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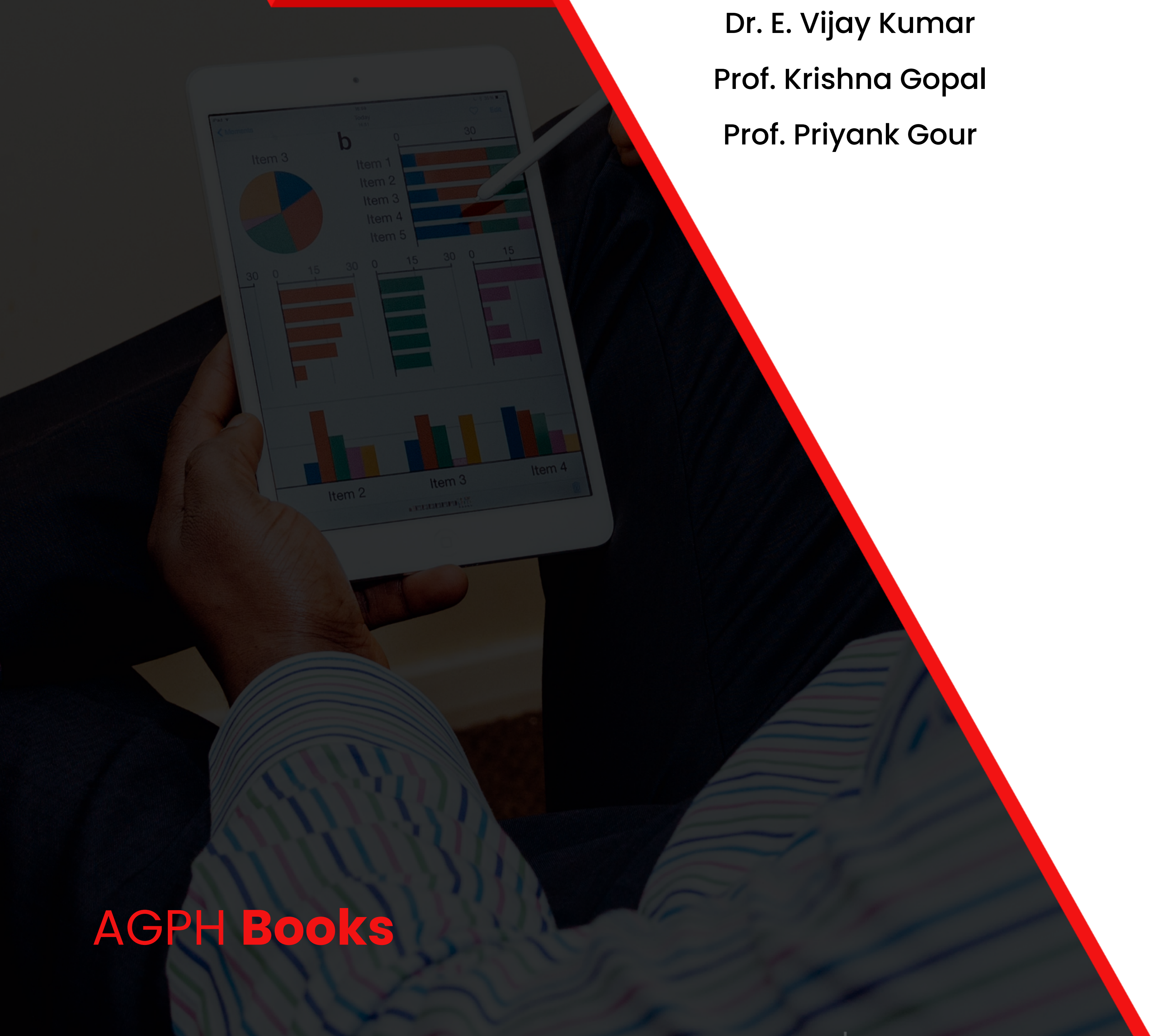
Technological Advancements

Research & Reviews

Dr. E. Vijay Kumar
Prof. Krishna Gopal
Prof. Priyank Gour



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Technological Advancements: Research & Reviews

Dr. E. Vijay Kumar
HOD Department of Electrical and Electronics Engineering, RKDF Institute of Science & Technology, SRK University, Bhopal, M.P, India.

Prof. Krishna Gopal
Associated with Samrat Ashok Technological Institute,
(Grant in aid autonomous engineering college under the Gov.t of M.P.) Vidisha

Prof. Priyank Gour
Associate Professor and HOD Department of Electrical and Electronic, Bhopal institute of technology and management, Bhopal (M.P.)

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About the Author

Dr. E. Vijay Kumar, HOD Department of Electrical and Electronics Engineering, RKDF Institute of Science & Technology, SRK University, Bhopal, M.P, India. Had awarded Ph.D. in Electrical & Electronics Engineering from Rabindranath Tagore University (RNTU), Bhopal, and his Doctorate in the area "Investigations on control strategies of multilevel inverters for Improved power Quality". M.Tech from Jawaharlal Nehru Technological University, Hyderabad, A.P, B.Tech from Kakatiya University, (KITS) Warangal, Telangana State. And Diploma from SRRS Govt. Polytechnic College, Sricilla, Karimnagar Dist., A.P.

