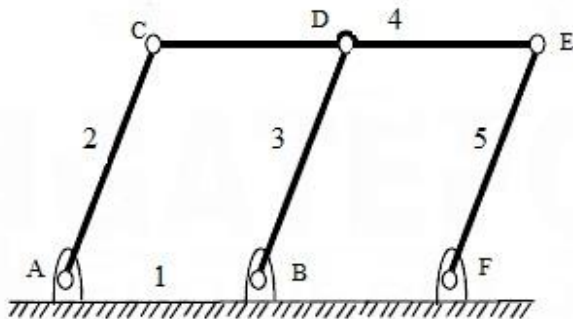
### Design Parameters

The parameter for design of the robot is the diameter of pipe. We have chosen 8'' and 10'' (approx. 200 mm and 260 mm) pipes as the lower and upper limits respectively for our robot.

**Selection of the wheel:** The wheels of the robot should be chosen such that they should be capable of moving without slipping in the vertical direction by exerting the required

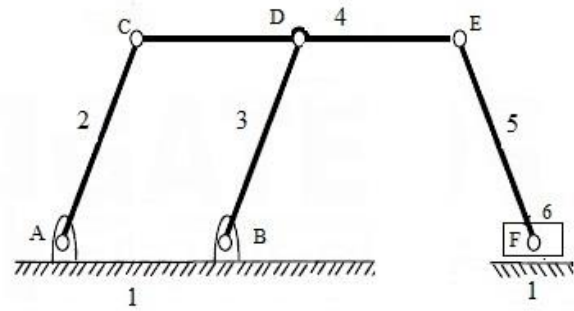
traction force. They should also not wear out easily with use. These factors are determined by the co-efficient of friction between the wheel and the pipe. Rubber wheels are a natural choice for this environment as they meet the above demands. The co-efficient of friction between rubber and two commonly used pipe materials (concrete and PVC) are considered. Coefficient of friction between rubber and concrete is in the range of 0.6 – 0.85. Coefficient of friction between rubber and PVC is in the range of 0.5 – 0.7. The power requirements are calculated using a coefficient of friction of 0.8. The range of diameter of pipes considered in the present work is 200 to 260 mm. To accommodate the mechanism with rubber wheels and considering market availability of standard wheels, the diameter was chosen to be 80 mm.

**Mechanism Synthesis:** The robot mechanism is to be designed in such a way as to expand and contract between the chosen limits. This necessitates the use of a mechanism where the input link causes the other links to move in a uniform fashion without any crossovers. A parallelogram linkage offers the required type of uniform motion.



**Fig. 2 – Simple Parallelogram Mechanism**

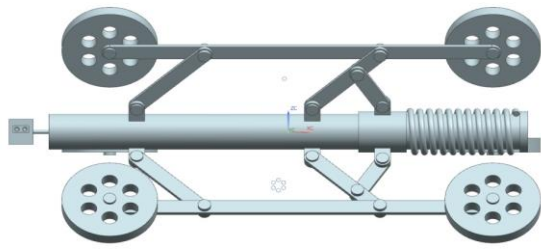
But, the required way of motion is not achieved from this design. The joint F is made into a screw pair. The orientation of link 5 is changed so that when the input, link 2 moves in the clockwise direction, link 5 moves in the opposite direction pushing the screw pair forward and vice versa. This combination of linkages makes the mechanism contract in the clockwise direction and expands in counter clockwise direction.



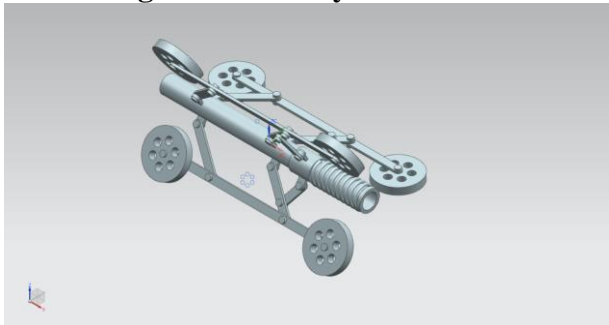
**Fig. 3 – Modified Mechanism**

**Feasibility of the mechanism:-** The feasibility of the mechanism is determined with the help of “Linkage”, which is a computer program that lets one design and edit a two dimensional mechanism and then simulate the movement of that mechanism. The editing and simulation are both done in the same window and are part of the same user interface.

**Material Selection:-** The materials used for this machine are to be rigid. Different materials can be used for different parts of the robot. For optimum use of power the materials used should be light and strong. Wood is light but it is subjected to wear if used for this machine. Metals are the ideal materials for the robot as most of the plastics cannot be as strong. Material chosen should be ductile, less brittle, malleable, and have high magnetic susceptibility. Among the metals/metal alloys, aluminum is a good choice. But, mild steel 1018 was chosen as the material for links and a translational element as it is sufficiently rigid and less brittle. It balances ductility and strength and has good wear resistance; used for large parts, forging and automotive components. However, mild steel is denser compared to aluminum and makes the robot heavier. C45 steel is chosen as the material for screw rod as it is a medium carbon steel, which is used when greater strength and hardness is desired than in the "as rolled" condition. Extreme size accuracy, straightness and concentricity combine to minimize wear in high speed applications. It is generally used for screws, forgings, wheel tyres, shafts, axes, knives, wood working drills and hammers.



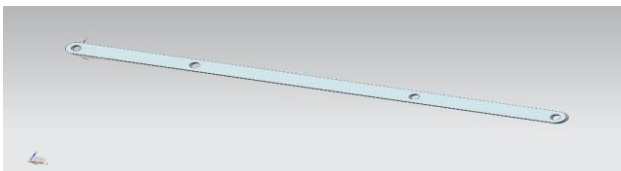
**Fig. 7 – Assembly-Front view**



**Fig. 8 – Assembly-Isometric view**

**Fabrication and Working**

The fabrication phase of the project involves production of the parts designed. It also entails the selection of appropriate electronic circuitry which can be effectively used to achieve and control the robot motion. The various processes used in fabrication of the components are Cutting drilling Welding Turning.

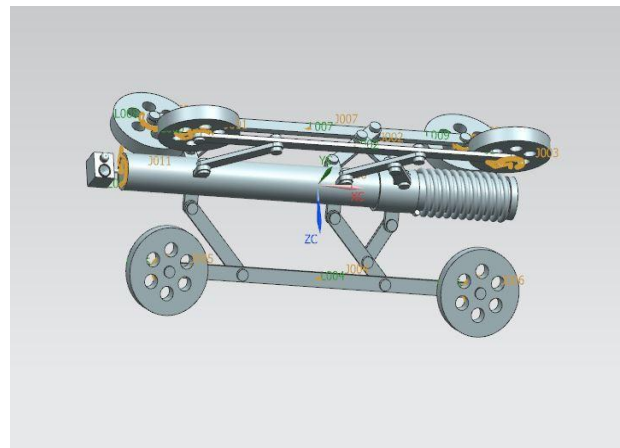


**Fig. 9 – Holes drilled on link 1**



**Fig. 11 – Welding of Nut strips**

Turning: Turning was performed on a C45 steel rod to make M8×1.25 using the turning process as per the calculations. The turning process was done on a lathe machine.



**Fig. 12 – Assembled robot**

Electronic circuit and components: The assembled robot needs to start or stop instantaneously. Also, its direction of motion ought to be easily switched over. This can be achieved by using a relay circuit and a remote control. Double Pole Double Throw (DPDT) relay is an electromagnetic device used to separate two circuits electrically and connect them magnetically. They are often used to interface an electronic circuit, which works at a low voltage to an electrical circuit which works at a high voltage.



**Fig. 13 –IR 4 Channel Remote Control Relay (Courtesy: hitechlogics.com)**

Four channel relay circuit: IR Remote control relay is a combination of Infrared Transmitter and Receiver which contains 4 Relays and 1 Fan with Speed Control through TRiAC which can be controlled wirelessly is shown in Fig.13. This makes the unit very easy to operate and notegrate with existing systems. The remote control operates the corresponding relay on the receiver board.

Power supply board: The power supply board as seen in Fig. 14 is used to regulate the voltage to the camera plate. A potentiometer present on the board can be used to change the



resistance, thereby changing voltage. This results in control of the speed of the motor.



**Fig.14 Power supply board (Courtesy: nskelectronics.com)**

**Wireless camera:** Wireless cameras are wireless transmitters carrying a camera signal. The components are shown in Fig.15. The camera is wired to a wireless transmitter and the signal travels between the camera and the receiver. This works much like radio. Wireless cameras also have a channel. The receiver has channels to tune in and then the picture is obtained. The wireless camera picture is sent by the transmitter the receiver collects this signal and outputs it to a Computer or TV Monitor depending on the receiver type.



**Fig.15 Wireless camera with radio receiver (Courtesy: Google images)**

**DC motors:** DC (direct current) motor works on the principle, when a current carrying conductor is placed in a magnetic field; it experiences a torque and has a tendency to move. If the direction of current in the wire is reversed, the direction of rotation also reverses. When magnetic field and electric field interact

they produce a mechanical force, and based on that the working principle of dc motor established. DC motors are used to achieve the drive on wheels and rotation of rods. Two types of DC motors used in the project are shown in Fig.16.



**Fig. 16. 200 and 60 rpm DC motor (Courtesy: tomsonelectronics.com)**

**Circuit integration and assembly:** At the end of fabrication, the electronic circuitry is implemented onto the robot. The DC motors are fitted for the wheels, screw rod and camera plate rod. The 4 channel relay is integrated with all the DC motors. Appropriate wiring is done and a 12 V battery is connected to all electronic components **Working:** The complete assembly of the robot leads to the next phase of the project – Working.

Here the robot is checked for its performance the desired functions. Drive to the wheels is achieved through DC motors. These motors are connected through relay switches which govern the start/stop functions and rotational direction of the motors. The robot works through the electronic circuit - mechanism interface.

One relay switch, worked manually, is used to control the expansion or contraction of the frames. The camera placed at the other end of the robot is switched on manually. RF receiver is set up with connections made to a TV monitor.

The DC motors to the wheels are started through the 4 channel relay circuit. This makes the wheels rotate at a set rpm of 60.

Once placed sufficiently inside the pipe, the manual relay switch is actuated to expand the frames so as to accommodate to the pipe diameter. The expansion is continued till sufficient gripping is achieved. The gripping ensures motion in horizontal or vertical direction. The 4 channel relay circuit is actuated through the remote for forward motion.

Camera plate is controlled through another relay on the circuit board. This is activated to initiate rotation of camera.

As the robot moves inside the pipe, wireless signals are conveyed to the receiver giving a view of the inside surface. The surfaces are checked for defects visually. Results: Pipeline systems are prone to degradation and corrosion resulting in a number of defects. Identification of defects is an important problem in chemical plants, sewage pipes and other industries. This project aimed to create an autonomous robot for in-pipe inspection capable of vertical and horizontal motion. The following results were obtained from the completion of the project. The robot was capable of adapting to pipe diameters in the range of 200 mm to 260 mm. The robot was tested for motion in a 250 mm PVC pipe. It was found to move well in both horizontal and vertical direction. The wireless camera transmitted the video feed through the RF transmitter onto a TV screen up to a range of 40 m. The velocity of the robot is 30 cm/s.

### Conclusions and Future Scope

Conclusions: Robots can be effectively used as tools to carry out work in labor intensive, hazardous and unreachable work environments. Pipeline systems are one such environment. Robots can be successfully implemented in pipe line inspections for better detection of defects.

The project aimed to create an in-pipe robot with adaptable structure, autonomy and achieve vertical motion. The following conclusions can be drawn from the project. Future Scope: The project is limited in several ways and can be worked upon to broaden its features and applications. A few of the improvements that can be implemented are mentioned below. Use of tilted and guide wheels for traversing curves and bends in pipes. Use of lighter material for the links to reduce the weight. Infrared/Ultrasonic inspection for better detection of defects. Implementation of long range sensors. Implementation as a bore well rescue robot. Alternate design without links to facilitate better motion.

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## DEVELOPING THE CONDITION INDEX FOR THE CONDITION ASSESSMENT OF ESR

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### ABSTRACT

*The condition of Elevated Service Reservoir (ESR) in rural areas of India is very poor, as it is always neglected after the construction. The repairing and maintenance of the ESR depends upon the interest of stake holders in the area, budget and financial condition of local authority and also on the political will of local leadership. There is no index available which would state the condition of ESR to decide the priority of repairs and maintenance required to keep it in serviceable condition. The study deals with developing the condition index (CI) for ESR in rural water supply system (RWSS). The ESRs constructed rural area near by the Nashik city were inspected as per the methodology developed. Entire structure is divided into the main & sub components of structural and non-structural group. The factors and sub factors influencing the condition ESR are listed and used for developing CI. These factors and sub factors identified through the data collected from the visual inspection & different non-destructive tests (NDT) at site. The D.E.R method is used to develop the CI. The CI can be used as metric for assessment of condition of ESR. This can be used for predicting future conditions and thus to fix the budget for repair and maintenance.*

**Keywords:** Condition Index, DER method, Elevated Service Reservoir, Rural Water Supply System

### Introduction

ESR's are enormous elevated water storage containers designed to hold a supply of water at a height high enough to pressurize a flow of water through water distribution system. RCC ESRs deteriorate due to reinforcement corrosion, chloride diffusion, alkali aggregate reaction, freezing and thawing, and other factors, which can lead to failure. As a result, assessing the quality of RCC ESRs is required to guarantee that the execution quality is sufficient and to identify any flaws so that they can be corrected. This can only be accomplished by doing some in-situ testing on the structures in addition to visual assessment. Existing concrete structures are typically assessed using the rebound hammer test & ultrasonic pulse velocity (UPV) test. The main objective of present work is to propose DER rating technique to find out the condition ranking of elevated service reservoir in Nashik region in Maharashtra.

Visual examination, surface sounding, and coring to analyse interior concrete conditions have been used to assess concrete condition for structural evaluation purposes throughout the last few decades. NDT methods can be used to assess the structural performance of concrete, such as dimensions of members, cracking,

delamination, presence of voids and honeycomb, steel reinforcement location and size of bar, reinforcement corrosion, and extent of damage from freezing and thawing, fire, or chemical exposure.

Core testing, as defined by IS 516:1959 'Method of test of strength of concrete' [6], is more trustworthy for determining the real compressive strength of the concrete in the structure. Core tests are the most accurate in-situ strength assessments, but they also cause the greatest damage and are time-consuming and costly & not practical for structure in use. However, because these methods are inconvenient, non-destructive tests are used, which not only provide an estimate of the relative strength and overall quality of

concrete in a structure, but also assist in determining whether more rigorous tests, such as load testing or core drilling under specific conditions, are required, as specified in IS 13311: part 1, 1992 [4-5].

Arun Kumar Dwivedi et al. [1] has studied rural water supply schemes which were constructed in Dhule district of Maharashtra state of India to establish the composite sustainable management index for assessing

the long term sustainability of the scheme. Rajan L. Wankhede et al. [8] has carried out nondestructive testing of concrete structures in Karad region to assess the condition of structures. Yiching Lin [10] and colleagues conducted an experiment to test mathematical models for forecasting concrete pulse velocity. Ayop and Mohamad Ismail [2] reported the construction of a condition assessment system for assessing the condition status of concrete marine structures in Malaysia. Bhadauria and Gupta [3] looked into the in-service durability of water tanks based on the condition Index approach created by the US Army Corps of Engineers. To determine the repair sequence of an existing reinforced concrete bridge, Ming-Te Liang, Chin-Ming Lin, and Chi-Jang Yeh [7] used the comparisons matrix approach. K. Subramanian et al. [10] investigated the use of an ultrasonic wave reflection factor between the hardening concrete and a steel interface to monitor the setting and hardening of Portland cement concrete. To uncover correlations between the numeric condition rating and the estimated remaining service life of bridges, Saito and Sinha [9] created relationships between subjective bridge condition evaluations and the FHWA's numeric ratings.

### Methodology

#### Components of ESR under consideration

Entire structure is divided into 2 major components

- A. Structural components
- B. Nonstructural components

Structural components considered are

- a) RCC Column
- b) RCC Beam
- c) RCC Slab
- d) RCC Container wall

Nonstructural components considered are

- a) Inflow pipe
- b) Outflow pipe
- c) Overflow pipe
- d) Inlet valve
- e) Outlet valve
- f) Bypass valve
- g) Handrail

- h) Ladder
- i) Passage

#### Tests carried out

Following tests are carried out on the said structural components of ESR.

- a) Visual Inspection
- b) Rebound hammer test
- c) Ultra sonic pulse velocity test

Indian standard code of practice for nondestructive testing of concrete- Method of test (Ultra sonic pulse velocity) I. S. 13311 (Part 1, 1992) Bureau of Indian Standard (BIS) & Indian standard code of practice for nondestructive testing, of concrete- method of test (Rebound hammer) I. S. 13311 (Part 2, 1992) Bureau of Indian Standard (BIS) are referred to carry out the NDT tests.

#### DER Evaluation method

The D (Degree) E (Extend) R (Relevancy) evaluation method is now widely used to evaluate the damage grade for existing RCC structure. But the same is not applied for the ESR, so in this work, we have applied the D.E.R. method to evaluate the damage grade for existing ESR in rural water supply scheme of Nashik region. The results presented in this study can be used as engineering decision-making for the repair, strengthening or demolition orders for existing ESR.

The D.E.R. evaluation method involves separating ESR deterioration into the following

- a) D - Degree-that is the Degree of severity of the defect of the check item under consideration.

- b) E - Extent-that is the extent to which the defect occurs over the area of that particular component

- c) R - Relevancy-that is the importance of the effect of the severity of the defect of the particular component on the serviceability and safety of the ESR.

Each of the criteria is numerically rated on a scale on 0 to 4.

**Table I- DER rating scale for visual inspection**

Rating	0	1	2	3	4
D	No such item	Good	Fair	Poor	Severe
E	Cannot be inspected	< 10 %	< 30%	< 60%	< High
R	Cannot be decided	Minor	Small	Medium	High

**Table II- D rating scale for visual inspection**

Rating	0	1	2	3	4
Defect	No defect	Hair cracks	Falling of plaster	Minor cracks & reinforcement exposed	Major cracks & reinforcement corroded
D	No such item	Good	Fair	Poor	Severe

**Table III- D Value rating for rebound hammer test**

D Value Rating	Criteria
0	No such item
1	$P_d \leq P_t$
2	$0.85 P_d \leq P_t < P_d$
3	$0.75 P_d \leq P_t < 0.85 P_d$
4	$P_t < 0.75 P_d$

$P_d$  and  $P_t$  are the design and test results of the concrete compression strength in  $N/mm^2$

**Table IV- D Value rating for Ultrasonic Pulse Velocity Meter test**

D Value Rating	Criteria – Velocity in Km/sec
1	> 4.5
2	3.5 – 4.5
3	3 – 3.5
4	<3

**Condition Index**

The Condition Index is used to find out the deterioration grade of concrete. It is the numerical index that indicates the damaged level of the element as well as the entire structure. It is calculated on the basis of in-situ tests and visual observation of the intensity and extent of damage. Condition Index (CI) is represented by a quantitative ranking between 0 and 100 as shown in Table V; 0 being the worst condition and 100 being the best condition.