Prof. Krishna Gopal currently associated with Samrat Ashok Technological Institute, (grant in aid autonomous engineering college under the Gov.t of M.P.) Vidisha since 2005. He has completed his masters from M.A.N.I.T. Bhopal and currently pursuing his Doctoral from R.G.P.V. Bhopal. He has published his research papers in repute journals. His research areas are Signal & Image processing, Machine Learning application in health analytics and Embedded systems.

Prof. Priyank Gour has been in the Profession of teaching since 20 years with more than 10 years of research experience. He has published more than 40 International journals and conferences, and 15 Elsevier & Scopus papers are published along with One PATENT titled "Invention is system and method to recognize human emotions with multi scale features from video sequences" App. No. 202021027187 Date.26.06.2020. He has Supervised 06 Ph.D. Scholars and more than 25 students in M.Tech. His research area is Control Strategies of Multilevel Inverters Technology, Power Quality Improving Techniques, Renewable energy systems, Power electronics, Electrical drives and Electrical Machines design.

Preface

We are delighted to publish our book entitled "Technological advancements: Research and Reviews". This book is the compilation of esteemed articles of acknowledged experts in the fields of technological advancements.

This book is published in the hopes of introducing the modern technology and their recent advancements to our readers. Technology has grown to become an essential part of our daily life but new modern features remain unknown until a long time. This book provides our readers with a better understanding of the advancements that are made in the field of technology.

The articles in the book have been contributed by eminent scientists, academicians and research scholars. Our special thanks and appreciation go to experts and research workers whose contributions have enriched this book. We thank our publisher AGPH BOOKS (Academic Guru Publishing House), India for taking pains in bringing out the book.

Finally, we will always remain a debtor to all our well-wishers for their blessings, without which this book would not have come into existence.

- Editorial Team

Technological advancements: Research and Reviews

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CONTENT

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Technological Advancements : Research & Reviews
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CFD ANALYSIS ON COLD STORAGE TO FIND OUT THE EFFECT OF DESICCANT MATERIAL ON RELATIVE HUMIDITY

Shalini Singh[1*]

[1] Research scholar, Jabalpur Engineering College, Jabalpur-482011, India

Abstract

Cold storage or refrigerated warehouses are facilities where perishable foodstuffs are handled and stores under controlled temperatures with the aim of maintaining quality. The study attempted to bring down the humidity as well as temperature within the best required range to keep the onions fresh for a longer period of time. A duct was added in the cold storage system. A desiccant material of blue gel silica is used to maintain the humidity and a fan is used to circulate the cold storage air. Both the desiccant material as well as fan was mounted inside the duct pipe. The results obtained were satisfactory and exhibited evidently in the study. For simulation 3 ton and 6-ton cold storage is selected for 2 cases. Simulation is done for checking the proper requirement of keeping onion, apple and potato for longer period. Humidity has wise impact on onion, for controlling humidity within the requirement range desiccant material (Blue silica gel) is used.

Keywords: Cold storage; desiccant material; humiditry; duct; desiccant air conditioning.

1. Introduction

India is one of the world's biggest fruit and vegetable producers; however, the losses of post-harvest production can reach up to 40% to 50%. Failure to store cold waste is a key factor in the high waste

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and must enhance food quality, quantity, and shelf life in order to satisfy the people's nutrition requirements. Hunger, particularly because of the vast number of underprivileged people across the country, is one of the most serious challenges facing Indian society. Some measures have been undertaken to create cold chains in India, however, the architecture of the cold chain is highly fragmented. But such problem cannot be solved alone by cold chain installations. Other difficulties include inadequate logistics, many food chain intermediaries causing low pay, poor post-harvest management and processing, and obsolete technology and infrastructure. However, if India exploits and exploits this potential through, among other things, the development of post-harvest management and the infrastructure of the cold chain, India will become the world's leading agricultural supplier [1].

1.1. Cold Storage

Cold warehouses are installations where foodstuffs that are biodegradable are kept under supervision in order for quality to be preserved. Food can be preserved under temperatures frozen or cooled. Apart from temperature, it may be necessary for numerous different commodities. [2] The cold store may be a location to protect them against being spoilt and to increase their preservation by various items like vegetables, fruits, medications, etc.

Cold storage design to be effective is an essential business requirement since poor style could lead to a loss and in certain circumstances might lead to a dangerous system operation. Apart from capital loss, because of degradation of product quality, there is also power loss and it is of the utmost significance to conserving as much electricity as possible in the country.

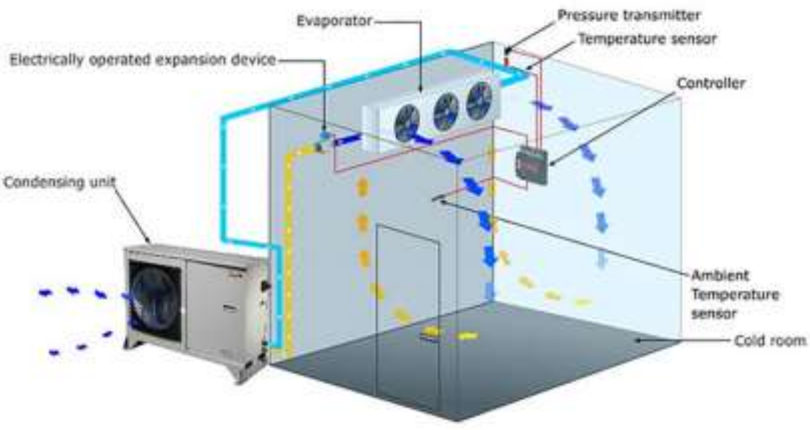


Figure 1: Cold Storage Room

1.2. Desiccant

Materials that are capable of attracting and holding other gases and liquids are often called sorbents. These sorbents are generally employed in chemical separation processes and used for the absorption of non-water vapour gasses or fluids. Desiccants are a subgroup of sorbents that exhibit water affinity in particular. This process of water vapor absorption and maintenance by the dryers is described as absorption/adsorption depending on whether or not the dry material undergoes a chemical modification when moisture is absorbed (adsorption). [3] In general, a desiccant draws 10-1100% of its dry water vapor weight, depending on the ambient humidity content and the type of material employed to dry. Even from dry air, dry matter continually attracts humidity until it finds a balance with the surroundings. The heating of the desiccant substance and exposure to a regeneration airstream removes humidity at temperatures between 50°C and 260°C. The desiccant should be cooled down after thoroughly drying, in order to draw water vapor again. Solid or liquid desiccants, particularly solid desiccants, and liquid desiccants are available. Adsorbents are mostly solids and liquids are absorbents. [4]

1.3. Motivation for DAC system

For the preservation/storage of agricultural goods, standard vapor compression refrigeration and/or air conditioning systems are utilized. In literature, such as environmental deterioration and energy needs, the drawbacks of traditional refrigerating systems are widely recognized. In addition to these drawbacks, traditional cooling systems cannot be utilized for storing on-farm plenty of tropical fruit and plants such as bananas, tomatoes, oranges, mangoes, and other green vegetables due to chilling injuries and colour degradation.

On the other hand, due to greater relative humidity, independent evaporative refrigerators cannot be employed in tropical climates. The desiccant air conditioning (DAC) system has the capacity to handle sensitive and latent air conditioning loads separately though. This contrast between the DAC systems offers a chance to utilize this system efficiently for the storage of agricultural products, both because of its temperature and relative humidity. [5] In this connection, temperature is the key element for maintaining product quality, given the direct dependency on the physiologic and biological processes in the goods. In order to preserve them in an excellent physical and biological look, relatively low humidity is also essential for limiting the loss of moisture content in items. [6]

1.4. Objectives of the Study

Following are the objectives of the present study, which are as follows:

- To study the effect of temperature distribution in cold storage by using desiccant material.
- The distribution of air will be study in cold storage.
- To calculate the relative humidity of the cold storage.

2. LITERATURE REVIEW

(Guo et al. 2020) [7] For the delay of the water loss of fresh products, the moisture control that is influenced by the humidification device's performance and container structure is very important. In order to assess the characteristics of humidity control through computational fluid dynamic (CFD) models, humidity rate and moisture distribution uniformity in the fresh storage container were examined. To measure the ventilation resistance of products, a pressure gauge was used to obtain inertial resilience and viscous resistance values. The moisture performance results were assessed using an entropy procedure. Results showed that a significant effect on the humidifying rate was the number of ultrasonic atomizers and sensor locations.

(Cengiz and Yilmaz, 2020) [8] In order to ensure the sustainability of the agricultural industry and reduce food loss, the widespread construction of cold storage buildings is important. However, because of financial difficulties, the number of cold warehouses in the majority of developing countries is not enough. At present, the payback period is the main incentive for investors to finance such projects. Data from selected cold storage studies in Turkey have examined the energy consumption and profitability of cold storage buildings based on their capacities. By simulation, the optimum storage capacity was estimated, and the link between payback times and cold stores capacity was evaluated using the data obtained.

(Qi, Dong and Zhang, 2020) [9] Dehumidification liquid desiccants may remove humidity from air supply independently. It offers several benefits, including excellent moisture management, use of low-grade thermal energy, increased air quality supply, and energy storage. This technology and its economic worth have become practical in practice with the progress of recent decades. However, because of the use of corrosive desiccants with limited heat capacity and insufficient weighting on packaging columns, the system still faces certain constraints. This study will assist to identify research gaps and explore novel ways of enabling liquid desiccant air dehumidification to become more feasible.

(Mohammed et al., 2019) [10] In order to study the process of thermal and mass transfer in the two heat exchangers, a mathematical model has also been constructed. For the validation of numerical findings, the experimental data collected are employed and excellent agreement is achieved. The impacts of DPHE and DCHE on the performance of the heat exchanger length and inlet circumstances are examined. The DPHE exceeds the DCHE's cooling capacity and moisture removal capacities in terms of experimental and numerical findings.

(Watanabe et al., 2019)[11] Appropriate moisture control can help to save electricity. But there are several weaknesses to the current dehumidification technology. Recently considerable interest has grown from the standpoint of decreasing energy use during dehumidification with liquid desiccant air conditioning. A systemic study of the humidifying capabilities of 16 IL types was performed to assess the adequate ionic liquids (ILs) as the desiccant for the liquid desiccant air conditioning system. Among the tested ILs, tributyl(methyl) phosphonium dimethyl phosphate ([P4441] [DMPO4]) exhibited the best dehumidification capacity and had a less corrosive effect on four types of metals as possible piping materials.

(Mishra and Aharwal, 2019)[12] Computational Flow Analysis Enable Large Cold Storage Air Distribution to be shown. Cold storage thermal performances are based on a closed chamber on airflow mechanism costly Cold Store Experimental Investigation. Thus, In This Paper the Impact of Auxiliary Draught systems (Ads) On Airflow Distribution Is Carried out with the Help of Computational Fluid Dynamics (CFD). 26 percent Error in the Simulation result is shown by experimental validation. The results reflect the use of ads, which decreases the cooling time by 25%. Auxiliary Draught provides the plant with a homogenous environment.