Based on the visual inspection & test results of all ESR elements, the Condition Index is calculated by using

$$CI = \frac{\sum_{i=1}^n I_{C_i} \times W_i}{\sum_{i=1}^n W_i}, \text{ Where } \sum_{i=1}^n W_i = 100$$

Where,

$I_{C_i}$  = Condition index of each components

$I = 1 \sim n$  (n is the number of components of water tank)

$W_i$  = Weightage of water tank components

$I_{C_i}$  is calculated by using the following formula

$$I_{C_i} = 100 - 100 \times \frac{[D_{max} + E] \times R^a}{b}$$

Where,

$$b = (D_{max} + E_{max}) \times R_{max}^a$$

Usually the value of ‘a’ ranges from 1 to 2. As ESR is important structure, so a=2 in our case.

**Table V – Condition Index scale**

Zone	Condition Index	Condition Description	Recommended action
1	85-100	Excellent: No noticeable defects. Some aging or wear may be visible.	Immediate action is not required.
	70-84	Very Good: Only minor deterioration or defects are evident.	Immediate action is not required.
2	55-69	Good: Some deterioration or defects are evident, but function is not significantly affected.	Economic analysis of repair is required.
	40-54	Fair: Moderate deterioration. Function is still adequate.	alternatives is recommended to determine appropriate action.
3	25-39	Poor: Serious deterioration in at least some portions of the structure. Function is inadequate.	Detailed evaluation is required to determine the need for repair.
	10-24	Very Poor: Extensive deterioration. Barely Functional.	Rehabilitation or reconstruction. Safety evaluation is recommended.
	0-9	Failed: No longer functions, General failure or complete failure of major structural component.	Rehabilitation or reconstruction. Safety evaluation is recommended.

## Case Study

### Case 1

RCC ESR located in Naigaon water supply scheme Sinnar, was selected for the study purpose. The water tank was constructed in 1998. The capacity of the ESR is 1.25 lack liters. Tank is supported on five columns of size 0.3m x 0.3m. The staging height is around 12 m above ground level. Staging height is divided into 3 stages. Structure consists of 5 columns (4 at periphery & 1 at the center) and brace beam which are connecting the columns and braces of rectangular shape. Size of brace is 0.3m x 0.45m.

For identification purposes, the columns are numbered as column  $C_1$  to Column  $C_4$  in clock wise direction. Brace beams are categorized as peripheral beam which are connecting the

peripheral columns, & bracing beams which are connecting the center columns to the other 4 columns. Peripheral beams are numbered as  $PB_1$  to  $PB_4$  such that beam  $PB_1$  appears after column  $C_1$  in clockwise direction. Bracing beams are numbered as  $BB_1$  to  $BB_4$  in clockwise direction such that beam  $BB_1$  is connecting  $C_1$  and  $C_5$ . RCC top slab is marked as  $TS_1$  to  $TS_4$  in clockwise direction such that  $TS_1$  is the area of top slab in between the columns  $C_1$ ,  $C_2$  &  $C_5$ . RCC bottom slab is marked as  $BS_1$  to  $BS_4$  in clockwise direction such that  $BS_1$  is the area of bottom slab in between the columns  $C_1$ ,  $C_2$  &  $C_5$ . Tank container wall is marked as  $WQ_1$  to  $WQ_4$  in clock wise direction such that  $WQ_1$  is the wall between  $C_1$  &  $C_2$ .

**Table VI – Calculation of  $D_{max}$  for different columns**

Sr. No.	Item	Visual	Rebound		UPVM Test		$D_{max}$
		Inspect	hammer	hammer	Test	Test	
		D	Pt	D	Vt	D	
1	$C_{11}$	4	16	4	3.1	3	4

2	C <sub>12</sub>	2	22	2	3.6	2	2
3	C <sub>13</sub>	2	24	2	3.75	2	2
4	C <sub>21</sub>	3	19	3	3.3	3	3
5	C <sub>22</sub>	1	25	1	3.82	2	2
6	C <sub>23</sub>	4	19	3	3.3	3	4
7	C <sub>31</sub>	4	16	4	3.1	3	4
8	C <sub>32</sub>	4	16	4	3.1	3	4
9	C <sub>33</sub>	1	22	2	3.95	2	2
10	C <sub>41</sub>	2	23	2	3.45	3	3
11	C <sub>42</sub>	2	19	3	3.3	3	3
12	C <sub>43</sub>	4	16	4	2.8	4	4
13	C <sub>51</sub>	4	16	4	3.1	3	4
14	C <sub>52</sub>	4	16	4	3.1	3	4
15	C <sub>53</sub>	3	21	3	3.5	2	3

In the above table VI, the value of D for visual inspection is calculated on the basis of Table 1 & Table 2. Pd is the design strength of concrete which is 25 N/mm<sup>2</sup>. Pt is the test result of concrete compression strength in N/mm<sup>2</sup> by Rebound hammer test & corresponding value of D is taken from Table 3. Vt is the Velocity in Km/sec calculated by Ultrasonic Pulse Velocity Test & corresponding value of D is taken from Table 4. Cij stands for Column where “i” denotes the number of column & “j” denotes the number of level.

Value of E & R for all the elements is taken from Table 1 depending upon the extent to which the defect occurs over the area of that particular component & the importance of the effect of the severity of the defect of the particular component on the serviceability and safety of the ESR correspondingly.

Table VII shows the DER values for each components. D<sub>max</sub> is the maximum value of D calculated from visual inspection, rebound hammer test & ultrasonic pulse velocity test. D<sub>max</sub> is taken as D in Table VII.

**Table VII- DER values of Columns**

Sr. No.	Item	D <sub>max</sub>	E	R	W <sub>i</sub>	I <sub>ci</sub>	I <sub>ci</sub> x W <sub>i</sub>
1	C <sub>11</sub>	4	4	4	3.59	0.00	0.00
2	C <sub>12</sub>	2	3	3	3.59	64.84	232.79
3	C <sub>13</sub>	2	2	2	3.59	87.50	314.13
4	C <sub>21</sub>	3	3	3	3.59	57.81	207.55
5	C <sub>22</sub>	2	3	3	3.59	64.84	232.79



6	C <sub>23</sub>	4	2	3	3.59	57.81	207.55
7	C <sub>31</sub>	4	4	4	3.59	0.00	0.00
8	C <sub>32</sub>	4	4	4	3.59	0.00	0.00
9	C <sub>33</sub>	2	3	3	3.59	64.84	232.79
10	C <sub>41</sub>	3	2	2	3.59	84.38	302.91
11	C <sub>42</sub>	3	3	3	3.59	57.81	207.55
12	C <sub>43</sub>	4	3	3	3.59	50.78	182.30
13	C <sub>51</sub>	4	4	4	3.59	0.00	0.00
14	C <sub>52</sub>	4	4	4	3.59	0.00	0.00
15	C <sub>53</sub>	3	2	2	3.59	84.38	302.91

Calculation of Condition Index of C<sub>12</sub> i.e. Column 1 at 2<sup>nd</sup> level is as per the following

$$I_{C_i} = 100 - 100 \times \frac{[2 + 3] \times 3^2}{(4 + 4) * 4^2}$$

$$I_{C_i} = 64.84$$

$$I_{C_i} \times W_i = 232.79$$

In the same manner Condition index of each component like bracing beam, top slab, bottom slab, container wall, staircase & all the nonstructural items is calculated.

Condition Index of ESR is

$$CI = \frac{\sum_{i=1}^n I_{C_i} \times W_i}{\sum_{i=1}^n W_i}, \text{ Where } \sum_{i=1}^n W_i = 100$$

$$CI = \frac{4976.46}{100}$$

$$CI = 49.76$$

CI value lies between 40-54. ESR is in Zone 2 from Table V, it means ESR is moderately deteriorated and alternative is to be recommended to determine the appropriate action.

### Case 2

RCC ESR located in Bhatawadi water supply scheme Sinnar, was selected for the study purpose. The water tank was constructed in 1999. The capacity of the ESR is 1.00 lack liters. Tank is supported on five columns of size 0.3m x 0.3m. The staging height is around 10 m above ground level. Staging height is divided into 3 stages. Structure consists of 5 columns (4 at periphery & 1 at the center) and brace beam which are connecting the columns and braces of rectangular shape. Size of brace is 0.3m x 0.35m.

**Table VIII – DER values of Top slab, Bottom slab & Container wall**

Sr. No.	Item	D <sub>max</sub>	E	R	W <sub>i</sub>	I <sub>ci</sub>	I <sub>ci</sub> x W <sub>i</sub>
1	TS <sub>1</sub>	4	2	3	0.39	57.81	22.55
2	TS <sub>2</sub>	4	4	4	0.39	0.00	0.00
3	TS <sub>3</sub>	4	3	4	0.39	12.50	4.88
4	TS <sub>4</sub>	4	3	4	0.39	12.50	4.88
5	BS <sub>1</sub>	4	3	4	2.5	12.50	31.25

6	BS <sub>2</sub>	3	3	3	2.5	57.81	144.53
7	BS <sub>3</sub>	4	3	4	2.5	12.50	31.25
8	BS <sub>4</sub>	3	2	2	2.5	84.38	210.94
9	WQ <sub>1</sub>	4	3	4	1.69	12.50	21.13
10	WQ <sub>2</sub>	4	2	3	1.69	57.81	97.70
11	WQ <sub>3</sub>	4	3	4	1.69	12.50	21.13
12	WQ <sub>4</sub>	4	3	4	1.69	12.50	21.13

Calculation of Condition Index of TS<sub>1</sub> i.e. Top slab in 1<sup>st</sup> quarter is as per the following

$$I_{C_i} = 100 - 100 \times \frac{[4 + 2] \times 3^2}{(4 + 4) * 4^2}$$

$$I_{C_i} = 57.81$$

$$I_{C_i} \times W_i = 22.55$$

In the same manner Condition index of each component like bracing beam, column, staircase & all the nonstructural items is calculated.

Condition Index of ESR is

$$CI = \frac{\sum_{i=1}^n I_{C_i} \times W_i}{\sum_{i=1}^n W_i}, \text{ Where } \sum_{i=1}^n W_i = 100$$

$$CI = \frac{3261.83}{100}$$

$$CI = 32.61$$

CI value lies between 25-39. ESR is in Zone 3 from Table V, it means condition of ESR is poor & serious deterioration is observed in bottom slab, column & beams. Detailed

evaluation is required to determine the need for repair.

### Conclusion

Condition Index is developed based on DER method. Condition Index of ESR located in Naigaon & Bhatwadi water supply scheme Sinnar is found out. Ranking assessment is carried out on the basis of visual inspection, rebound hammer test & ultrasonic pulse velocity test. Condition Index of ESR located in Naigaon water supply scheme, Sinnar is 49.76 which mean the condition is fair. Condition Index of ESR located in Bhatwadi water supply scheme, Sinnar is 32.61 which mean the condition is poor. Condition Index is used find out the urgency of carrying out the repair & maintenance work.

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**DESIGN, DEVELOPMENT AND TESTING OF SEMI-AUTOMATIC DISHWASHER****A.S.Dube<sup>1</sup>, Sumeet Nathani<sup>2</sup>, Vaibhav Waghmare<sup>3</sup>, Amey Pardeshi<sup>4</sup>, Rahul Khairnar<sup>5</sup>**<sup>1</sup> Professor, Mechanical Engineering, SIEM, Nashik, India<sup>2,3,4,5</sup> BE Mech.Student, SIEM, Nashik, IndiaEmail: <sup>1</sup>anil.dube@siem.org.in, <sup>2</sup>sumeetnathani2628@gmail.com, <sup>3</sup>waghmare6899@yahoo.com,<sup>4</sup>pardeshiamey11@gmail.com, <sup>5</sup>rahulkhairnar569@gmail.com**ABSTRACT**

*Machine dishwashers are a distinctive consumer appliance since they are often replaced with manual dishwashing. Although some studies indicate machine dishwasher does not use much energy and water than manual dishwashing, their scopes are limited to the use phase. Our study evaluates the design & development of machine for dishwashing. Due to the dishwasher the cleaning and drying dishes becomes much easier and more efficient. This project work has been came up with the difficulty in washing of any type of plates. Our survey report shows that the maximum difficulties occurred in washing dishes manually. The washing power contains the chemical substances which may be harmful to human hand. The suitable device has been developed to overcome the problems encountered during manual dishwashing. From that the dish washing can be easily done without application of any extra force. By using semi-automatic dishwasher, we can not only reduce time but also human efforts significantly. In conventional dish washing process large amount of human power as well as quantity of water is used. So keeping that in mind to reduce this automatic dish washing machine is developed.*

**Keywords:** Automation, dish washing, energy efficient, low cost

**Introduction**

Dishwashing is the daily performed activity in the world. In India, the manual process of washing is done by hand scrubbing which is straining to the muscles through its energy and postural requirements. It may also affect the operator's health due to clinical, anatomical disorders and back pain. So in several ways which we can improve their lifestyle, and one aspect that we can improve on is the way they wash their dishes. Currently the day to day task of washing dishes is performed, and can be very labor intensive as it is done for up to several hours each week. The same can be analyzed in marriage ceremony with caterers. In today's world of Automotive Era it is rarely possible to find any field that implemented atomization which reduces Human effort, improves Production rate and also increases Efficiency.

Because of the less knowledge of automation, our country is not getting enough benefits from it. However this fear is not seen in the product which does not involves much Sensors, Complex Electronic Circuits, and simple easy User Friendly devices. This automatic dishwasher are used on mass scale in foreign countries, however the same is rarely seen in our country. The dishwasher has made cleaning

and drying dishes much easier and more efficient. We also discuss the problems faced in usage of Automatic Dishwasher and solutions on those problems. Automatic dishwashers are costly and uses large amount of energy and time.

Due to the cost issue, the usage of automatic dishwasher in our country is very less. B we can reduce time as well as human efforts significantly by using semi automatic dishwasher. Also by using plastic material for casing part, the overall weight of the assembly is also reduced. In conventional dish washing process consumes large amount of human power as well as quantity of water. So keeping that in mind, to reduce the time this semi automatic dish washer is developed. We can also use this in places where there is vast use of dishes for example, marriage ceremony. This dishwasher is useful for household purpose, which can save time and cost rather than spending in washing dishes by hand and wasting large amount of energy.

**Literature Review**

Shilpa N. Dehedkar, done the work on, Design of basic model of semi-automatic dish washer machine, according to her work, Main aim of semi-automatic dish washer machine is to reduce human efforts and time with its

innovative simple design which is also environment friendly. A dishwasher is a low-cost machine made up of easily and readily available parts in daily life. The model of semi-automatic dish washer machine is new concept, which in its one washing cycle does all the operations of conventional dish washing i.e. spraying soda water, scrubbing with brush and rinsing with clean water similar to fully automatic dish washer machines in market. The dishwasher operates with help of DC motor, Universal motor, conveyor belt and microcontroller for time delay. Dish which is placed on the conveyor belt enters the first washing chamber where it is cleaned with soda water and scrubbed with the brushes. This is then passed to next chamber where it is rinsed with the clean water and finally moves out as a complete washed dish. The basic model of semi-automatic dish washer machine is designed to reduce human efforts with saving in time while increasing the efficiency for washing a dish. It satisfies the need of small restaurants or family which are not able to buy expensive full automatic machine. The model is built with very basic material and can be more standardize by altering motor used. The product designed has minimal operating cost, cost effective, eco-friendly and it can be used with almost zero efforts. [1]

SuhasHukire, Anant Thorat, Vaibhav Shinde, Babasaheb Shetake, RutikaIngavale, Prof. Avadhut Jadhav, done the work on, Semi-Automatic Dishwashing Machine, according to his work. In this paper the construction and performance of dish washing machine is discussed. Performance of machine is compared with manual and automatic dish washing. The parameter includes time and quantity of water. This machine is used for the dish of diameter 20 cm. The current model of semi-automatic dishwashing machine is designed to reduce human efforts with saving in time while increasing the efficiency for washing a dish, minimize time required to wash dish, minimize quantity of water require to wash dishes. It satisfies the need of small restaurants which are not able to buy expensive full automatic machine. The model is built with very basic material and can be more standardize by altering motor used. The product designed has minimum operating cost,

cost effective, eco-friendly and it can be used with almost zero efforts. This model is more efficient than automatic and manual method for time of cleaning and water used for cleaning. [2].

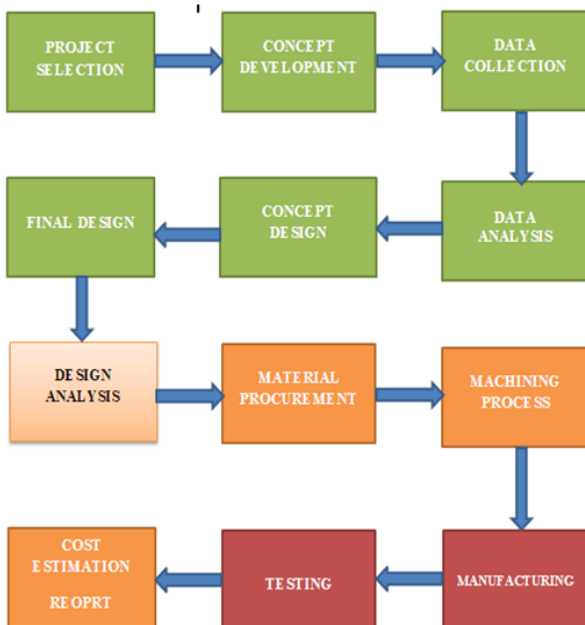
Shaila S. Hedaoo, Dr.C.C. Handa, V.D.Dhopte, done the work on, Fabrication of Semi-Automatic Dish and Utensil Washing Machine, according to his work, dish and utensil washing are most difficult and time consuming work. But if it is done by Automatic dish washing machine, it become costly for every person. So that we introduce Semi-automatic dish and utensil washing machine. The dishwasher has made cleaning and drying dishes much easier and more efficient. This Concept discusses the problems faced in Automatic Dishwasher and solutions on those problems. Automatic dishwasher uses large amount of energy, time and is costly. And being costly, the usage of automatic dishwasher in our country is very less. By using semi-automatic dishwasher, we can reduce time as well as human efforts significantly. Also by using Galvanized iron material for inner & outer part, the overall weight of the assembly is also reduced. The capacity of machine is to wash 24 pieces of dinner set at a time by using two rotary jet controlled by single pump using parallel connection.[3]

D.Meganathan, P.Pradhip, M.Sanjaikumar, S. Venkatarajulu, done the work on, Design and Fabrication of semi-automatic Dishwasher, according to his work, semi-automatic dish washer machine is to minimize human efforts with its innovative simple design which is also eco-friendly. A dishwashing machine is made of cheaply available materials which are used in our daily life. This model of semi-automatic dish washer machine is new concept, in which the plates are placed in vertically and in its one washing cycle does all the operations of conventional dish washing i.e. spraying of soap water, scrubbing with brush and rinsing with clean water similar to fully automatic dish washer machines. These dishwashing machines are very efficient to operate. This semi-automatic dish washing machine, it is found that mostly the studies are carried out on the way the plates are placed, time and energy consumption. Thus the project based on the

way of plate being placed in the dishwashing is made experimentally.[4]

### Methodology

The way to work is the process of launching and developing a project. The purpose and success of a project depends on how well the strategy works to achieve the outcome. The operating procedure describes each step to accomplish the flow task sequence from the beginning until the result is achieved. All results obtained are evaluated and improved until the best possible result comes out and will be taken. This operation will be and get some serious consequences for trial and error here. The below flow chart shows the sequential operation/steps that will be performed during the process.



**Fig.: Flow Diagram of methodology**

### Working Principle

Dish washer with siphons in which water is move through PVC pipes which is associated with turning planes which is in upper side and descending side with sprayer stationary nozzle. These water streams are sprinkling the water with required weight on the plates and utensils. Controller is given in the machine which controls the activity of machine. Water utilization of this machine is relies upon client. Time, water and vitality utilization are extremely less. Automatic micro controller is use to change over input electronics vitality to Mechanical vitality output. At the point when

electronics vitality converts to mechanical vitality, water suck by outward siphon and it goes through funnel to revolving sprinkler nozzle plane which is equal associated. Water stream tosses the water into plates and utensils at some weight for cleaning reason.

Dishwasher pipe joins flow water and soap solution as per demand into powerful mixed at that point showers it on the dishes. The dishwasher at that point sprays out the water containing food particles that have been expelled from the dishes, and washes the dishes with clean water. After cleaning out the dish from wash water, leave the dish for drying. The working of the Utensils washer is to give the mechanical activity important to disseminate and coordinate the cleanser arrangement and flush waters over, under and around the dishes to slacken.

The dishwasher should likewise expel waters from the machine after each period of the cycle and give drying of dishes after the cleaning procedure has been finished. The motor is rotating the shaft with utensil carrying trays pivoting plate by sprocket and chain system. The pole turn relies on the revolution of motor by sprocket chain system. The soap solution as well as clean water is splashed to the turning plate by chain drive.



**Fig.: Fabricated Model**

### Testing and Result

Electricity Consumption:

Total Power used by machine = 84 W  
= 0.084 KW

= 0.06111 Kwh

$$\text{Power used for each cycle} = \frac{0.084 \times (t_c + t_s)}{3600} \text{ Kw}$$

### Result table

Sr. No	Load (kg)	Cycle time (sec)		Water consumption (litre)		Cleanliness	Electricity consump <sup>n</sup> for each cycle (Kw)
		Clear water (t <sub>c</sub> )	Soap sol <sup>n</sup> (t <sub>s</sub> )	Clear water	Soap sol <sup>n</sup>		
1	2	60	30	5	2.5	Good	0.0021
2	4	60	30	5	2.5	Good	0.0021
3	6	120	40	10	4	Good	0.0037
4	7	140	60	15	5	Good	0.0046
5	8	180	60	15	5	Moderate	0.0056

### Result

The machine performs well and satisfies its purpose to a large extent. As the load and cycle time increase the water & energy consumption of machine also increases. The cleaning capabilities of machine is slightly reduced at full load condition.

### Conclusion

From the study semi-automatic dish washing machine, it is clear that function of machine is like washing dishes, utensils, cups, glasses, spoons etc. Following are the conclusion of semi-automatic dish washer.

- The performances of the machines are better than automatic dish washer and manually dish washing.

- Low maintenance and easy to operate.
- Design is simple and very efficient.
- Less time and water consuming machine.
- Cost is less than automatic dish washer.
- Every component of this machine is easily available in market.
- Semi-automatic dishwashing machine can be purchased by every type of customer.

### Future Scope

Semi-automatic dishwasher is new to the Indian society, so our work begins with spreading awareness about it. For the further use we can provide fully automated kits. Moreover to reduce energy consumption, we can shift to solar powered semi automatic dishwasher.

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**SYNTHETIC APERTURE RADAR IMAGE ANALYSIS FOR CHANGE DETECTION****Sushant J Pawar<sup>1</sup>, Dr. S. T. Gandhe<sup>2</sup>**<sup>1</sup> Research Scholar, Savitribai Phule Pune University, India<sup>2</sup> Professor, Sandip Institute of Technology & Research Centre, Nashik, India**ABSTRACT**

*Change detection using SAR images is a significant application within the wide space of remote sensing like deforestation, maritime surveillance, defence / civilian sector for security, disaster management, etc. Change Detection in SAR image could be a difficult task, as these images are intrinsically affected with the speckle noise & strong clutter interference due to backscattering. An environmental challenge for change detection from SAR includes image quality and camouflage. Device sensor-based challenges embody restricted resolution, image process indicant, miniature or sparkling objects indications, and low object to background signal to noise ratios, etc.*

*Here proposed the elaborated literature review on the change detection in SAR representational process on associated problems in SAR images. Major three issues in SAR images, Range Cell migration, Speckle noise, complex clutters are elaborated within the discussion.*

**Keywords:** Change detection, Range Cell Migration, Radar Cross Section, Synthetic Aperture Radar, Speckle noise, Signal to clutter noise

**Introduction**

The continuous movement of the space-borne systems around the globe renders them an ideal source of information for the identification of changes occurred on the earth surface.

Imaging techniques currently type a vital a part of radiolocation use, and high-resolution pictures from aircraft and satellites area unit used for remote sensing environmental observation. In the last few decades, the remote surface has enjoyed a growing amount of attention due to a variety of emerging military and civilian objectives. Based on the objectives, the remote sensing task differs in many ways. For example, the ground area of interest may be as small as the area of ground a military vehicle for reconnaissance and targeting information to military applications, or as large as a whole continent. Today ground moving target indication and imaging is no longer limited to military applications. A synthetic Aperture Radar target indication and imaging systems flying at high altitude can also have other potential applications, such as for civilian application, such as for civilian wide area traffic monitoring, maritime traffic monitoring, such as ship detection which has evolved into an important research topic during last year's. For example traffic monitoring centers for ensuring the mobility and safety of the users etc.

The appealing unique features of the Synthetic Aperture Radar, like all-weather capabilities and independence of daylight, so it is free from the illumination kind of changes, it is complementary information to the optical systems, high penetration of radar wave as well as geometric resolution is independent of the distance. Synthetic Aperture Radar takes benefit of these uniqueness of radar signals and complex information processing capability of recent digital electronics to provide high-resolution imagery. The kind of applications for civilians is hitherto properly not explored as a result of less price instruments are simply beginning to create synthetic aperture microwave radar technology cost-efficient for a smaller scale. However, these imaging technology systems might be used in the near future to fill the information gap, especially if the information is required a non-regular basis as in the area of major events. Hence in this paper, we explore the detail analysis & understanding of synthetic aperture radar images for major application processing related to the object detection on global dimensions. Acquisition of SAR images faces certain problems, due to which it exhibits difficulty for effective object identification.

**II. Literature review**

In the last few decades, many developments have been made in the area of Synthetic Aperture Radar imaging & related signal

processing mechanism, because it provides the unique information to solve many society related problems of global dimensions. Therefore Synthetic Aperture Radar imaging has become a high level and powerful monitoring tool, used in a wide range of surveillance applications. It creates a great interest in the scientific community as well as for commercial & security related applications. Following are the list of some of the potential applications, It is observed that several techniques & methodologies have been developed related to object detection in Synthetic Aperture Radar Imagery in the last decade to deal with the different issues in the SAR images.

Viet Thuy Vu et.al. [1] Proposed the false alarm reduction in the change detection of SAR images. The false alarms are caused due to the different kinds of backscattering from the earth surface this includes elongated structures, manmade objects, foliage, etc. To deal with this kind of backscattering presented the available signal processing mechanism which includes adaptive noise canceller, Manual thresholding followed by the Morphological operations. This kind of signal processing mechanism able to handle the false alarm caused due to the manmade structures. But need advanced adaptive signal processing techniques to deal with the major backscattering problems due to adaptive noise caused due to other than manmade objects. This has been suggested to use the multitemporal & multispectral SAR images to handle the problem of backscattering. Maoguo Gong et.al [2] proposed the change detection in SAR using deep neural network analysis to automate the noise reduction due to backscattering. Identified the most important downside within the SAR images because of backscattering referred to as speckle noise that is inherently present within the SAR image. Therefore the primary task of analyst to get rid of the speckle noise. Speckle noise could be a granular noise like salt & paper that inherently exists in and degrades the standard of the active measuring systems. The majority of surfaces, synthetic or natural are very rough on the size of the wavelength. Image obtained from these surfaces by coherent imaging systems suffers from a common phenomenon

called speckle Noise. Change detection is widely used in various disciplines such as remote sensing, disaster evaluation, medical diagnosis, and video surveillance. In particular, when a natural catastrophe strikes, an effective and efficient change detection task appears critical when lives and properties are at stake. It proves to be an important application of remote sensing technology. However, due to speckle noise, it exhibits more difficulties for change detection. One of the solutions proposed i.e. ratio method for difference image for speckle noise reduction [2]. Conventionally difference Image analysis uses thresholding followed by clustering methods. Deep neural analysis provides better performance than the existing methods but at the cost of high computational cost, have the problem of underfitting & sometimes Overfitting. It shows the different results for different images from different sensors. Feng Gao et.al [3] provided the automatic change detection methodology using PCA-Net for multitemporal SAR images. With the recent development in the earth observation program, there is more and more development in the SAR image sensors. It is capable to produces hundreds of images; hence require an automated process to analysis of these many images for different kinds of applications. Used two multitemporal SAR images, Gabor wavelets and fuzzy *c*-means are used to choose involved pixels that have a high chance of being modified or unchanged. A new image patches focused at involved pixels are generated and a PCA-Net model is trained using these patches. Pixels within the multitemporal images are classified by the trained PCA-Net model. PCA-Net classification result and therefore the pre-classification result are combined to make the concluding modification map. Vincenzo Carotenuto et.al [4] proposed the new approach is in position to provide scale-invariant decision rules, providing benefits in terms of sturdiness to intensity mismatches as well as inaccurate and false alarm rejection. This is an important property as images over the same scene can exhibit different intensity scales due to different observation angles and propagation properties. This type of framework provides to each enhance the strength of the detectors with regard to intensity inaccuracy effects & to

force the constant false alarm reduction feature at the design stage. It lack of accuracy due to the specular noise. Fatih Nar et.al [5] proposed to reduce a variable cost function. Within this cost function, a floating distinction map is obtained with the use of two log-ratio terms where smoothness is imposed and speckle effects square measures reduced employing a 1-norm total variation (TV) regularization term. During this new constraint are often introduced by adding necessary information or regularization terms. Hence deliberating only amplitude information it troublesome to find the potential variation within the region of interest.

Ding Tao et.al [6] proposed the segmentation-based CFAR detection algorithm using truncated statistics for oceanographic applications. It deals with two problems of target detection in the nonhomogeneous sea-clutter environment. The capture effect from interfering outlier & the clutter edge effect from background intensity transition. The performance of this system strongly relies on the accurate statistical modeling of the local background clutter measurements due to multiple targets & meteorological & Oceanographic phenomenon. This uses the sliding window technique CFAR for single look complex SAR images using truncated statistics for multi-look intensities. On the other hand, the Conventional sliding window is often contaminated. One common source of contamination is multiple interfering targets, which usually occurs in dense target situations, such as busy shipping lines, offshore oil/gas production sites, and crowded harbors. Joint use of multifrequency & multipolarization data to further improve the effect of diversity (false Alarms).

Bovolo et.al [8] proposed the stability of UWB low-frequency SAR operating on the very high frequency (VHF) and ultrahigh frequency (UHF) band, is very efficient for change detection (CD). Change can be detected by subtracting samples of image magnitude. Consideration of Gaussian statistics are stable for sub-vectors then the noise mainly caused due to thermal noise instead of speckle noise. Due to the Gaussian statistics performance of the systems efficiently less, alternatively

bivariate distribution further exploring the properties of the backscattering in the images. Francesca Bovolo et.al [10] proposed the SAR image statistics and adaptive signal processing for change detection. Change detection suffers mainly due to speckle noise & coherency. A possible solution provides using the Adaptive line enhancer (ALE) for change detection and linear subtraction, which can approximately be represented by the probability density function of the Gaussian or normal distribution. It deals with only amplitude change detection no phase information considered. Hence it has low computational complexity but it fails to handle the false alarms that come from the elongated structures. Carlo Marin et.al [11] proposed the automatic method for detection and reconstruction of building radar footprints from Single VHR SAR Images. The few number of features are available for small buildings hence it increases the false alarm in detection. It uses thresholds to detect only large size building to avoid false alarms. For urban area change detection more numbers of features to be considered for increased detection performance. Lars M. H et.al. [12] Proposed the architecture for the identification of multiple modifications in bi-temporal & multispectral remotely sensing images to conquer the limits of unsupervised methods. This rely on a compressed 2D representation of change information & two-step automatic decision taken strategy using Change vector analysis & Bayes decision rule. It is important to note that, in complicated change detection issues some ambiguity might arise from the dimension reduction methods, mainly due to the simplified illustration of the angle variable. This might end in a loss of data. It's important to note that the processing complexity grows with the scale of the investigated scene [13]. Hence, in order to process the full image, parallel computing solutions could also be thought of. Dominik Brunner et.al [14] proposed a graded approach to change detection in VHR SAR images for monitoring applications. It is important to note that, the idea on the provision of the previous information on the usage of various areas is reasonable since the strategy has been developed for high-frequency monitoring of

sensitive areas like as maritime ports, airports, etc.

Urban sprawl may be a worldwide challenge. It's necessary to observe the land-cover changes occurring with populated area and create plans for continual development [15]. The difficult task is to incorporate the geometrical distinction of buildings caused by the various read angles of sensors in multitemporal images, further because the conditions of shadow ensuing from different solar elevation angles. The attainable resolution is to add the spatial attributes with the spectral data for multitemporal image analysis. This used the unsupervised method for change detection, comparing with the structure of building instead of pixel matching techniques. In change detection analysis of information indicate that the improvement in the change detection reduces for increasing angle of incidence, principally because of reduced target radar cross sections [16]. Vehicle-sized targets change detection performance, in forest concealment has been investigated for VHF -and UHF -band SAR systems with the use of co-polarized data. It is harder to attain coherence between the candidate and target images using higher frequency systems where; for example, little changes within the flight trajectories could result in low coherence. A detector used for one angle of incidence isn't essentially helpful for an additional incidence angle. Wan Jing Meng et.al [17] proposed the method for False alarm reduction using SAR CCD, known as CLEAN which indicate clutter location, Estimation, and negation to remove different sets of false alarms, which enhance the identification of true modification in CCD. The SAR CCD includes the applications of search and rescue operations and activity monitoring. The uniqueness of SAR CCD as compare to the other is, it uses phase information with amplitude enabling the detection of changes that are on the order of the radar wavelength rather than the image resolution. SAR CCD is a coherent change detector, which is more sensitive & competent of finding tiny changes like tire tracks left on the bottom.

Francesca Bovolo [18] proposed the standard framework architecture for a wide variety of change detection problems. A general abstract

framework that aims at giving classification of various radiometric modifications that occurred when concern with very high resolution (VHR) remote sensing images. This represents the initial step towards a valuable guideline for a new generation of change detection methods. Using this guidelines sources of false alarms are exactly known & mitigated, multiple changes occurred on the ground can be classified. The proposed model of architecture could be used for comparisons of VHR images having diversified properties and/or acquired by multiple sensors. This could be achieved by selecting appropriate abstraction levels for defining the change detection algorithm. Mikael Lundberg et.al [20] applying the properties of registration noise in very high resolution images, the projected method analyzes the distribution of the spectral change vectors computed according to the change vector analysis in a quantized polar domain. With the definition of adaptive homogeneous regions both in the temporal & spatial domain the spatial context information is designed. The planned technique strong to registration noise within the VHR images, however residual false alarms are present in the estimated change detection map, this is mostly associated with the radiometric changes tempted by seasonal changes that are irrelevant. F. Bovolo et.al [22] proposed a method which is alternative to pixel-based change detection in VHR images. Significant findings of this method is that it neglect high-resolution levels will effect in the loss of sensibility to boundaries & geometrical details, also ignoring low-resolution levels will cause poor accuracy in homogeneous areas. Compare with standard pixel-based technique, proposed technique have sharply higher accuracy.

Generally, there are three methods of change detection: (1) pixel-based methods, (2) segment-based methods and (3) feature-based methods. Pixel-based methods & segment-based method have the problem of missing small changes, to overcome this a feature -based methods will be useful [23]. Pixel-dependant, change detection results affected by SAR speckle to a certain extent and produce some remote and inaccurate regions. L.M.H. Ulander [25] proposed the Signal Subspace Change Detection in Averaged Multilook SAR

Imagery this addresses the Change detection technique based on hypothesis, used 2-D adaptive filter called signal subspace processing to detect the surface landmine for the area under surveillance. A coherent, single look, normalized signal subspace difference change detection performs slightly better than the ratio detector. Due to the presence of clutter, it causes false alarms in change detection. Generally Averaged multi-look SAR images are preferred for full-aperture SAR reconstructions when the imaging algorithm is approximation-based or when motion data are not accurate over a long full aperture. Lorenzo Bruzzone et.al [26] proposed a theoretical framework for unsupervised change detection based on change vector analysis (CVA) in the polar domain. The goal is to present a set of formal definitions in the polar domain for better understanding of the information present in the spectral change vectors. Which also analysing the distribution of changed & unchanged pixels theoretically. Based on these theoretical results implementing a pre-processing procedure for multitemporal images. Which defines the fundamental background for the development of advanced & accurate automatic change detection algorithms in the polar domain. Further, need the reformulation of threshold selection algorithms derived from the theoretical analysis.