3. RESEARCH METHODOLOGY

3.1. Steps of working

- Design and modeling in CAD according to the experiment setup.
- Further converting the CAD File in .step format for importing it in Ansys Fluent work bench.
- Assigning the name selection to the different parts.
- Meshing for performing the simulation process.
- Providing the suitable boundary conditions according to the selected base paper.
- Assigning the material properties.
- Evaluating the results after the finish of simulation work.

3.2. Model Development

The cold store room used in this study is designed for a capacity of about 3 tons of onion preserved at storage temperature of 5 °C. The onions are arranged in two rows; each row contains 6 crates, built in column of about 2 m of height. Circulation corridors are provided between the different rows and near the walls. The table mentioned below shows the design parameters of cold storage.

Table 1: Design parameters of cold storages

S. No	Particular	Specification
1.	Cold Storage Length	2.8194m
2.	Cold Storage Width	2.6678m
3.	Cold Storage Height	2.5654m
4.	Crates along the length	2
5.	Crates along the Width	4
6.	Crates along the height	6
7.	Dimensions of the crates	0.54m x 0.36m x 0.29m
8.	Capacity of per crates	25 kg/crates
9.	Total capacity	1.2 MT

4. RESULTS AND DISCUSSION

4.1. Result Validation

RH is the most important variable affecting moisture components of the onion including moisture loss by fresh produce. The below graph represents the relative humidity in respect to the temperature. Both the results obtained from CFD as well as experimentation are exhibited. The results obtained for very similar and negligible difference can was reported. The maximum difference is when the temperature is 12°C which showed the value from CFD analysis and experimentation as 68.122% and 66.136% respectively. The experimental results were obtained from "Maulana Azad National Institute of Technology (MANIT), Bhopal, Madhya Pradesh".

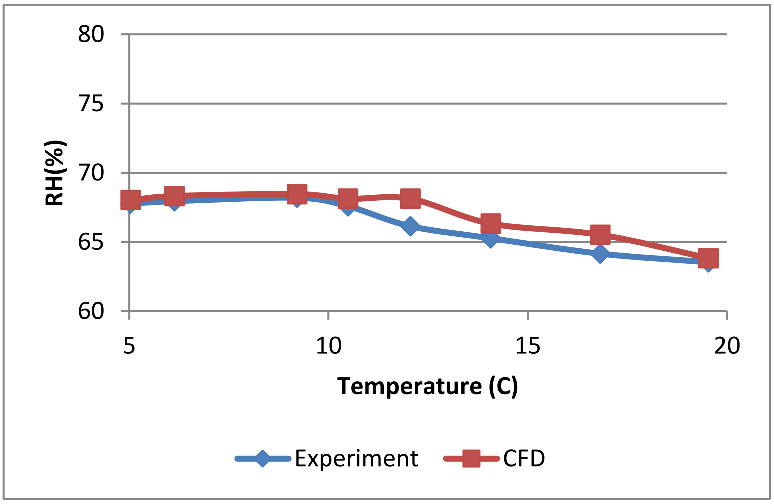


Figure 2: Validation graph of experimental and CFD study

4.2. Variation of Relative Humidity

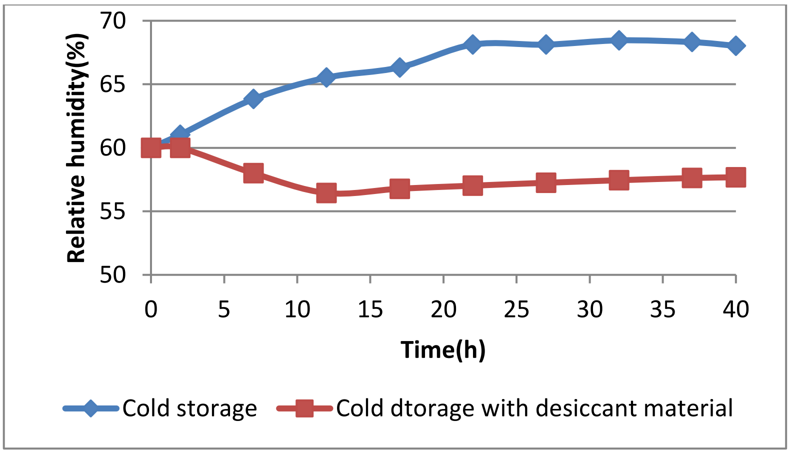


Figure 3: Comparison of Relative humidity of simple and modified cold storage from CFD analysis