The preservation of geometrical details is an important sub-step in change detection [28]. This is caused due to the different types of speckles present in the acquired images & it exhibits different characteristics. The proposed approach exploits a Wavelet-based multiscale decomposition of the log-ratio images (obtained by the comparing of the original image data). The final detection result obtained according to an adaptive scale-driven fusion algorithm (pixel-based). In this selection of fusion algorithm is an important step for multiple data fusion challenges. Jong-Sen Lee et.al [29] proposed algorithm based on coherent & Incoherent change detectors. Development concludes that incoherent change detectors perform better than the coherent change detectors due to low complexity. In this to reduce the false alarms need multiple passes. Lorenzo Bruzzone et.al [30] proposed key

problem associated to the unsupervised change detection methods based on the "difference image" lies in the lack of competent automatic technique for classification between new & unchanged pixels in the difference image. Proposed two automatic techniques based on the Bayes theory for the analysis of difference images. One is assuming pixels in the difference image are free of one another, automatic threshold that minimizes the overall change detection error problem. Another analysis of the difference image by considering the spatial- contextual data included in the vicinity of each pixel based on the Markov Random Fields that explore the interpixel class dependency context. The requirement for both the methods is the understanding of the statistical distribution of the modified and unmodified pixels in the difference image. This can be achieved by using expectation-maximization algorithms iteratively.

Dekker et.al [31] proposed speckle filtering in satellite SAR change detection imagery, which is multiplicative in nature. An introduced a new technique based on filtering the logarithmic- scaled ratio of SAR images. Logarithmic scaling changes the increasing speckle noise within the ration image into additive noise and alters the distribution, which may be filtered exploitation the next filtering method. This has been tested on the urban area but more accuracy can be achieved by using the Bayesian filter at the expense of complexity. The disadvantage of this method is it does not give the difference between relevant irrelevant changes.

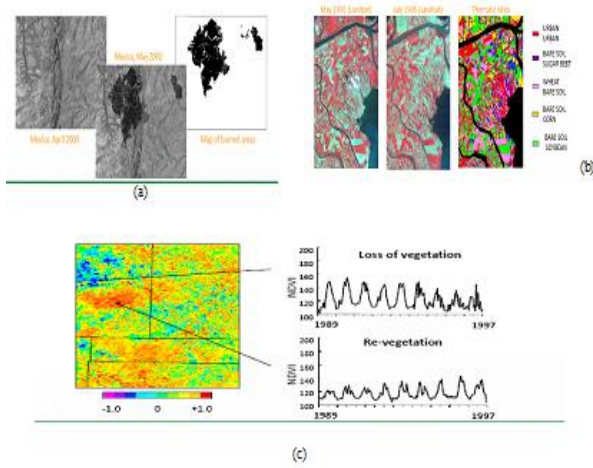
### Change Detection of SAR Image

Change Detection: "Process that analyzes multi-temporal & Multispectral VHR remote sensing images acquired on the same geographical area for identifying changes occurred between the considered acquisition dates".

Following are the different change detection problem identified from the literature which depends on the type of application of Synthetic Aperture Radar.

1. Binary Change detection: Detection of Abrupt (step)Change

2. Multiclass Change detection: Detection of multiple Changes, Updating Thematic Map.
3. Change detection in long time series of Images: Monitoring Seasonal / annual Changes



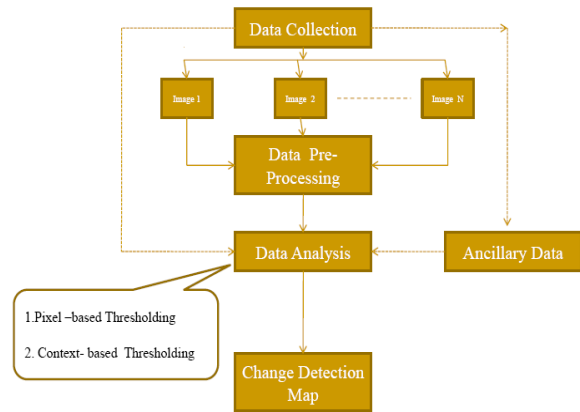
**Figure.1. Change detection problem (a) Binary Change Detection (b) Multiclass Change Detection (c) Change Detection in long time series of Images**

Binary Change detection is ineffective for some of the multi-temporal image analysis due to several peculiar factors:

1. Differences in light, sensor calibration, & ground moisture
2. Absence of reference background
3. Lack of prior information about the shape changed area
4. Non-perfect alignment (Registration Noise)
5. Different acquisition conditions (View, Angle, and Shadow, etc)

**A. General Architecture of Change Detection:**

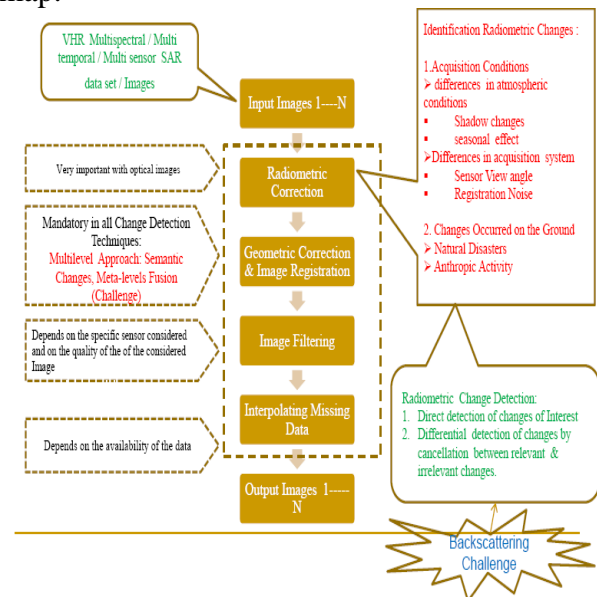
Following figure.2 shows the general architecture of Change detection which is useful to address the change detection problem. Which shows the first multiple images are combined together for data preprocessing then followed by the data analysis using ancillary data this is done by using one of the thresholding method from the pixel-based thresholding & context –based thresholding, then followed by the change detection map using priority data.



**Figure.2. General Architecture of Change Detection**

**B. Data Pre-processing Map:**

Following figure 3 shows the Data Pre-processing Map which elaborates the top-down approach for change detection which defines the hurdles in each step and major cause in the change detection due to backscattering. This approach is very effective for change detection using a few ancillary data for change detection map.



**Figure.3 Data Pre-processing Map**

**C. Comparison Techniques / Operator:**

The following are the different comparison techniques used for both optical images and SAR images.

1. Differencing:
  1. Univariate image differencing
  2. Vegetation index differencing
2. Change vector analysis
3. Regression

4. Principal component analysis
5. Image Rationing :
  1. Ratio detector
  2. Log-Ratio detector
6. Kulback- Leibler distance (similarity Measure)
7. Differences of scattering matrix element product
8. Differences of scattering matrix amplitude correlation coefficient Images

**Analysis of SAR Image**

As stated in the literature as Change detection using SAR is a challenging task because the SAR image consists of three major issues. In subsequent points discussed the details of each.

**1. Range cell Migration:**

RCM is the distance between the radar and any fixed point on the ground/ ocean is changing within the synthetic aperture time. This can be modeled by the following equation.

$$RCM = \sqrt{r_0^2 + (vt)^2} - r_0 \approx \frac{(vt)^2}{2r_0} \dots\dots(4.1.1)$$

where  $r_0 \rightarrow$  shortest approach distance / slant range  
 $vt \rightarrow$  sensor velocity

If not correcting the RCM will result an azimuth defocusing when

$$RCM_{max} = RCM(t = t_{ill}/2) > \frac{\delta_a}{2} \dots\dots(4.1.2)$$

where,  $t_{ill} \rightarrow$  illumination time a point on the ground is observed.  
 $\delta_a \rightarrow$  azimuth resolution given by smallest separation between two point targets that can be detected by the radar.

in this case, the point target energy is distributed over several range cells and hence the data need to be correlated with a non-stationary two-dimensional reference function, therefore making the accurate correction of RCM the challenging aspect of SAR focusing.

**2. Speckle Noise:**

A kind of effect to be seen in SAR images is called *speckle*, reason is that of presence of many elemental scatterers with a random distribution within the resolution cell. Strong fluctuation of the backscattering from the resolution cell to the resolution cell which is the result of coherent sum of amplitude & phase. Similarly the intensity and the phase in the end image are no far deterministic but follow instead an exponential and uniform

distribution, respectively. The total complex reflectivity for each resolution cell is given by

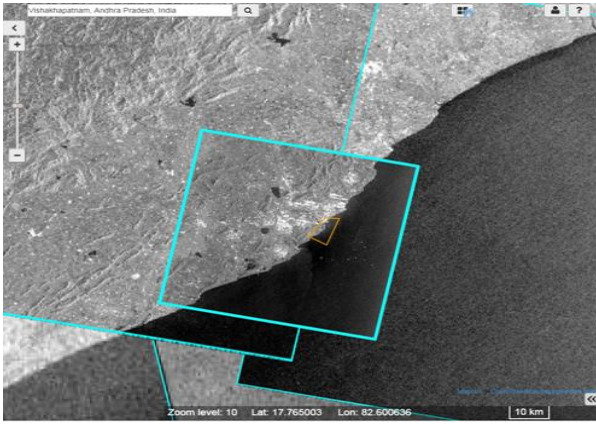
$$\Phi = \sum_i \sqrt{\sigma_i} \exp(j\phi_i^{scatt}) \cdot \exp(-j \frac{4\pi}{\lambda} r_{0,i}) \dots\dots(4.2.1)$$

where,  $i \rightarrow$  no. of elemental scatteres within the resolution cell  
 $\sigma_i \rightarrow$  radar cross section interms of intensity value  
 $\phi_i^{scatt} \rightarrow$  Scattering phase  
 $\frac{4\pi}{\lambda} r_{0,i} \rightarrow$  azimuth phase variation due to the changing distance

speckle is truly a physical measurement of the resolution cell at a sub-resolution level. While it is commonly referred to as noise, speckle can't be minimized by increasing the transmit signal power, since it has a multiplicative in nature, i.e., its variance increases with its intensity. To reduce speckle a method known as multi-look is used, which is basically a non-coherent averaging of the intensity image since SAR is a coherent sensor. While multi-look causes a reduction in the image resolution, it significantly enhance the representation of the SAR image. Also, the effect of speckle tends to minimize for very high-resolution systems, since the number of elemental scatterers within a resolution cell reduced.

**3. Complex Clutters:**

The clutters are produced due to the ground /maritime discontinuity effect due to the wind, wave and currents, islands, and other manmade objects are facilitating to appear. High backscatter may be regarded as the target, whereas a target with low visibility or low backscatter may lead to miss the detection. This leads to a small signal to clutter noise ratio (SCNR) degrades the performance of detection because consideration of only the intensity parameter will not work. Thus Improving signal to clutter noise ratio (SCNR) is a key to solving some problems. Change detection performance is positively correlated with the SCNR in the SAR image. Therefore selecting best polarimetric SAR Image including more features, Parameters (Imaging mode, Spatial resolution, Incidence angel, pixel size, polarization channels) estimation requires for improving the change detection performance and the reduction of false alarm. Following figure.4 shows the sample Radarsat-2 SAR images.

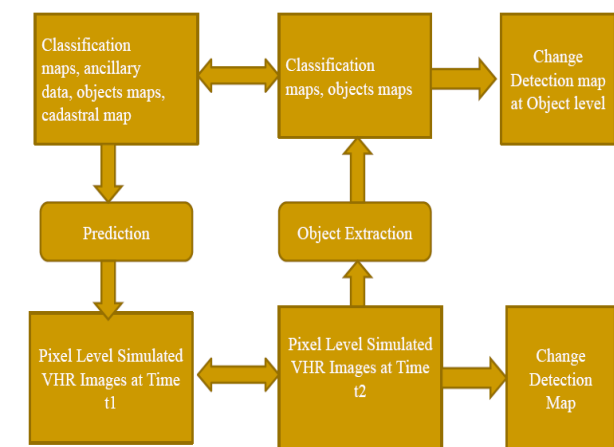


**Figure.4 sample online Radarsat-2 SAR images near the Vishakhapatnam coastal region**

**Discussion**

1. With the existing research, it has been observed that the major challenge area in the SAR image processing lies in Reconstruction, Detection, Tracking, and Recognition.
2. Reconstruction of the SAR image mostly relies on the sensors calibrations i.e. the reconstruction can take place over the timing of multiple intervals and sensor trajectories.
3. Detection of an object in the SAR image is a challenging task, as these images are intrinsically affected with the speckle noise & strong clutter interference (buildings, hills, power lines, trees, sea, rain, etc) due to backscattering.
4. An environmental challenge for detection from SAR includes scene intricacy and camouflage. Sensor-based challenges include limited resolution, image processing vestige, small or sparkling objects signature, and small object to background signal noise ratios.
5. Hence investigation of efficient processing for finding actual type & scattering characteristics of an object mentioned above still deserves due to the increasing demand for the application.
6. From the analysis, it is observed that the "Top- Down" architecture of Change detection will give maximum accuracy. Analysis and exploitation of time series and multitemporal images is a very important topic both from the methodological and the application perspective.

Combination of Top-down & Bottom-up approach is the effective solution for the different complex change detection problem. The architecture of the combination is shown in the following Fig. 5. The final expected outcome of this approach will enhance the change detection performance by improving some qualitative parameters in Synthetic Aperture Radar Images. It will eliminate the associated noise and suppress the clutters; hence it will have a high false alarm reduction rate. This method will also improve some quantitative parameters, which will be efficient in terms of accuracy & computational complexity.



**Figure.5 Top-down & Bottom-up Approach for change detection.**

**Conclusion**

Analysis of Synthetic Aperture Radar imagery for change detection, it is important to conclude that the combination of Top-down & Bottom-up approach is an effective solution for the different complex change detection problem. From the presented analysis, there are three major issues in the SAR images namely, Range cell Migration (RCM), Speckle Noise & Clutters. For RCM correction data need to be correlated with a non-stationary two-dimensional reference function. To mitigate speckle a technique known as multi-look is utilized, which is basically a non-coherent averaging of the intensity image since SAR is a coherent sensor. Therefore more features, parameter estimation requires for improving the change detection performance and the reduction of false alarm. The use of



polarimetric SAR image data is one of the promising solutions to said issues.

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## A REVIEW PAPER ON MACHINING OF $\alpha$ - $\beta$ TITANIUM-ALLOY (Ti-6Al-4V) USING PVD & CVD COATED CARBIDE INSERT FOR GREEN MACHINING

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### ABSTRACT

As we know that today every manufacturing industry is working on optimum cost for machining process by effective optimization of various process parameters like speed, feed & depth of cut. In this paper we studied the various paper of machinability issues on  $\alpha$ - $\beta$  Titanium alloy (Ti-6Al-4V) by using PVD and CVD coated inserts which is widely used in various fields such as automotive, aerospace and bio-industry, nuclear plant and medical application because of titanium alloy is having a highly specific strength material, excellent mechanical characteristics such high hardness, corrosion resistance, specific strength and bio-compatibility, due to this titanium alloy is very much difficult to machine because its internal mechanical properties like ability of high strength at elevated temperatures, low thermal conductivity high hardness. Moreover, titanium alloys lower thermal conductivity and high specific heat limit the effective removal of heat developed during machining through workpiece and chips. In this paper we worked on literature study of optimization of process parameter of turning operation of machining process for improvement in surface roughness and reduction in tool wear on titanium alloying  $\alpha$ - $\beta$  Titanium alloy (Ti-6Al-4V) material by different methods.

**Keywords:** Machining,  $\alpha$ - $\beta$  Titanium alloy Ti-6Al-4V, speed, feed, depth of cut, surface roughness, tool wear, PVD and CVD

### Introduction

Ti-6Al-4V alloy is a versatile material for industrial applications because of its high strength to weight ratio, combined with high ductility and corrosion resistance but at the same time considered as a difficult to machine material. Past studies [1–15] indicated that some reasons for difficulty in machining Ti and its alloys include: (i) high temperatures generated in a narrow adiabatic shear band (ASB) as a result of localized shear concentration and poor heat dissipation due to low thermal conductivity of Ti, (ii) segmentation in chips due to non-homogenous deformation and localization of heat resulting in the formation of ASB. It was reported that the formation of ASB is usually associated with cyclic variation in the cutting forces. This in turn causes vibrations affecting the work piece tool machine system stability, (iii) continuous contact at or near the apex of the tool with the segment being formed due to lack of relative motion between the segment and the tool face for a considerable portion of the chip segmentation cycle, (iv) unusually small contact area with the cutting tool (about one

third of that of steel at same feed rate and depth of cut) that causes high stresses at the tip of the tool, (v) high reactivity of titanium with conventional tool materials such as cemented carbides, borides, or nitrides resulting in dissolution wear at high temperatures. Thus, to maintain a reasonable tool life (flank wear less than 200  $\mu$ m), current machining practices in industry employ various coolants to reduce the cutting zone temperature. Flooded machining and cryogenic cooling strategies have been employed in machining of titanium alloys to reduce the cutting zone temperature and influence chip segmentation.

### 1.1 Properties of Titanium alloy (Ti-6Al-4V)

**Table 1.1 Chemical composition of Ti-6Al-4V** (Ezugwu and Wang, 1997)

Element	%	Element	%
C	<0.08	V	3.5-4.5
Al	5.5-6.75	N	<0.05
Fe	<0.4	H	<0.01
O	<0.2		
Ti	Balances		

**Table 1.2 Mechanical Properties of Ti-6Al-4V** (Machado and Wallbank, 1990)

Work piece material	Tensile strength (MPa)	Yield strength (MPa)	Elongation %	Modulus of Elasticity (GPa)	Hardness (HRC)
Ti-6Al-4V	993	830	14	114	36

**Table 1.3 Thermal Properties of Ti-6Al-4V** (Ezugwu and Wang, 1997)

Specific heat capacity	0.5263 J/g <sup>0</sup> C
Thermal conductivity	6.7 W/mk
Annealing temperature	700-785 <sup>0</sup> C
Melting point	1604-1660 <sup>0</sup> C
Solidus	1604 <sup>0</sup> C
Liquidus	1660 <sup>0</sup> C
Beta transus	980 <sup>0</sup> C

### Literature Review

Various researchers have contributed to address issues related to machining of Ti-6Al-4V. Few major studies are mention as below.

**A R Machado et al, (1990)** In this paper the types of titanium alloys, their properties are discussed also varies factors like specific machining problem, surface integrity, cutting temperature and stresses and wear mechanism are discussed. Many non-conventional manufacturing methods of titanium alloys are also given like ledge tool, rotary tool, UAMR, free machining titanium<sup>[1]</sup>.

**C. H. Che-Haran, (2001)** investigated various factors and parameters when machining process are taken place under by cutting condition, surface roughness values are higher at lower cutting speed when cutting speed increased surface roughness value decreased. Titanium alloys have poor machinability property<sup>[2]</sup>.

**Mustafizur Rahmanet al, (2002)** reveals that Titanium and its alloys are hard-to-cut materials mainly because of their low thermal conductivity and high chemical reactivity. Most of the research works are carried out with turning operation. High pressure coolant produce better lubrication and better cooling effect in the chip-tool interface thereby reduces cutting force and coefficient of friction. The cooling effect eliminates welding effect of the

tool and chip and improves the tool life and surface finish. Since the BCBN tool show significantly improved tool life good surface finish and low cutting force. It can be concluded that BCBN tools are the most suitable for machining titanium alloys both economically and functionally<sup>[3]</sup>.

**J. I. Hughes et al, (2005)** the term surface integrity is increasing the cutting speed and using a cutting fluid reduces surface defect. Surface integrity and its microstructure damage consisted of deformed grain boundaries in the direction of cut elongation of grains, surface cavities<sup>[4]</sup>.

**Emmanuel O. ezugwu et al, (2006)** does comparative study on conventional and high-pressure coolant is used not proper result found on the surface characteristics such as porosity, micro-cracks, surface finishing. When high pressure coolant is used tool, life becomes 5.4 min to 3.0 min at 175m/min and 200m/min there was no defect on sub-surface after machining with high pressure coolant<sup>[5]</sup>.

**S. Rameshet al, (2008)** have used Fuzzy logic because fuzzy logic, an expert system in AI, can be successfully adopted in prediction of the tool wear, surface roughness, and specific cutting pressure in machining of titanium alloy. Enhanced output quality coupled with reduced cost of production can be assured with the help of a developed model of fuzzy logic system. Surface finished increased with increasing cutting speed and increase of feed rate increase the surface roughness due to generation of more heat in machining titanium alloy<sup>[6]</sup>.

**Yakup Yildiz and Muammer Nalbant (2008)**, analyzed and point out the effect of cryogenic liquid nitrogen cooling on cutting performance in material removal operations and its application methods. Other conventional coolants, heat generation and temperature distribution in a cutting process have been also discussed.

Cryogenic cooling has been executed in cutting operations in different ways by using liquid nitrogen for precooling the workpiece, cooling the chip, cooling the cutting tool and cutting zone. Cutting tool and cutting zone have been cooled cryogenically by heat transmission, general repulsing of the coolant to the cutting zone and spraying injects with nozzles too. Cold temperatures were also used for

strengthening of the cutting tools by cryogenic treatment<sup>[7]</sup>.

**Vishal S. Sharma, et al., (2009)**, concluded and suggested the future works are as below:

1. The application of cryogenic cooling for turning of difficult to cut materials has resulted in several fold increase in tool life without compromising on the environmental conditions. Tool life improves dramatically due to the fact that cryogenic fluid is able to penetrate the chip–tool interface and perform both lubrication and cooling functions satisfactorily but cooling function in particular. Productivity is also high as cryogenic cooling shows better results at higher feed rates.

2. Turning with HPC technique results in formation of segmented chips, better penetration at interface and thus lower cutting force, better tool life and acceptable surface finish. It seems to be a potential solution for turning of hard to cut materials. Directing the nozzle at particular location plays a vital role in machining with HPC.

3. Performance of solid lubricants is better at higher cutting speed; it means they offer opportunities for increasing the MRR. Higher the adhesion quality of solid lubricants better will be their performance. Pollution-free environment and capacity to handle high cutting temperature are encouraging the use of these lubricants.

4. Air, water vapor and other environment-friendly gases mixtures are better solutions for green cutting. Air when mixed with oil gives better performance. The use of water vapor as coolant is encouraging due to their better lubrication qualities. Straight oils provide the best lubrication but poor cooling capacities. Water, on the other hand, is an effective cooling agent, removing heat 2.5 times more rapidly than the oil. The performance of water is encouraging when it is mixed with soluble oils<sup>[8]</sup>.

**A. K. Nondy et al, (2009)** studied types of titanium alloys, their properties are discussed also varies factors like specific machining problem, surface integrity, cutting temperature and stresses and wear mechanism are discussed. Many non-conventional manufacturing methods of titanium alloys are also given like ledge tool, rotary tool, UAMR, free machining titanium<sup>[9]</sup>.

**Sunil Thakur et al, (2012)** Author explored that Taguchi method is a powerful tool for the design of high-quality system. It is valuable when design parameters are qualitative and discrete, so they used L27(3<sup>13</sup>) orthogonal design. ANOVA has been used to find the significant parameter and interaction of these factors. In this experiment cutting speed, feed rate, depth of cut and approach angle are optimized with consideration of surface roughness, cutting force and pressure as machining criteria using CBN cutting tool insert. Approach angle and feed rate are the main parameter that influence the Ra, it has % contribution 39.68% & 10.93% for Ra resp. Ra is improved with increase in feed rate but Ra decreases with increase in approach angle<sup>[10]</sup>.

**N. Fang et. al., (2013)**, in their research work a total of 60 high-speed machining experiments have been performed covering a range of cutting speed and feed rate conditions. Based on extensive experimental data and observations, the following paragraphs summarize the major scientific contributions and research findings<sup>[11]</sup>.

1. Under the same cutting conditions, tool edge wear develops more rapidly in high-speed machining of Ti–6Al–4V than in high-speed machining of Inconel 718. Compared with Ti–6Al–4V, Inconel 718 has a higher (nearly double) thermal conductivity, which results in less heat going “back” into the cutting tool itself and thus helps prevent rapid tool edge wear in machining of Inconel 718.

2. In general, tool edge wear does not significantly increase the cutting force under the cutting conditions employed in the present study. The cutting force is higher in machining Inconel 718 than that in machining Ti–6Al–4V.

3. Tool edge wear has a profound but complex effect on the feed force. The feed force in machining Inconel 718 can be higher, or lower, than that in machining Ti–6Al–4V, depending on the extent of tool edge wear and the particular cutting conditions employed. This phenomenon can be explained from the rubbing (also called ploughing) action that occurs, rather than cutting, at the tool workpiece interface when machining with a small uncut chip thickness.

**Rosemer B. da silva et al, (2013)** have carried out experiment on machining of titanium alloy

under different coolant pressure and speed. They found the best fitted result about (20.3 MPa) coolant pressure at lower speed condition with PCD insert tool. Adhesion wear mechanism frequently occurs when there is chemical affinity between tool and workpiece material<sup>[12]</sup>.

**C. Veiga et al, (2013)** the machinability of titanium alloys, in this experiment dry cutting technique is used. When dry cutting technique is used environmental pollution, health risk and thermal shocks are less. But absence of coolant increases cutting temperature, rapid tool wear and degradation of work piece surface integrity take place<sup>[13]</sup>.

**J. Nithyanandamet al, (2014)** they analyzed the surface roughness in turning process of titanium alloy using nano coated Carbide insert by Taguchi orthogonal array. The dominant parameter which affects the surface roughness is feed rate & decrease with high cutting speed. The results of analysis of variance shown that minimal surface roughness could be arrived for specific condition<sup>[14]</sup>.

**Balasubramaniyan Sigarvelet al, (2015)** studied combined TOPSIS and AHP method, a multi-objective optimization method has been adopted to find the optimal combination of machining parameter such as cutting speed, feed rate and dept of cut for simultaneous minimization of micro hardness, surface roughness and maximization of MRR while turning operation<sup>[15]</sup>.

**A. Bordin, S. Imbrogno, et. al., (2015)**, in their research work presented a FE model of semi-finishing turning operation carried out on EBM Ti6Al4V under dry and cryogenic cooling conditions. Due to the lack of literature works and material properties, a modified Johnson-Cook model validated for the wrought Ti6Al4V was implemented and coupled with an hybrid sticking – sliding friction model for modelling the friction forces on the cutting tool. The model was calibrated and validated by comparing the predicted main cutting force with the experimental one under a couple of cutting conditions. The numerical results show a very good prediction of the main cutting force for all the tested cutting conditions under dry and cryogenic machining. The predicted feed force shows a trend that respects the experimental findings but wider discrepancies

between the values are present, mainly due to the friction model that should be validated for 3D turning operations. Furthermore, the FE model predicts correctly the trends of importance parameter to evaluate when investigating the machinability of a material as the SPD layer thickness under the machined surface and the cutting temperature<sup>[16]</sup>.

**G. Krishnamurthy, et. al., (2016)**, studied the effects of two different methods namely the use of cryogenic cooling and application of ethanol blended MRF in improving the machining performance of Ti-6Al-4V. The variation in cutting forces, surface roughness parameters along with the changes in material adhesion to the cutting tool were recorded. Additionally, the chip formation mechanism during cryogenic machining was studied using an in situ experimental setup. The following conclusions are drawn<sup>[17]</sup>.

1. Cryogenic machining resulted in a 25% decrease in cutting forces compared to ambient (dry) machining. A decrease in material transfer from the workpiece to the tool and a reduction in surface roughness of the machined workpiece were achieved during cryogenic machining.

2. Flooded machining using 10% ethanol in the MRF decreased friction at the PCD tool-chip interface and led to a 65% reduction in cutting force, as well as smoother surface finish, and less material transfer to the cutting tool. Surface-sensitive compositional studies suggested that passivation of the carbon surfaces by OH groups dissociating from ethanol could be responsible for the observed reduction in friction and cutting forces.

**Ampara Aramcharoen, (2016)**, presented the investigation of the effects of cryogenic turning, using a developed modular cryogenic system, on the machinability of Ti6Al4V materials, and compared with that under oil-based coolant condition. The study showed that the modular cryogenic system was able to integrate with commercial cutting tool holder for positive implementation. It successfully improved machinability of turning titanium alloys in terms of tool wear, chip formation and friction between tool-chip interfaces. A greater penetration of cryogenic media improved efficiency in cooling, hence reduced friction between tool-chip interfaces, influenced the

chip formation mechanism and resulted in tool wear reduction. Additionally, a smaller radius curvature of chip with helical shape led to easier control during chip removal and enhanced process stability<sup>[18]</sup>.

**Aurelie Bono, et. al., (2016)**, in their work proposed a phenomenological model including its contribution to enhance flank wear prediction. The hierarchy of the effects on flank wear is:

- this study confirms that the uncut chip thickness and cutting length have significant effects on flank wear. Flank wear increases with respect of this two parameters;
- the contact radius has also an effect on flank wear. Flank wear rises when contact radius grows;
- the flank wear seems more sensitive to uncut chip thickness and cutting length effects than contact radius effect.

Those results represent an advance in implementing flank wear in future cutting force modelling. Indeed, the cutting forces are highly sensitive to flank wear. Therefore, a small improvement in flank wear modelling could lead to significant consequences in cutting force modelling<sup>[19]</sup>.

**Swapnil Kekade, et. al., (2016)**, investigated that the incorrect industrial practices of delayed quenching for the reason that the transfer time associated with furnace and quench tank, makes significant effect on the volume fraction alpha and beta percentage, during solution treatment and annealing of titanium alloy Ti6Al4V. During machining process this effect of change in volume fraction was clearly visible on the surface roughness, subsurface deformation and micro-hardness. For QD 50, a decrease in difference between the volume percentage of two phases further contributes to an alternate hard and soft cutting which causes thermal and frictional shock at the cutting face leading to higher surface roughness, highly deformed grains, high deformation depth, high shear strain and higher micro-hardness which leads to poor machinability. Use of high pressure coolant generates adequate lubrication at the cutting interface to reduce the overall effect of phase change on machinability<sup>[20]</sup>.

**Alborz Shokrani, et. al., (2016)**, conducted a series of machining experiments at 200m/min cutting speed. Cryogenic cooling, minimum

quantity lubricant (MQL) and flood cooling with water-based emulsion were investigated. The analysis clearly demonstrated that a 71% reduction in surface roughness Ra and a 96% reduction in flank wear can be achieved using cryogenic cooling when compared to conventional machining best practice.

- Cryogenic cooling has resulted in a 35% and 42% reduction in surface roughness Ra as compared to MQL and flood conditions.

- Significant reduction in tool flank wear was achieved using the cryogenic cooling approach. The flank wear was 26 and 17 times larger for MQL and flood cooling environments when compared to cryogenic cooling.

- Diffusion and abrasive wear were dominant irrespective of the machining environment. However, microscopic images of the cutting tools indicated that cryogenic cooling has effectively controlled the extent of tool wear where minimum crater wear was observed<sup>[21]</sup>.

**Abdulhameed Alaa Dawood, (2016)** has investigated there is comparative experimental analysis of machinability of Ti6Al4V for conventional flood coolant & sustainable dry machining. Surface roughness increase with cutting rate, feed rate, depth of cut<sup>[22]</sup>.

**Nikolaos Tapoglou, et. al., (2017)**, in their paper focused on the investigation of wear progression during cryogenic milling of Ti-6Al-4V in the beta annealed condition. A literature review of material from academic and industrial sources has established that while significant variation in results exist, cryogenic machining has the potential to improve tool life, surface finish, productivity and surface integrity when compared with conventional coolant methods. Tool life trials used the cooling options dry, flood emulsion, through tool emulsion, MQL, CO<sub>2</sub>, CO<sub>2</sub> plus air and CO<sub>2</sub> plus MQL. The best performance at 100 m/min was achieved using flood emulsion coolant, which easily achieved a tool life of 30 minutes. The best performing cryogenic method was CO<sub>2</sub> plus MQL which achieved a tool life of 18.5 minutes in equivalent testing<sup>[23]</sup>.

**Julius Schoop, et. al., (2017)**, in their work, Ti-6Al4V alloy was machined using polycrystalline diamond (PCD) tools under three different cooling/lubricating environments: cryogenic cooling (liquid

nitrogen ( $LN_2$ ) at  $-195.8$  °C), hybrid cooling/lubrication ( $LN_2$  and oil based MQL – minimum quantity lubrication) as well as conventional flood cooling (emulsion). The machining parameters were selected to achieve very low kinematic surface roughness ( $f = 0.01$  mm/rev,  $ap = 0.1$  mm) and three cutting speeds of  $V_c = 120, 240$  and  $360$  m/min were evaluated.

Although the PCD tools are not commonly used in high speed machining of *Ti* alloys because of the problem of thermally induced chemical wear, it was found that with the use of cryogenic cooling, the tribological system changed sufficiently to allow for sustained machining performance, with very low tool-wear ( $VB_C(\text{cryogenic}) < 10$   $\mu\text{m}$  after 65 min of cutting at  $V_c = 240$  m/min). Surface roughness values were as low as  $Ra = 40$  nm for cryogenic machining. Interestingly, flood machining did not lead to reduce surface roughness values. However, hybrid cooling/lubrication did yield the lowest cutting forces compared to both flood and cryogenic conditions. All conditions evaluated during this study resulted in cutting forces of less than 15 N, suggesting that cryogenic precision machining with PCD tools may be a suitable alternative to grinding, even for slender and thin-walled components<sup>[24]</sup>.

**Akhtar Khan and Kalipada Maity, (2017)**, compared some of the key machinability aspects acquired during turning of commercially pure (CP) titanium grade-2 with untreated and cryogenically treated carbide tools in a dry cutting environment. Some of the findings are as mentioned<sup>[25]</sup>.

1. Microhardness of carbide tools were found to be higher by around 9% after cryogenic treatment in comparison with untreated one.
2. Cryogenic treatment resulted a significant improvement in wear resistance of carbide tools.
3. The chips were characterised by two predominant features i.e. shear crack and lateral flow. Both the phenomenon was observed to be less when machining of the work material was done by using a cryo-treated tool.

**Ning Li, Yongjie Chen, et. al.,(2017)**, in their research, cutting tools with nine kinds of deep

submillimeter-scaled textured surface on their rake face were developed in order to reduce cutting forces and improve the friction properties at the tool-chip interface and eventually lower the energy consumption for machining titanium alloy Ti-6Al-4V. Dry cutting tests were performed with these textured tools and their corresponding conventional tools for comparison. Some conclusions are summarized as follows<sup>[26]</sup>.

- (1) The implantation of the textures on the rake face does not greatly affect the mechanical strength of the tools.
- (2) The deep submillimeter-scaled textured tools do have an influence in improving cutting performance.
- (3) The main cutting forces obtained from the simulations are in good agreement with those measured in the tests within the error of about 3% for both textured tool and conventional tool.

**Chakradhar Bandapalli, et. al., (2017)**, presented an experimental investigation and estimation of surface roughness using optimization techniques ANN, GMDH & MRA in high-speed micro end milling of Titanium alloy (Grade-5). It was found that, each control factors are affecting the response variables to different extent<sup>[27]</sup>.

□ From the experimental investigation, the input milling process parameters i.e. spindle speed, feed rate and depth of cut, the most influential factor noted was the feed rate followed by depth of cut & finally by spindle speed which has least significant factor on surface roughness. If the feed rate and depth of cut were maintained constant and only spindle speed increased then surface roughness found to decrease, i.e. good surface quality.

□ Comparison of the three theoretical methods for estimation of machining performances was done. It was found that, ANN function shows better prediction than GMDH & MRA. In GMDH it was found that the least error of estimation and best-fit was found for 62.5% of data in training set at level 3 under combined criteria for surface roughness. It is found that neural network trained with 70% of the data in training set gives good prediction results when compared to the 50% and 60% of data in training set. Thus, predicted response variables of 70% training set correlates well with the



measured response variables. ANN function gave better prediction than GMDH & MRA.

□ ANN technique is practically proven tool for an in-process surface recognition system. It is further applied to predict accurately the surface to avoid and control the unwanted factors under different real time machining conditions in high speed micro milling process ensuring quality products for industrial economy.

**Aimin Yang et al, (2017)** Author constructed a mathematical model by the response surface methodology to fit the relationship between & surface roughness & it was verified by ANOVA & stability test. They analyzed that feed has most important effect on surface roughness followed by cutting speed. Iso-surface plot of surface roughness & contour maps were plotted to analyze & optimize the ideal Parameter<sup>[28]</sup>.