4.3. Variation of Temperature

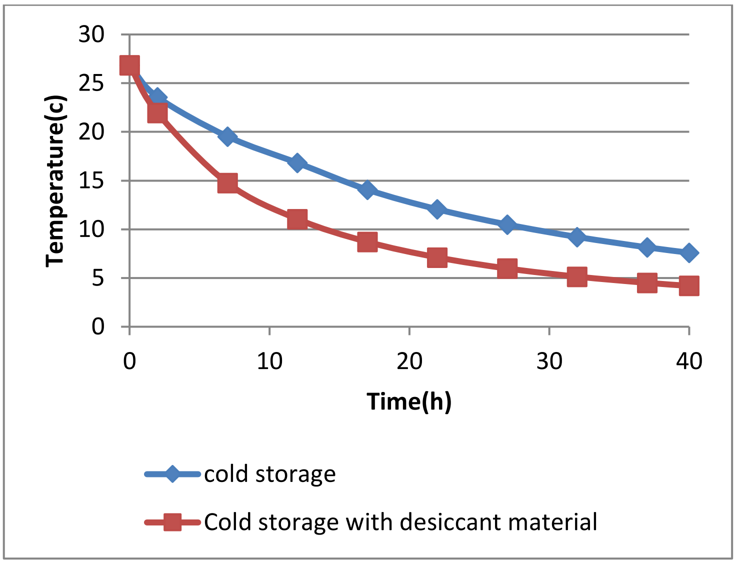
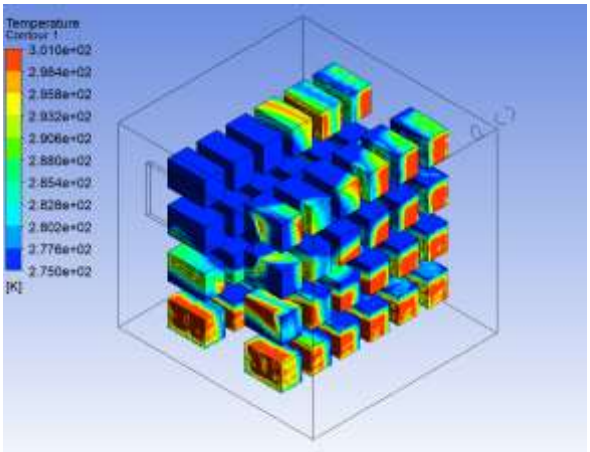


Figure 4: Comparison of Temperature of simple and modified cold storage from CFD analysis

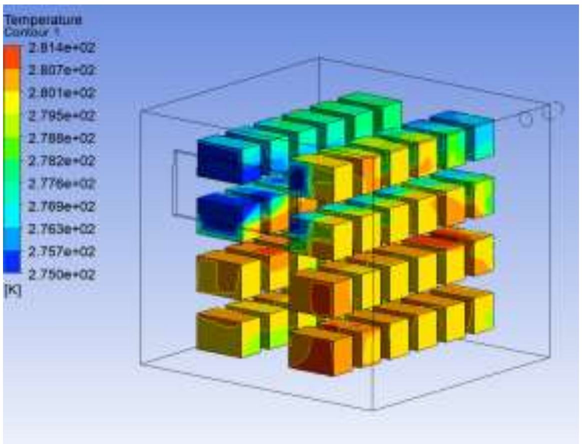
4.4. *Steady state result*

Case 1: Temperature variation among without desiccant, onion, apple and potato with 3 ton

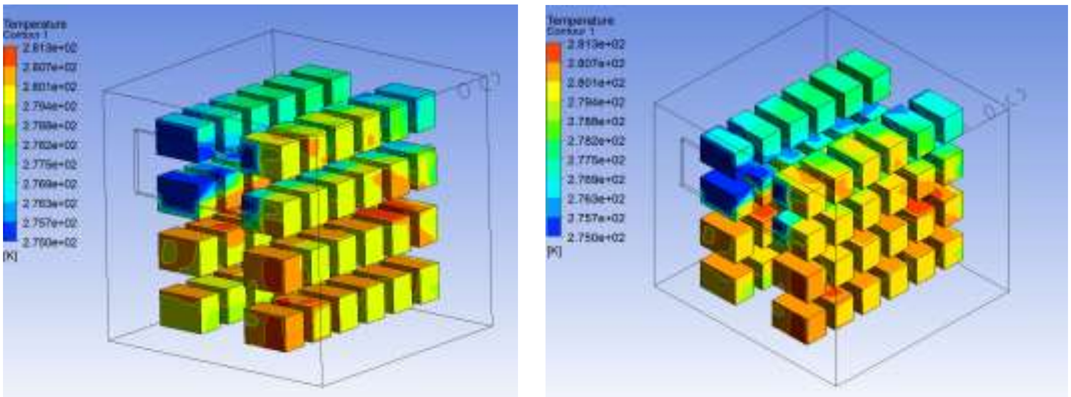
Temperature contour of all four different factors is shown in the figure given below for without desiccant, onion, apple and potato. Maximum temperature obtained for without desiccant, onion, apple and potato are 301.0K, 281.4K, 281.3K and 281.3K respectively. And minimum temperature obtained for without desiccant, onion, apple and potato is 275.0K for all.



(a)



(b)

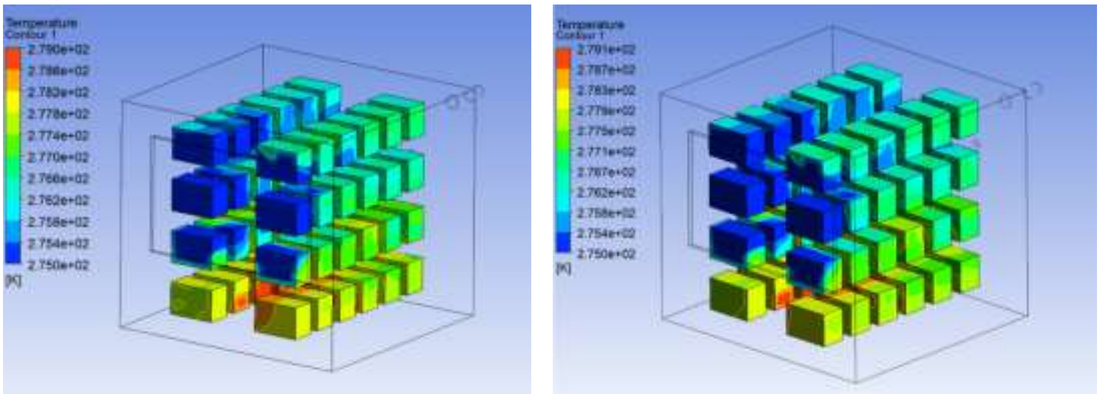


(c) (d)