**V. G. Umasekar et al, (2017)** surface roughness and surface parameters of Ti-6Al-4V depends on machining parameters cutting speed, feed rate, cutting depth, flank wear, work-tool properties. When feed is high cutting speed is low then surface roughness is higher<sup>[29]</sup>.

**Raghavendra M. J. et al, (2018)** they have defined Taguchi's array method is used to determine the optimal cutting parameters in the turning of titanium grade-5 with PVD coated carbide inserts to achieve low surface roughness and low cutting speed. If speed, depth of cut is larger & feed rate is smaller than it affects the surface roughness of materials<sup>[30]</sup>.

**Jianfei Sun et al, (2018)** studied and found that small feed rate can get a smaller surface roughness at the same time, cutting speed has little effect on it & the process system vibration has a significant impact on the roughness. Machine surface appears obvious work

hardening phenomenon with increase in feed rate; the smaller feed rate is more suitable for finishing TB6<sup>[31]</sup>.

**Seung Hyeon Youet al, (2019)** studied that taguchi method is used to identify factor affecting the turning process. Surface roughness of titanium alloy is affected more by feed rate then by cutting speed and the slower the feed rate, the more excellent surface roughness<sup>[32]</sup>.

**Eva M. rubia et al, (2019)** present an experiment study to analyze the surface roughness in titanium alloy. Source of variation of surface roughness are depth of cut, feed rate, spindle speed type of tool, type of cooling system and measurement location. The main result that feed rate, spindle speed, measurement location is influence on surface roughness while cooling system and tool are not factors influencing the roughness independently<sup>[33]</sup>.

### Conclusion

From the various literature review lot of research mainly has been done their worked on various process parameters like cutting speed, feed, depth of cut for the machining of Ti-6Al-4V by using PVD and CVD coated inserts for the good results in terms of surface roughness and reduction in tool wear rate also it shows the improvement in tool life for so it helps for the cost optimization. From literature survey, it is observed that maximum level of cutting speed with minimum level of feed and depth of cut is recommended for minimum tool wear and better tool life. The most commonly used method is taguchi method but other methods such as RSM and fuzzy modelling are also effective.

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## EXPERIMENTAL AND OPTIMIZATION OF PARAMETERS ON LASER BEAM MACHINING TO MINIMIZE KERF, SURFACE ROUGHNESS AND DROSS OF SS304

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### ABSTRACT

In traditional machining on laser beam machine, the kerf taper is large and surface roughness is not uniform and optimum due to this the quality of workpiece may get affected, which hampered assembly of finished components. Here we defines there occurs a change in mathematical values of kerf taper, Kerf width and surface roughness, while conducting experimentation of CO<sub>2</sub> laser cutting on SS-304 Stainless steel using Nitrogen as assistance gas. To determine the laser cutting parameter values so as to maximize the material removal rate while simultaneously considering practical process constraints related to dross formation, The laser kerf width and cut edges quality was influenced by the process parameters like cutting speed (V), Assist gas pressure (p) and laser power (P). The experiment was constructed and followed on the base of orthogonal array. A predictive model is generated by using response surface methodology through ANOVA and implemented to find relative influence of process parameters on kerf geometry and surface roughness.

**Keywords:** CO<sub>2</sub> Laser cutting, Kerf Geometry, Laser cutting parameters and Dross

### Introduction

Laser cutting is a thermal energy based advanced machining process in which material is removed by focusing the laser beam on the work piece surface. Depending upon the prevailing conditions, the material may be removed by different mechanisms such as vaporization, fusion, reactive fusion, ablation and controlled fracture [11]. Laser cutting finds many applications in various manufacturing industries where a variety of components in large numbers are required to be machined with high quality and close tolerance at low costs.

AISI 304 stainless steel is widely used in industrial applications. It has captured approximately 50% of the world's stainless steel production and consumption. Because of its aesthetic view in architectures, high mechanical strength, corrosion and chemical resistance, it has become the preferred engineering material.

LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. The most important applications of laser are laser cutting. The machining of difficult-to-cut materials by conventional machining processes causes less material removal rate, high surface roughness

and less tool life. Laser cutting is the machining processes involving a laser beam as a heat source. It is a non-contact process, which does not involve any mechanical cutting forces and tool wear. In this process, the substrate material is locally heated by the targeted laser source. The melt is then blown out of the material with the help of assist gas that flows throughout the material with the help of laser beam. In metal cutting operations, oxygen or nitrogen is used. [13]

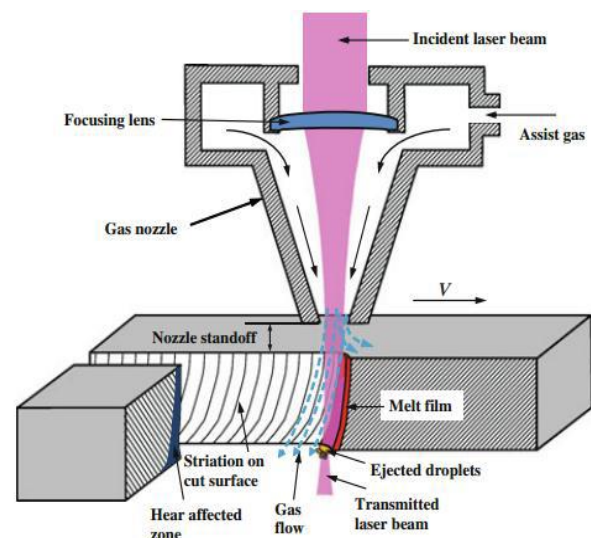


Figure 1.1: Laser Beam Cutting Process [12]

Figure 1 shows a schematic diagram of a laser cutting process. It is observed that the surface quality in the laser cutting depends on many process parameters including laser power, cutting speed, gas pressure, beam diameter, beam incident angle, stand-off distance, pulse frequency and focus positions.

### 1.1 Laser:

Laser is a coherent and amplified beam of electromagnetic radiation. The key element in making a practical laser is the light amplification achieved by stimulated emission due to the incident photons of high energy.

#### Types of Laser:

Lasers have two types, i.e. solid laser and gas laser. These can be of pulsed or of continuous type:

- **Solid Lasers**

Solid state lasers (viz., ruby and Nd: glass), operate below 1 ~ 2 Hz. Frequency and are used only for low pulse applications like spot welding, drilling, etc.

- **Gas Lasers**

CO<sub>2</sub> lasers emit light with a wavelength of 10.6 μm and possess overall efficiencies of approx. CO<sub>2</sub> lasers always utilize a gas mixture to generate the laser beam. This laser gas mixture invariably consists of helium, nitrogen, CO<sub>2</sub> and possibly other additives.

#### Types of Laser Cutting:

In laser cutting, there are three versions of the process

- Oxygen laser cutting
- Fusion laser cutting
- Evaporative laser cutting

**Oxygen Laser Cutting:** The laser beam heats the material to ignition temperature. The oxygen injected into the kerf burns the material and expels the slag formed. The combustion process generates additional energy. With the quality of the cut being continuously high, a distinct connection between the purity of the oxygen and the maximum possible cutting speed can be proven.

**Fusion Laser Cutting:** The material gets fused in the crossover point by laser radiation. The melt is expelled from the kerf by an inert gas. High-pressure fusion laser cutting is proving to be increasingly successful in oxide-free cutting

of stainless steels. It is used in cutting mild steels and aluminum. Nitrogen is used as the cutting gas. The cutting gas pressure at the cutting nozzle can be 20 bar or more.

**Evaporative Laser Cutting:** The material to be cut is evaporated at the crossover point of the laser beam. An inert gas, e.g., nitrogen or argon, expels the by products from the kerf. This cutting process is used with materials that have no liquid phase or melt, as is the case with paper, wood, several synthetic materials or plastics, textiles, and ceramics.

CO<sub>2</sub> lasers have proven suitable tools for fast 2-D laser cutting of thin sheets due to their good focus ability and high laser beam performances. [12]

#### Laser Beam parameters and Cutting Process parameters:

##### A) Laser Beam parameters

1. **Wavelength:** - The wavelength depends on stimulated emission with respect to the physical mechanisms involved in energy coupling and the process efficiency, stability and quality, the wavelength plays a significant role
2. **Power, intensity and spot size:** - Power of laser determines its size. The power of laser system is the total energy emitted in the form of laser light per second. The intensity of the laser beam is the power divided by the beam concentrated area. Spot size is the irradiated area of laser beam
3. **Continuous wave (CW) and pulsed laser power:** - Both the continuous wave and pulsed laser power can achieve the high intensity needed for laser cutting.

##### B) Cutting Process parameters

1. **Focusing of Laser Beams:** - The focal length of lens is about the distance from the position of focal lens to the focal spot.
2. **Focal Position:** - The focal point position must be controlled in order to get optimum cutting result.
3. **Process Gas and Pressure:** - The commonly used gases are the oxygen and nitrogen. Nitrogen is mainly used for stainless steel and aluminum, whereas the oxygen is

used for mild steel. When cutting thick material, the gas pressure must decrease with the increasing thickness, in order to avoid the burning effect, whereas the nozzle diameter is increased.

**4. Nozzle Diameter, Stand-Off Distance:** - Assisting gas is delivered through the nozzle. To minimize turbulence weld material stand-off distance is kept between 0.5 mm to 1.5 mm which is distance between nozzle and work piece.

**5. Cutting Speed:** - The cutting speed must be balanced with the gas flow rate and the power. As cutting speed increases, it reduces the flow of excess heat through the material reducing the HAZ. [7]

## 1.2 Response parameters:

### 1) Surface roughness (Ra)

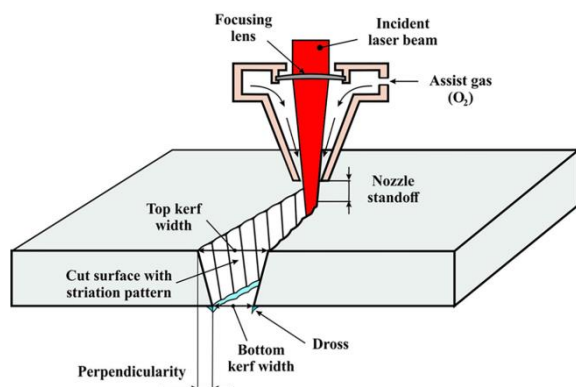
It is a component of surface texture. It is qualified by vertical deviations of the real surface from its ideal form. The unit is micrometer.

### 2) Kerf taper (Kf)

Kerf taper is special and undesirable geometrical feature inherent to laser beam machine. It is the angle which ranges from  $0.1^\circ$  to  $2^\circ$  in normal condition and measured in degree.

### 3) Dross (Br)

Dross is residual melt which remains attached to the underside of the cut edge after the cutting process is complete. With some laser/materials combinations (eg CO<sub>2</sub> laser cutting steels) dross is insignificant. However dross can be a problem when cutting thicker section steels.



## Figure 1.2 Response Parameter Considered in the Formulation of the Optimization Problem [15]

### 1.3 Objectives

- To minimize the kerf taper and kerf width in Laser Beam Cutting.
- To optimize and reduce surface roughness.
- To reduce the dross formation during the machining process (Laser Beam Cutting).

### Literature Review

**D. Pramanik et al.**, presents the investigation to reveal the ability of the low power fibre laser to cut stainless steel AISI 316 L with 1 mm thickness. The effect of the cutting wedge angle and other process variables like power, duty cycle, pulse frequency and scanning speed has been analysed through an application of Response Surface Methodology (RSM) with CCD technique. [1] **Seungik Son and Dongyoung Lee.**, investigated the process quality of laser cutting for SS41 and SUS304, with the usage of a continuous wave CO<sub>2</sub> laser cutting system. The experimental variables are set to the laser cutting speed, laser power, and different engineering materials. The results are significantly affected by the laser parameters. As the result, the process quality of the laser cutting has been observed by measuring the top and bottom kerf widths, as well as the size of the melting zone and Heat Affected Zone (HAZ) according to volume energy. [2] **Milos Madic et al.**, determine the laser cutting parameter values so as to maximize the material removal rate while simultaneously considering practical process constraints related to dross formation, kerf width, perpendicularity deviation, surface roughness and severance energy. [3] **Goncalo Costa Rodrigues et al.**, revisits model assumptions of an in-house developed laser cutting model as it is validated for larger thicknesses. This model assesses polarization and beam shaping effects on the cutting performance of thin sheets. In this work, dedicated cutting experiments to assess the maximum cutting speed of stainless steel 304L of 2, 6, and 10 mm thickness for a wide range of focal point positions are conducted and compared to the model prediction. [4] **K. Rajesh et al.**, defines there occurs a change in mathematical values

of surface roughness (Ra,  $\mu\text{m}$ ) and Kerf width (Kw, mm), while conducting experimentation of CO<sub>2</sub> laser cutting on SS-304 Stainless steel using Nitrogen as assistance gas. The laser kerf width and cut edges quality was influenced by the process parameters like cutting speed (V), Assist gas pressure (p) laser power (P). The experiment was constructed and followed on the base of L27 orthogonal array. A predictive model is generated by using multiple regression analysis through ANOVA and implemented to find relative influence of process parameters on Kw and Ra. [5]

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#### Typical Chemical Composition of SS 304:

**Table No. 1.1: Chemical Composition of SS 304[14]**

Grade	%	C	Mn	Si	P	S	Cr	Ni	Fe
304	Max	0.08	2.0	1	0.045	0.03	20.0	10.5	74
	Min	-	-	-	-	-	18.0	8.0	66.345

Experiments are carried out using L27 Orthogonal array by varying laser power, cutting speed and assist gas pressure for stainless steel SS 304 material. The results showed that the assist gas pressure and laser power are the most significant parameters affecting the surface roughness and kerf width respectively, whereas the influence of the cutting speed is much smaller. [9] **Tushar V. Jadhav et al.**, analysis the work by “Taguchi Methodology”, input parameters are taken as Cutting Speed, Gas pressure, laser powers are studied. Simultaneously their optimum set is analyzed by using Taguchi Method from Minitab software for Surface Roughness and Kerfs taper as output Parameter. [10]

#### Material and Methodology:

##### 3.1 Material

Grade 304 is the standard "18/8" stainless; it is the most versatile and most widely used stainless steel, available in a wider range of products, forms and finishes than any other. It has excellent forming and welding characteristics. The balanced austenitic structure of Grade 304 enables it to be severely deep drawn without intermediate annealing, which has made this grade dominant in the manufacture of drawn stainless parts such as sinks, hollow-ware and saucepans. For these applications it is common to use special "304DDQ" (Deep Drawing Quality) variants. Grade 304 is readily brake or roll formed into a variety of components for applications in the industrial, architectural, and transportation fields. Grade 304 also has outstanding welding characteristics. Post-weld annealing is not required when welding thin sections. The austenitic structure also gives these grades excellent toughness, even down to cryogenic temperatures.



**Mechanical Properties:**

**Table No. 1.2: Mechanical Properties of SS 304 [14]**

Grade	Tensile	Yield Strength ≥	Elongation at	Hardness	
	Strength (Mpa) ≥	(MPa) at 0.2% Offset		Break (%)	Brinell Hardness (HBW) ≤
304	505	215	70	123	70

**3.2 Methodology:**

RSM attempts to analyze the influence of the independent variables on a specific response. The purpose of mathematical models relates the process responses to facilitate the optimization of the process. The mathematical model commonly used for the process responses is represented as:

$$Y = F(X_1, X_2, X_3, \dots) + \epsilon \text{ ----- 1}$$

Where X<sub>1</sub>, X<sub>2</sub>, X<sub>3</sub>... X<sub>n</sub> are process parameters and ε is the error which is normally distributed about the observed response Y.

Coefficients of process parameters using RSM is represented as

$$[B] = \text{Inverse}([Z]^T * [Z]) * [Z]^T * [F] \text{-----2}$$

Where [B]: array of coefficients of process parameters, [Z]: orthogonal array with values of selected process parameters, [F]: array with values of measured response, and [Z]<sup>T</sup>: transpose array of [Z].

In order to judge the accuracy of the predicted model, Percentage of deviation Φ<sub>i</sub> and average percentage of deviation Φ are defined as:

$$\Phi_i = \frac{|\text{Absolute}[R_{\text{measured}} - R_{\text{predicted}}]|}{[R_{\text{measured}}]} * 100 \text{-----3}$$

Where Φ<sub>i</sub>: percentage deviation of single sample data.

R<sub>measured</sub>: measured response.

R<sub>predicted</sub>: predicted response.

$$\Phi = \frac{\sum \Phi_i}{n} \text{-----4}$$

Where Φ: average percentage deviation of all sample data.

n: the size of sample data.

**Results and Discussion**

The goal of the formulation and solving of the laser cutting optimization problem with constraints was to determine the set of main laser cutting parameter values that are to be

used for cutting parts made of SS 304. In an extreme case, a further increase in the gas pressure during reactive laser fusion cutting may produce poor cut quality and dross formation due to excessive burning effects.[11] To analyze the effect of the laser cutting parameters on kerf quality characteristics main effect plots were generated. A main effect plot is a plot of the mean response values at each level of a design parameter. The main effect of a parameter is defined as the average change in the response when the level of the parameter is changed from a low to a high level. A positive gradient indicates that with an increase in parameter value there is an increase in response value, and a negative gradient means a decrease in response value.

However, the relative contribution of each laser cutting parameter on the kerf quality characteristics was determined through ANOVA that enables more accurate determination of the optimal process parameter levels.

**Conclusion**

The mathematical modelling and the response surface methods for design of experiment are mostly employed to find the optimum value of control parameters to achieve minimize the kerf taper, reduce surface roughness and minimize the dross during laser cutting at bottom.

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## EXPERIMENTAL AND OPTIMIZATION OF PARAMETERS ON LASER BEAM MACHINING TO MINIMIZE KERF, SURFACE ROUGHNESS AND DROSS OF SS304

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### ABSTRACT

In traditional machining on laser beam machine, the kerf taper is large and surface roughness is not uniform and optimum due to this the quality of workpiece may get affected, which hampered assembly of finished components. Here we defines there occurs a change in mathematical values of kerf taper, Kerf width and surface roughness, while conducting experimentation of CO<sub>2</sub> laser cutting on SS-304 Stainless steel using Nitrogen as assistance gas. To determine the laser cutting parameter values so as to maximize the material removal rate while simultaneously considering practical process constraints related to dross formation, The laser kerf width and cut edges quality was influenced by the process parameters like cutting speed (V), Assist gas pressure (p) and laser power (P). The experiment was constructed and followed on the base of orthogonal array. A predictive model is generated by using response surface methodology through ANOVA and implemented to find relative influence of process parameters on kerf geometry and surface roughness.