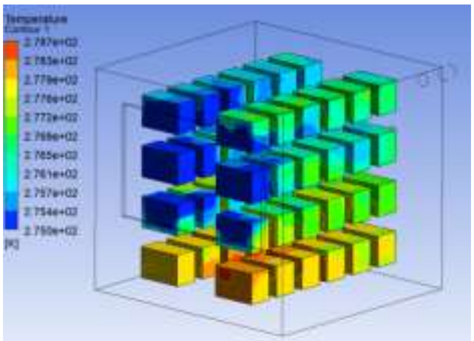
Figure 5: Temperature contour of (a) without desiccant, (b) onion, (c) apple and (d) potato in 3 ton refrigerator

Case-2: Temperature variation among onion, apple and potato with 6 ton

Temperature contour of all four different factors is shown in the figure given below for onion, apple and potato. Maximum temperature obtained for onion, apple and potato are 279K, 279.1K and 278.7K respectively. And minimum temperature obtained for onion, apple and potato is 275.0K for all.



(a) (b)

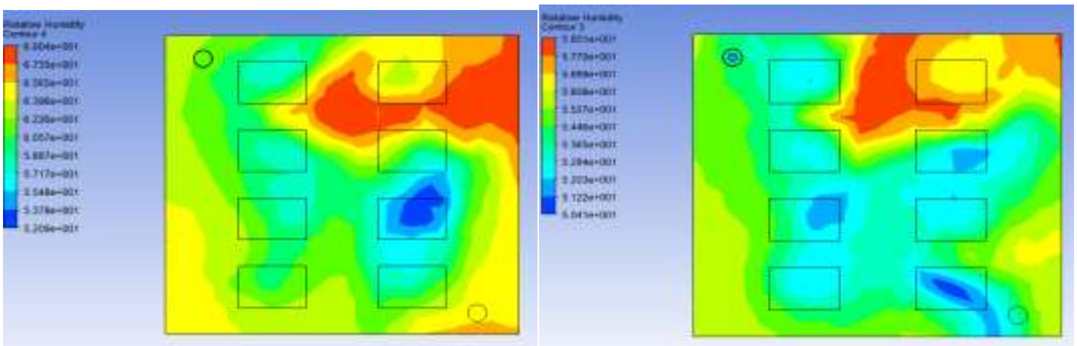


(c)

Figure 6: Temperature contour of (a) onion, (b) apple and (c) potato in 6 ton refrigerator

4.5. Humidity

As shown in figure 3a, it can be stated that the available humidity is recorded approximately as 70%. However, using the dessicant material brought the humidity within the required range, i.e. 60%, as shown in figure 3b.



(a) (b)

Figure 7: Humidity contour of (a) without desiccant, (b) with desiccant

4.6. 3 ton and 6 ton refrigeration

Below shown graphs shows temperature at different point inside cold storage in both 3 ton and 6 ton cold storage. By the graph it can be described that 6 ton refrigerator maintain much lower temperature as compare to 3 ton refrigerator. All 3 material follow the same trend 6 ton refrigerator is better for all materials; it can maintain low temperature and keep the materials fresh for longer period.

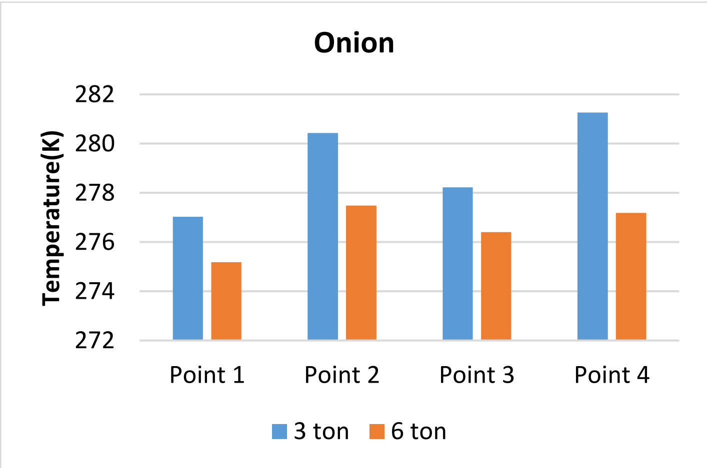


Figure 8: Temperature comparison of onion

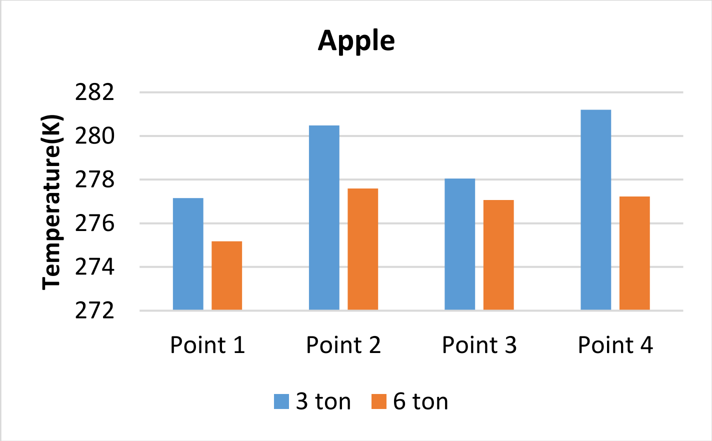


Figure 9: Temperature comparison of apple

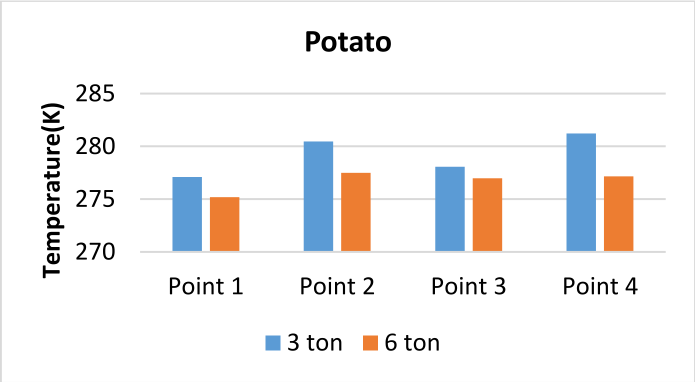


Figure 8: Temperature comparison of potato

5. CONCLUSION

This study was based on both experimental as well as CFD simulation. The used desiccant material brought down the humidity by a significant value. The maximum humidity required in a cold storage for storing onions is within the range of 55-65%. The results in this study showed that after using the desiccant material, the obtained humidity was 58.5%. This will help in storing the onions on a better required humidity and will keep the onions fresh for a longer time. Since the humidity content affects the quality of the onions, therefore this desiccant material can now evidently be used on larger scales. The fan used in the duct also reduced the temperature by a significant difference bringing down the temperature under the needed value i.e. 5°C. The results showed the temperature of 4.623°C which was attained because of using the fan in the duct. An approximate temperature attained with 6 ton capacity is 3-4 degree Celsius whereas with 3 ton capacity, 7-d degree Celsius temperature is attained. With the help of these results, it can be concluded that 6 ton capacity is capable of keeping the stored item fresher for longer period of time.

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COMBINATORIAL ANALYSIS OF LEAN MANUFACTURING AND REVERSE ENGINEERING FOR JOINT PROPELLER SHAFT IN AUTOMOBILE INDUSTRY: A REVIEW

Manish Deshmukh[1*], Anshul Gangele[2], Deepak Kumar Gope[3]

[1]*Research Scholar, Depart of Mechanical Engineering, Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan, India 33001*

[2]Priciple, Depart of Mechanical Engineering, adina institute of science and technology, Sagar, Madhya Pradesh, India 470002

[3]*Assitant Professor Scholar, Depart of Mechanical Engineering, Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan, India 33001*

Abstract

A wheel's axle is its middle shaft. Axles keep the wheels in place in relation to one another and to the vehicle's frame. Attempts are being made to address this problem in this publication. A comprehensive review of the relevant literature is now being conducted, and several potential study avenues have been identified. Lean Manufacturing is a fast-growing and efficient strategy in today's competitive marketplace. Lean Production is used to continually remove wastes from the manufacturing process in order to increase productivity and efficiency. It is the primary goal of lean manufacturing to meet the needs of the customer in terms of quality and cost. In addition to identifying the root causes of waste, the method helps to remove it by establishing clear rules and norms. This article focuses on the fundamentals of lean manufacturing in order to increase production, quality, and decrease the product's cost. Various wastes have been classified. The methods for reducing waste are explored in detail.

Keywords: Axle; Drive Shaft; Lean manufacturing; wastes; continuous improvement; manufacturing industry

[*] ISBN No. 978-81-953278-8-1

1. INTRODUCTION

Manufacturing has been around for a long time and was initially carried out by experienced craftsmen, often with the help of helpers, who passed on their knowledge via apprenticeship. There may have been guilds that protected the craftsmen' trade secrets and privileges. Alternatively, manufacturing may take place on a smaller scale in rural regions, where artisans would use their home-based manufacturing to augment their farming income. The putting-out approach was used to organise these industrial homes into joint ventures.

1.1. Types of losses in manufacturing

In the 1970s, the “Japan Institute of Plant Maintenance” established the Six Big Losses framework, which identifies industrial losses and gives criteria for analysing efficiency issues. Proactive improvements are encouraged in the framework, which focuses on reducing faults, delays, and breakdowns.
Finding the fundamental cause and scope of each of the Six Big Losses may be a difficulty. This approach may be used to break down problems into manageable chunks, which can subsequently be used to build long-term solutions.