**Keywords:** CO<sub>2</sub> Laser cutting, Kerf Geometry, Laser cutting parameters and Dross

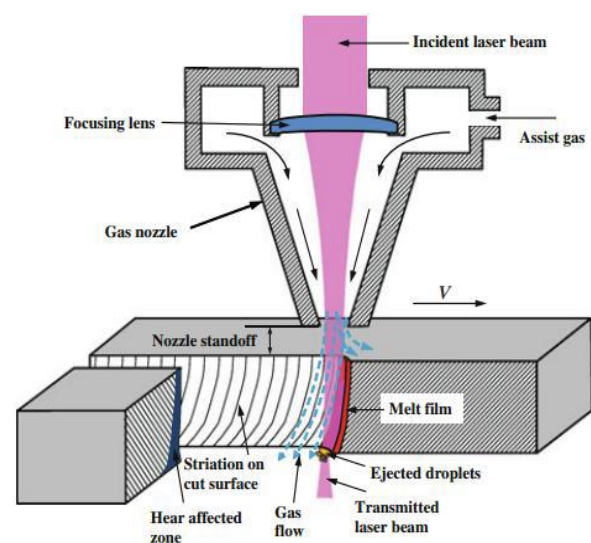
### Introduction

Laser cutting is a thermal energy based advanced machining process in which material is removed by focusing the laser beam on the work piece surface. Depending upon the prevailing conditions, the material may be removed by different mechanisms such as vaporization, fusion, reactive fusion, ablation and controlled fracture [11]. Laser cutting finds many applications in various manufacturing industries where a variety of components in large numbers are required to be machined with high quality and close tolerance at low costs.

AISI 304 stainless steel is widely used in industrial applications. It has captured approximately 50% of the world's stainless steel production and consumption. Because of its aesthetic view in architectures, high mechanical strength, corrosion and chemical resistance, it has become the preferred engineering material.

LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. The most important applications of laser are laser cutting. The machining of difficult-to-cut materials by conventional machining processes causes less material removal rate, high surface roughness and less tool life. Laser cutting is the

machining processes involving a laser beam as a heat source. It is a non-contact process, which does not involve any mechanical cutting forces and tool wear. In this process, the substrate material is locally heated by the targeted laser source. The melt is then blown out of the material with the help of assist gas that flows throughout the material with the help of laser beam. In metal cutting operations, oxygen or nitrogen is used. [13]



**Figure 1.1: Laser Beam Cutting Process [12]**

Figure 1 shows a schematic diagram of a laser cutting process. It is observed that the surface

quality in the laser cutting depends on many process parameters including laser power, cutting speed, gas pressure, beam diameter, beam incident angle, stand-off distance, pulse frequency and focus positions.

### 1.1 Laser:

Laser is a coherent and amplified beam of electromagnetic radiation. The key element in making a practical laser is the light amplification achieved by stimulated emission due to the incident photons of high energy.

#### Types of Laser:

Lasers have two types, i.e. solid laser and gas laser. These can be of pulsed or of continuous type:

##### ▪ Solid Lasers

Solid state lasers (viz., ruby and Nd: glass), operate below 1 ~ 2 Hz. Frequency and are used only for low pulse applications like spot welding, drilling, etc.

##### ▪ Gas Lasers

CO<sub>2</sub> lasers emit light with a wavelength of 10.6 μm and possess overall efficiencies of approx. CO<sub>2</sub> lasers always utilize a gas mixture to generate the laser beam. This laser gas mixture invariably consists of helium, nitrogen, CO<sub>2</sub> and possibly other additives.

#### Types of Laser Cutting:

In laser cutting, there are three versions of the process

- Oxygen laser cutting
- Fusion laser cutting
- Evaporative laser cutting

**Oxygen Laser Cutting:** The laser beam heats the material to ignition temperature. The oxygen injected into the kerf burns the material and expels the slag formed. The combustion process generates additional energy. With the quality of the cut being continuously high, a distinct connection between the purity of the oxygen and the maximum possible cutting speed can be proven.

**Fusion Laser Cutting:** The material gets fused in the crossover point by laser radiation. The melt is expelled from the kerf by an inert gas. High-pressure fusion laser cutting is proving to be increasingly successful in oxide-free cutting of stainless steels. It is used in cutting mild steels and aluminum. Nitrogen is used as the

cutting gas. The cutting gas pressure at the cutting nozzle can be 20 bar or more.

**Evaporative Laser Cutting:** The material to be cut is evaporated at the crossover point of the laser beam. An inert gas, e.g., nitrogen or argon, expels the by products from the kerf. This cutting process is used with materials that have no liquid phase or melt, as is the case with paper, wood, several synthetic materials or plastics, textiles, and ceramics.

CO<sub>2</sub> lasers have proven suitable tools for fast 2-D laser cutting of thin sheets due to their good focus ability and high laser beam performances. [12]

#### Laser Beam parameters and Cutting

##### Process parameters:

##### A) Laser Beam parameters

4. **Wavelength:** - The wavelength depends on stimulated emission with respect to the physical mechanisms involves in energy coupling and the process efficiency, stability and quality, the wavelength plays a significant role
5. **Power, intensity and spot size:** - Power of laser determines its size. The power of laser system is the total energy emitted in the form of laser light per second. The intensity of the laser beam is the power divided by the beam concentrated area. Spot size is the irradiated area of laser beam
6. **Continuous wave (CW) and pulsed laser power:** - Both the continuous wave and pulsed laser power can achieve the high intensity needed for laser cutting.

##### B) Cutting Process parameters

1. **Focusing of Laser Beams:** - The focal length of lens is about the distance from the position of focal lens to the focal spot.
2. **Focal Position:** - The focal point position must be controlled in order to get optimum cutting result.
3. **Process Gas and Pressure:** - The commonly used gases are the oxygen and nitrogen. Nitrogen is mainly used for stainless steel and aluminum, whereas the oxygen is used for mild steel. When cutting thick material, the gas pressure must decrease with

the increasing thickness, in order to avoid the burning effect, whereas the nozzle diameter is increased.

**4. Nozzle Diameter, Stand-Off Distance:** - Assisting gas is delivered through the nozzle. To minimize turbulence weld material stand-off distance is kept between 0.5 mm to 1.5 mm which is distance between nozzle and work piece.

**5. Cutting Speed:** - The cutting speed must be balanced with the gas flow rate and the power. As cutting speed increases, it reduces the flow of excess heat through the material reducing the HAZ. [7]

## 1.2 Response parameters:

### 1) Surface roughness (Ra)

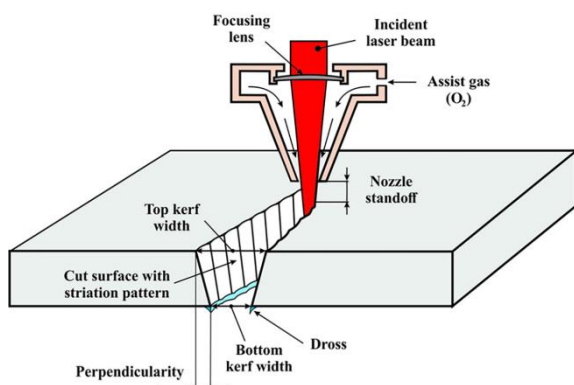
It is a component of surface texture. It is qualified by vertical deviations of the real surface from its ideal form. The unit is micrometer.

### 2) Kerf taper (Kf)

Kerf taper is special and undesirable geometrical feature inherent to laser beam machine. It is the angle which ranges from  $0.1^\circ$  to  $2^\circ$  in normal condition and measured in degree.

### 3) Dross (Br)

Dross is residual melt which remains attached to the underside of the cut edge after the cutting process is complete. With some laser/materials combinations (eg CO<sub>2</sub> laser cutting steels) dross is insignificant. However dross can be a problem when cutting thicker section steels.



**Figure 1.2 Response Parameter Considered in the Formulation of the Optimization Problem [15]**

## 1.3 Objectives

- D. To minimize the kerf taper and kerf width in Laser Beam Cutting.
- E. To optimize and reduce surface roughness.
- F. To reduce the dross formation during the machining process (Laser Beam Cutting).

## Literature Review

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Where, [B]: array of coefficients of process parameters, [Z]: orthogonal array with values of selected process parameters, [F]: array with values of measured response, and [Z ] T: transpose array of [Z].

In order to judge the accuracy of the predicted model, Percentage of deviation Φ i and average percentage of deviation Φ are defined as:

$$\Phi \text{ I} = [( \text{Absolute} [R \text{ measured} - R \text{ predicted}] ) / (R \text{ measured})] * 100 \text{ -----3}$$

Where, Φ i: percentage deviation of single sample data.

R measured: measured response.

R predicted: predicted response.

$$\Phi = (\sum \Phi \text{ i}) / n \text{ -----4}$$

Where, Φ: average percentage deviation of all sample data.

n: the size of sample data.

**Results and Discussion**

The goal of the formulation and solving of the laser cutting optimization problem with constraints was to determine the set of main

laser cutting parameter values that are to be used for cutting parts made of SS 304. In an extreme case, a further increase in the gas pressure during reactive laser fusion cutting may produce poor cut quality and dross formation due to excessive burning effects.[11] To analyze the effect of the laser cutting parameters on kerf quality characteristics main effect plots were generated. A main effect plot is a plot of the mean response values at each level of a design parameter. The main effect of a parameter is defined as the average change in the response when the level of the parameter is changed from a low to a high level. A positive gradient indicates that with an increase in parameter value there is an increase in response value, and a negative gradient means a decrease in response value.

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**Conclusion**

The mathematical modelling and the response surface methods for design of experiment are mostly employed to find the optimum value of control parameters to achieve minimize the kerf taper, reduce surface roughness and minimize the dross during laser cutting at bottom.

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**USE OF RECYCLED AGGREGATE IN REINFORCED CONCRETE PAVEMENT****Vishal B. Shinde<sup>1</sup>, Shantanu G. Pande<sup>2</sup>, Pranita Balve<sup>3</sup>, Dr. Kisan L. Bidkar<sup>4</sup>,  
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<sup>4</sup>kisanbidkar@gmail.com, <sup>5</sup>sanjay.dahiwelkar@gmail.com**ABSTRACT**

The present investigation essentially aims at establishing all the physical and mechanical properties of recycled aggregate on rational scientific basis and to evolved a suitable mix design based on typical characteristic of recycled aggregate exclusively for recycled aggregate concrete. To attain the above said objectives, extensive experimental program has been planned. From concrete test specimen have been used as a source concrete for generating graded recycled aggregate of 20mm maximum size. Variety of aggregates as stated above, have been tested for their all physical and mechanical properties. Reduction in specific gravity accompanied by sharp increase in water absorption due to the presence of adhered cement mortar with the aggregate particles is notable observation. By observing 4 different mixes in their above derived relationship, the performance of recycled aggregate concrete designed by proposed method have been compared with the corresponding recycled aggregate concrete and conventional concrete designed by IS, ACI, & BS methods. The mix cases designed by proposed method have yielded relatively good and satisfactory results for a recycled aggregate concrete both in their fresh and hardened state, thus indicating the suitability and efficiency of the proposed method of mix design. All 4 mix cases have been examined for evaluating relative performance of recycled aggregate concrete in terms of for its short term and long-term properties.

**Keywords:** Pavement quality concrete, Recycled aggregates, Time lag, Rigid Pavement

**Introduction**

Cement concrete is the most widely used construction material. It is difficult to point out any other material which is as versatile as concrete. It is the material of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required. It is so closely associated now with every human activity that it touches every human being in his life. Cement concrete is one of the seemingly simple but actually complex materials. In any country, construction accounts for about 60% of the plan outlay. Out of this, cement and cement product would account for more than 50%. Today in India the annual consumption of cement is in the order of 22 million tons of cement would work out to about Rs.4000cores which is about 1/5 of the plan outlay. It is in this context that the knowledge of proper utilization of concrete assumes importance.

The quality of concrete and other cement products made, utilizing 120 million tons of cement to cater for the tremendous

infrastructural development that is taking place, is making the concrete industry one of the biggest in monetary terms. Western and Eastern countries have been making concrete of strength M40, M80, M100 and over. In India concrete of strength M30, M50, and even have recently used. Concrete it has been claimed is not environmentally friendly due to its destructive resource consumption and severe environmental impact after its use. Nevertheless, it will remain one of the major construction materials being utilized worldwide. Taking the concept of sustainable development into consideration the concrete industry has to implement a variety of strategies with regards to future concrete use, for instance improvement in the durability of concrete and the better use of recycled materials. In general aggregates occupy 55%-80% of concrete volume. Without proper, alternative aggregates being utilized in the near future, the concrete industry globally will consume 8-12 billion tons annually of natural aggregate after the year 2016. Such urge

consumption of natural aggregates will cause destruction of the environment. Therefore, to find and supply suitable substitutes for natural aggregates is an urgent task. Even though the utilization of recycled aggregates in the concrete industry has been taking place for many years, the promotion of this recycled material as an alternative has never been easy in the industry. Basically, recycled aggregates are seldom utilized in structural construction instead they have been used as filters in road construction and in low level application due to the high AC of recycled aggregates will cause poor workability and large slump-loss of concrete such poor quality further hinders the strength development of the resulting concrete. Research has indicated that the addition of an extra 5% of cement may be needed to compensate for the strength reduction. Furthermore, due to the inconsistency of the surface of recycled aggregates the variation in concrete properties is larger than when using normal aggregates [12].

High performance concrete (HPC), as it is well known, can be designed to have the desired higher workability, higher mechanical properties and/or greater resistance to chemical attack than those of traditional concrete [2]. Many waste materials have been proven to be successfully utilized in the manufacturing of normal concrete (NC) and even HPC. However there have only been a few attempts to utilize aggregates. Nevertheless, the utilization of recycled aggregates for HPC is still necessary recycled aggregates might at least lead the concrete industry to embrace the concept of sustainable development in the near future. Reuse of aggregates from demolished concrete structure was introduced into practice many years ago, and from the beginning it has been considered in main two environmental aspects, solving the increasing waste storage problem and protection of limited natural sources of aggregates. At present, plenty of demolished reinforced concrete or prestressed concrete structures, originally erected from concrete of moderate or high strength, create the significant source of rubble aggregate of relatively good quality. This situation is particularly characteristic for the countries in Central and Eastern Europe, where the intensive programs of modernization and

reconstruction for roads, bridge, municipal and industrial structures started in 1990-ties. Not uncommonly it is necessary to demolished structures relatively young, for instance fifteen years old or less, because the functional features do not fit with the new projects. Such situation are typical at road bridges, for which the prestressed concrete beams with spans 15-18m are not sufficient now, and have to be removed to widen the span of structures to overpass new roads. The demolition of older RCC structure procedure is going on year by year because of life span. Hence fore reused of this RCC waste material is really necessary from the environment point of view. In this research set the appropriate limit of recycled aggregates to replace natural aggregates, set the requirement related to mixture of ingredients used in concrete for pavement quality control. Also, to check the performance of recycled aggregate concrete with respect to natural aggregates concrete. The compressive strength of pavement quality concrete mainly depends on the quality of natural aggregates, and recycled aggregate. The recycled aggregates quality mainly depends upon manufacturing process and output of demolition material. In the present study the replacement of NA to RCA are done, and finding out strength relationship at various ratio. The suitable thickness of road pavement was proposed based on the traffic volume and ingredient of concrete [15]. The natural aggregates sources are preserved by using demolition material as a replacing agent of civil construction materials. For said concept we here used recycled aggregates as a ingredients of pavement quality concrete. In rigid pavements load is suddenly transfer bottom instead of grain-to-grain layer like flexible pavement. In rigid pavement concrete the volume of coarse aggregates is higher than other ingredients so demolition material recycled aggregates are used as a best replacing agent of NA [10]. The recycled aggregates contain different types of material and its durability is low as compare to natural aggregates hence it is difficult to replace complete 100% of NA to RCA. Recycled aggregate contains other deleterious materials, which make it difficult for complete replacement of a good quality natural aggregate for concrete and, therefore, restricting its many

applications such as in reinforced concrete structural elements. In rigid pavements structure deflects very little under loading due to the high modulus of elasticity of their surface course, this is the reason behind the naming of this structure. Natural aggregate sources and the environment are preserved due to reducing a number of mining areas and disposal landfill areas. Additionally, using RA for concrete can reduce fuel consumption for transport and construction cost, while natural aggregate consumes a huge energy at each step of processing.

### Significant of Research

To answers the question of designers of mix composition as well as doubts of designers of structures a wide program of tests has been undertaken. The particular aim was to clarify the way how to obtain high-performance concrete using aggregates from demolished structures obtain in such concrete by introducing of silica fume and superplasticizers. In such aggregates apart from the obvious environmental aims of concrete recycling, there is a new economical aspect originally mixed with large amount of cement the crushed concrete retains some binding abilities, particularly when carbonated zone is not too deep. It may be activated with silica fume or fly ash admixtures. Considerable research work has been carried out to study the behavior of recycled aggregate concrete both in terms of its short-term and long-term properties. However, more research is required to make this technology viable and feasible. Since recycled Coarse aggregate (RCA), is processed aggregate from demolished concrete rubble, most of these aggregate particles have attached mortar. This component of attached mortar influences the basic properties of the aggregate, such as specific gravity and absorption. Normally, recycled aggregate is more porous, associated with high absorption capacity and low specific gravity.

These characteristics of recycled aggregate, in turn, have a bearing on the behavior of recycled aggregate concrete (RCA) both in the fresh and the hardened states. Reports indicated little change in workability of RAC but it may be noted that 8% to 10% more water is required. However, loss of workability with

time is faster for concrete containing recycled aggregate. Further, the literature cites approximately 10% lower compressive strength, 10-40% lower modulus of elasticity and 0% -20% reductions in tensile and flexural strength. 30% to 50% increase in creep and 20% to 70% increase in shrinkage are also reported for RAC. However, it may be noted that some of the above results cites here are from the limited work that has been reported so far.

While on the one hand, quality of concrete cannot be compromised, on the other it is also necessary to find means of utilizing the recycled aggregate effectively, economically and purposefully to overcome the difficulties stated earlier. It is, therefore, through fit to evaluate the behavior of concrete with part replacement of natural aggregate by recycled aggregate.

### Literature Review

Basic properties such as specific gravity, graduation, dry density, soundness, etc. are generally worse than those of natural aggregates due to the existence of residual mortar and impurities. Mixing utilizing recycled aggregates have satisfied initial slump requirements, however they will have high slump-loss after 1 hr due to AC of recycled aggregate. 20% to 30% reduction in compressive strength was found when compared to normal HPC [7]. The 28 days target compressive strength compressive strength was achieved expect for the 40MPa and 50 MPa RAC where the observed strength was slightly lower than the target strength. As in NAC, in RAC the strength can be increased by lowering the water cement ratio if water reducers are used provide the adequate workability [9]. RCA have relatively higher fineness modulus and lower bulk density. They possess significantly low specific gravity, very high absorbance and low resistance to mechanical action [1]. properties of original concrete have significant influence on mechanical properties of recycled aggregate concrete. It is possible to obtain recycled concrete with higher compressive strength. Properties if recycled aggregates concrete may be significantly improved by admixture of superplasticizers and silica fume, similarly to

cases of concrete with natural aggregates [2]. The test result shows that SF and MK improve both Mechanical and durability properties of recycled aggregate concrete. But the use of FA and GGBS significantly improved the durability performance of the recycled aggregate concrete [13]. The recycled aggregate is lighter, absorbs more water and contains a significant quantity of old mortar [14].

### Need for the Research

Recycled coarse aggregate has found a place as an alternative coarse aggregate for making concrete for all purposes. Accordingly, the extensive research work has been carried out by various investigators in different parts of the world. However, the test results of these extensive but fragmented research works have left construction engineers still on defense in utilizing recycled aggregate concrete. Although recycled aggregate concrete has been successfully utilized for construction and rehabilitation of pavement and runways, the engineers and researchers have doubts about its applicability as structural concrete for various reasons stated in the following chapter. However, these doubts can be removed by ensuring that;

- a) This recycling technology is developed on the basis of sound understanding of the properties of recycled aggregate.
  - b) A rational mix design is evolved based on the specific properties of recycled aggregate concrete both in fresh and hardened state.
- Thus, there is a strong need for systematic, comprehensive and co-ordinate research work.

### Aim and Objectives of the Investigation

- a) To investigate thoroughly all the physical and mechanical properties of aggregate obtained from concrete of various grades and ages.
- b) To study whether the properties of recycled aggregate are affected by properties of source concrete, (viz. grade of concrete, age of concrete, cement content etc.) if so, to establish possible trends and relationships with properties of source concrete.
- c) To observe the behaviour of recycled aggregate concrete in its hardened state for a wide range of mix cases. Further, to establish

relationship between various mix design parameters for a rational approach to mix design of recycled aggregate concrete mixes.

- d) To investigate the properties of fresh recycled aggregate concrete of different grades and short-term and long-term properties of hardened recycled aggregate concrete of different grades.
- e) To evolve possible relationships between various properties of recycled aggregate concrete.

### Methodology

- a) To have a variety of recycled aggregate samples laboratory controlled conventional concrete of five grades viz. M5, M20, M25, M30 and M35: and approximately 30-year-old reinforced concrete beams and slabs have been considered as source concrete.
- b) The maximum size of well-graded recycled aggregate considered has been restricted to 20mm. Recycled aggregate samples obtained from source concretes stated above have been considered for thorough investigation of all physical and mechanical properties.
- c) For parametric study, parameters like water-cement ratio, aggregate-cement ratio, percentage of fine aggregate, water demand, compressive strength, specific gravity and water absorption have been taken into account to establish desired relationships between various parameters, for this purpose, investigation of 6 mix cases of recycled aggregate concrete.
- d) M30 grade of concrete has been selected, for methods of mix design proposed IS method has been adopted.

**Phase I work:** There are no tests or experiments in this phase of work and only processing of recycled aggregate is carried out.  
**Method of production:** In recent years the concept of using old concrete of using old concrete pavements, buildings, and other structures as a source of aggregate has been demonstrated on several projects, resulting in both material and energy savings. The procedure involves breaking up and removing the old concrete, crushing primary and secondary crusher, removing reinforcing steel and embedded items, grading and washing of aggregates, and finally stockpiling the resulting coarse and fine aggregate.

### Experimental Observation

In this phase of work a number of experimental observation and derived results of various tests conducted on recycled aggregate have been recorded. All these test results are compiled in the table 1

**Table 1 Material Properties**

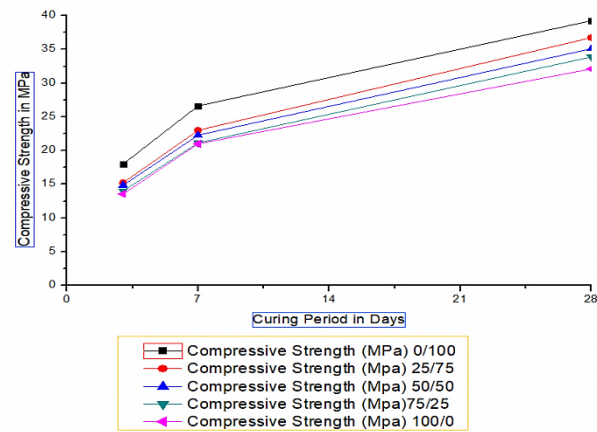
Sr. No.	Properties	NA	RCA
1	Specific Gravity	2.74	2.56
2	Bulk Density	1.487 kg/lit	1.49kg/lit
3	Impact Value	17.64%	16%
4	Fineness Modulus	3.092	4.068
5	Water Absorption	1.2%	2.12%
6	Moisture Content	37%	37.87%
7	Workability	110mm	87mm

**Phase II work:** This phase of work involves concrete mixing and testing of concrete in hardened state after 3, 7 & 28days, for 30 cubes of five different mix proportions. The testing work and other derived results are presented through tables 1 and figure1.

### VII. Result and Analysis

**Table 2 Characteristic Compressive Strength of concrete specimen**

Sr. No.	Grade of Concrete	% of RCA	% of NA	Days	Compressive Strength (MPa)
1	M-30	0	100	3	18
				7	26.62
				28	39.25
2		25	75	3	15.23
				7	22.99
				28	36.75
3		50	50	3	14.85
				7	22.27
				28	35.1
4	75	25	3	14	
			7	21.13	
			28	33.89	
5	100	0	3	13.54	
			7	21	
			28	32.1	



The percentage loss in compressive strength due to use of recycled aggregate is within the acceptable limit. The acceptable ratio of replacement of natural coarse aggregate to recycled coarse aggregate 50%

### Conclusion

The Crushing characteristic of hardened concrete are similar to those of natural rock and are not significantly affected by the grade or quality of the original concrete. Recycled aggregates produced from all but the poorest quality of the original concrete. Recycled aggregates produced from all but the poorest quality original concrete can be expected to pass the same tests required of conventional aggregates. The concrete with desirable properties can be produced using various secondary raw materials (waste for recovery), and their use can reduce consumption of natural resources as well as the conservation of disposal sites. This can result in the saving of non-renewable energy and the emissions associate with the process. Even if the energy consumption during the production phase, when considering the building materials, products and building during their total life span. Recycled aggregate competes favorably with natural aggregates in many aggregates in many local markets as road base material. Recycling has the potential to reduce the amount of waste dispose of in landfill, preserve natural resources, and provide energy and cost savings while limiting environmental disturbance. Potential sources for recycled material grow as maintenance or replacement of the Nation’s infrastructure continues. Because of the finite life of such infrastructure, this “urban deposit”

may be considered a renewable resource. The relative costs and charges of recyclers, their competitors, and landfills determine the amount of material ultimately available for recycling. The amount of material available

overall for recycling is insufficient to meet present industry demand. On a national basis, it is unlikely that recycling will ever completely replace natural aggregates as road base in road construction.

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## DESIGN AND MANUFACTURING OF AUTO REMOVABLE CROP PROTECTION SHED AND ITS PROTOTYPE

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### ABSTRACT

*These Days innovation has been improved immensely. Despite the fact, there is such a significance for innovation in our standard life there are even individuals whose ways of life is far to this notable term innovation. Along these lines, it is our duty to structure very few dependable systems which can be effectively utilized by farmers. The fundamental motivation behind this paper is to keep the fields safe from the substantial rain and furthermore secure the perimeter with the help of laser security system. The proposed system includes ensuring the fields by the auto roof which covers the entire territory where the crop is spread.*

**Keywords:** Automation, Crops, DC motors, Laser Protection

### Introduction

Farming is the science and art of creating plants and creatures. Agriculture was the key headway in the climb of stationary human advancement whereby developing of prepared species made sustenance surpluses that engaged people to live in urban regions.

The chronicled background of agriculture began an enormous number of years earlier. Consequent to get-together wild grains beginning at any rate 1,05,000 years earlier, early farmers began to plant them around 11,500 years back. Pigs, sheep, and cows were prepared over 10,000 years earlier.

Plants were autonomously developed in any event 11 districts of the world. Modern horticulture dependent for enormous scope mono culture in the twentieth century came to overwhelm agrarian yield, however around two billion individuals despite the fact that everything relied up on subsistence agribusiness into the twenty-first..

For protection of crop from heavy rain we design and develop auto removable crop protection shed, this shade will provide auto adjustment over crop by sudden climate changes. It will be able to protect crops from heavy rain or hailstorms in rainy season, in rainy season we see that many farmers are unable to protect their farm from heavy rain,

some crops are lay down or gets crack in fruits or foods because of hailstorms and heavy rain that causes multiple losses.

For that purpose, we design and develop auto removable crop protection shed that may give sudden arrangement over a farm during climate changes that can help to protect crops from damage.

### Literature Review

We have experienced past researched work on these kinds of projects. Examination in various techniques, farming is the foundation of Indian economy. Agriculture delivers the principle source nourishment for us.

But in the present circumstance the accessibility of a workers of caring out farming exercises is rare. The computerization in all sorts of industries prompts modern development. Here farming procedure is robotized up to some extent.

1. P. Goutham Goud et al [1] proposed a framework wherein the downpour is recognized consequently and defensive shield is wrapped on the rooftop, rain sensor, a clever microcontroller and a DC motor is utilized. The rain sensor of such drying shed which ensure the harvest against downpour and getting wet. To robotize this assignment, a downpour detects the downpour and information is passed to the microcontroller.

The microcontroller forms the information and initiates the DC motor control circuit and a defensive wrapper is wrapped on the rooftop top.

2. Dheekshith et al [2] proposed a framework which proposes utilizing a downpour distinguishing sensor to identify the precipitation. The sensor is associated with a direct actuator motor and a spread job which shield from downpour. At whatever point the sensor identifies the downpour it begins working and pivots the spread roll that covers the gathered merchandise and spares farmer from loses.

3. Ajay et al [3] proposed a framework which ensures the yield by the auto rooftop which covers the entire field. There is a precipitation the rain sensor gets actuated. The soil moisture sensors which are conveyed in soil checks the water level. At any point if there is downpour, the rain sensor is "ON" and when the water level in the dirt is surpasses the typical level at that point soil moisture sensor is "ON". In the event that both the sensors are "ON" at that point this data is sent to the controller and the GSM. At that point the controller shows that the DC motor runs which opens the rooftop. But this is performed physically by the farmers. This message is sent to their cell phone utilizing GSM. Then the rooftop can be opened physically utilizing mechanical roller. Right now, rooftop is open naturally when both the sensors are "ON".

4. Naveen K B et al [4] proposed a framework which has been structured by utilizing Proteus programming. When the rain sensor identifies downpour and soil moisture distinguishes dampness content, which is shown on LCD. The procedure of auto rooftop is insinuated by GSM which will be sent through SMS to the mobile user. The soil moisture sensor, temperature sensor and rain sensor identify the value that sent to PIC microcontroller. Taking into account the qualities, the automatic rainwater and crop saving system protects crops from excess amount of rainwater.

By utilizing this framework spares the power, boosts the profitability during both sunny season and rainy season. Here the human force was disposed of by giving auto rooftop. Water framework has been the foundation of human progression since man has begun agribusiness.

As of now, various procedures are proposed for water framework to supply water to the land. In the present scenario, more significant challenge is preservation of water. As of now in the current circumstance, there are no efficient frameworks.

The farmer himself ought to go to the drying territory and cover the collected fields which would be exceptionally troublesome if the place of the farmer is a long way from the harvest and before the farmer arrives at the entire harvest would be pulverized by the downpour.

### Limitations of Existing Systems

The conventional method of covering the field during sudden rainfall causes major effects.

Green house has certain limitations such as it cannot be adjusted to climatic conditions and it will not allow sun to pass through the crop.

Most of the existing systems concentrated on covering the crop from rainfall by providing roof over the crop rather than focusing on water level required for a particular crop.

If the crop needs certain amount of water in such case farmer needs to permit the rain over the crop and once it's having sufficient amount of water content, then he can protect the crop by covering with roof.

### Problem Statement

There is a problem that, in heavy rain falls the crops gets destroyed which causes huge loss for farmers. But unwanted rains are natural cause that we can't do anything about. For prevent this loss we have technological solution which will help to protect crops from heavy rain.

### Objectives

- 1) To prevent the harvested crops from the heavy rain.
- 2) To save human efforts in farming methods.
- 3) To make it easier to save farms from natural disasters.

### Methodology

As explained in the introduction and considering all aspects of problem, the topic got selected as in the title. The concept got developed by collecting information about farming and the problems occur in farm.



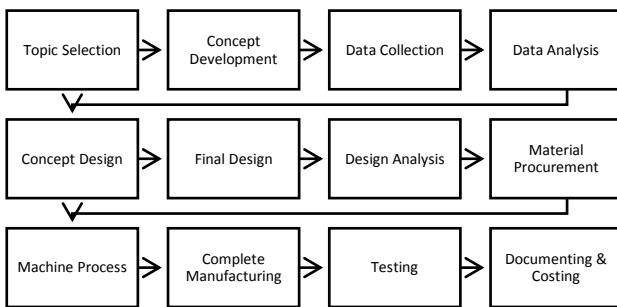
The concept design is developed in a CATIA V5. As shown in figure in design, the structure is made which can sustain high wind and rainfall. Considering all impacts and load, the final design selected and started design analysis on the same.

According to design, the material got selected which can sustain environmental effects on it like wind, rain, structure balance and comfort.

After material procurement and all necessary equipment, the machine processes started to begin. The got there shapes and size and attached in a proper way according to design.

The manufacturing completed is done after above procedure. The final assembly is done with extra accessories like laser security system and little lightings to make operation visible in dark areas.

After final manufacturing, the testing is done by operating the prototype on field with crops and rain. The documentation is done after testing and calculations.



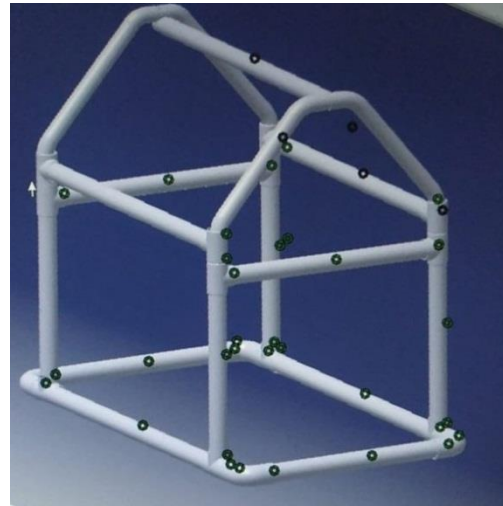
**Design**

We have made a design on CATIA V5 to describe our imagination into reality, first of all we designed base structure while making sure the base can handle the weight of model and to balance the whole body.

Then we designed the column to support upper body and shed with respect to the covering area of crop field.

After that, we worked on a design of upper body and ensured that it can handle the pressure and rainfall and pour the rainwater equally on both side.

Aerodynamics of structure matters the most here, considering that we designed aerodynamic shape for the upper body so it can sustain the high winds and won't affect the balance of structure.



**Fig. 3D model of design**

**Working**

An auto removable crop protective shed will help to protect crops and farm storage from predictable and unpredictable rain. Whenever rain starts to fall, the protective shed will cover the crops on a single switch by farmer.

Motors will pull the protective material over the frame and crops will get covered from top, and also from other sides in case of heavy rain and storm. This will save crops from getting destroyed by rain and all efforts and work of farmer who puts all his money and efforts to grow these crops.

This prototype also consists laser protection system to protect perimeter from threats. Laser sensor will be focused on LDR laser sensor, if this connection gets disturbed it will cause alarm to warn farmer for threats.

We have made the working prototype as shown below.



**Fig. Actual picture of prototype**

## Components Used

### Motor

Motor used here is high quality low cost DC geared motor.

Rated Speed: 100 RPM

Operating Voltage: 12 V

Rated Torque: 1.9 kgf.cm

Load Current: 0.3 Amp

### PVC Pipe

The PVC pipes used here rigid pipe for heavy duty purpose.

Material: PVC

Type: Hard type

Diameter: 2.5 Inch

Thickness: mm

### Protective Sheet

This sheet is used to cover the structure and to avoid rain water to fall in.

Material: Transparent PVC

Thickness: 0.1mm

Load Capacity: 5 kg approximately

Properties: Heat resistant, water proof, durable, high weight carrying capacity.

### Sliding Guide

The PVC pipes used here rigid pipe for heavy duty purpose.

Material: Stainless steel

Type: Clutch wire

Diameter: 1.6 mm

### Belt - Pulley

The purpose of belt - pulley is to pull the protective sheet.

Belt Material: Poly-urethane

Pulley Material: Plastic

### Security System

The security system used here is laser security system.

Laser sensor and LDR laser sensor.

## Advantages

- 1) Protection of harvested crop from rain.
- 2) Protection of crop from insects.
- 3) The proposed system works for longer period.
- 4) The roof has flexibility to use whenever it is required.
- 5) This system has laser security system to secure the perimeter from threats.

## Applications

- 1) The proposed framework can be utilized for storing vegetables and crops.
- 2) This system can be used to save machinery.
- 3) This system can be used to provide shelter to vehicles.
- 4) The proposed framework can be expanded to bigger scales.
- 5) This system can be used to provide required atmosphere.

## Future Scope

- 1) This system can be used to store grain bags in farm in case of emergency.
- 2) This system can be used for protecting vehicles from rain.
- 3) This system can be used for sheltering from snow fall by warming shed.
- 4) This can be modified into advanced shed to provide required atmosphere to crop field.

## Conclusion

The results of proposed system proven that it is reliable and can be used by the farmers effectively.

The proposed system can be enhanced and automated without intervention of farmer, by identifying the rain type farmers can immediately cover the crop field by just one switch and also uncover the crops by single switch after rain.

This simple mechanism will ultimately save the crops from getting destroyed by unpredictable rain and prevent unnecessary loss of farmer.

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