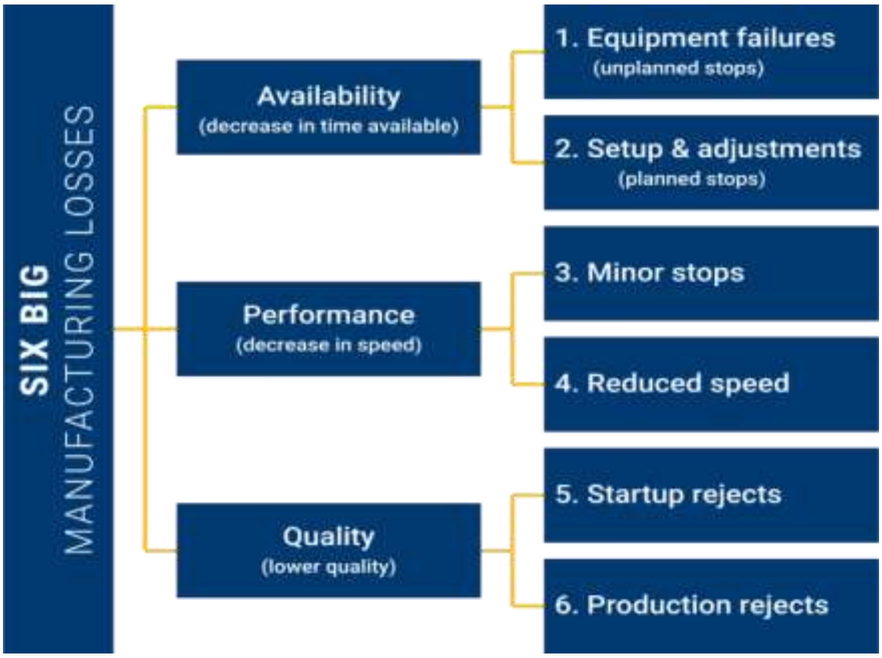

Figure 1: Six losses of manufacturing

1.2. Quality Losses

Process Defects

During steady-state manufacturing, process defects are responsible for the fabrication of faulty items. First Pass Yield takes into account both trashed pieces and those that can be repaired. Defects in the process are a Quality Defect.

Incorrect machinery settings, operator or equipment handling mistakes, and lot expiry are all examples of typical causes of process faults (e.g., in pharmaceutical plants). (Meena et al., 2016)

Reduced Yield

Defective components created from the commencement of production to stable (steady-state) manufacturing are included in the concept of reduced yield. First Pass Yield (OEE) takes into account both trashed pieces and those that can be repaired. However, it is most typically recorded following a transition, when equipment is restarted for the first time in a long time. Quality is harmed when yield is reduced.(Wei Dong Leong et al., 2019)

Equipment that requires warm-up cycles, equipment that produces waste when it is first used, and inadequate changeovers are among the most typical causes of reduced yield (e.g., a web press).

2. LITERATURE REVIEW

(Hore, 2019) This study is being conducted to fill a gap in the literature and provide a plan for implementing lean in an effective manner. A hierarchical model of lean implementation in the Indian steel sector is the topic of this investigation. Interpretive structural modelling is employed in this work to develop the hierarchical model, which is validated using MICMAC analysis. Following the formulation, the model was decrypted and advice were offered on how to effectively adopt lean in the Indian steel sector.

(Sundareshan et al., 2017) The Indian Foundry sector employees are surveyed extensively to study the deployment of Lean and the determining elements. The results of a research looking at age, firm size, educational background, gender, and years of experience in the context of the Indian subcontinent's Lean implementation reveal a jumble of data that obscures the causes, advantages, and obstacles to its adoption. There are 28 foundries in Karnataka, and a total of 204 employees filled out a detailed questionnaire to get their thoughts on the industry. Overall equipment efficiency, plan-do-check-act, total productive maintenance, bottleneck analysis, continuous flow manufacturing, poke yoke, as well as standard work are among the most successful categories of Lean, according to the findings of the study. The chi-square distribution's standard deviation numbers show the same thing.

(Womack & Jones, 2015) To attain this aim, lean manufacturing and related techniques are seen as a crucial tool for eliminating or reducing waste. It is thus necessary to develop a quantitative model to examine if lean manufacturing processes (tools) may enhance the company's sustainability performance in all three of these areas (economic, environmental and social). An extension of prior research, this study examines relationships between sustainability and lean techniques in terms of the triple bottom-line components of the triple bottom line.

(Erick et al., 2014) (Erick et al., 2014) In this work, CAD/CAM (Computer Aided Manufacturing) methods and composite materials are proposed for the design and manufacture of low-capacity wind turbine blades. TIMEO®, a programme created at the author's university, was used to create the blade designs. A three-axis CNC machining machine, DYNA MYTE DM-4800, was used to make the blades model. The final manufacture of composite materials was performed. The design requirements for a 600 watt wind turbine were based on the environmental conditions around the coast of Michoacán, Mexico, where the blades were constructed. Wood is used to make the blades model using mechanical milling, which is a manufacturing method in which a spinning cutting instrument known as a milling cutter removes metal. Internal structure designed to offer stiffness and flexibility in the final fibreglass manufacturing process.

(Cudney et al., 2014) Using a virtual simulation, students may play with lean ideas and learn about them in a safe environment. The need for engineers who have a thorough knowledge of lean principles necessitates exposing students to these ideas as early as possible in their education. Learning lean ideas via hands-on projects and simulations may be replicated using a virtual simulation platform created by a team of researchers. An intuitive user interface, the capacity to save findings, and the modelling capability of state-of-the-art virtual reality software are just some of the features of the platform available. With the VE-Suite virtual engineering framework, a user-friendly conversation box, graphical models, performance display gauges, and a changeable layout are all included in the platform.

3. LEAN MANUFACTURING

It is a manufacturing technique based on the idea of optimizing productivity while decreasing waste in a manufacturing activity, which is called lean manufacturing. Waste, according to the lean philosophy, is everything that does not provide consumers with more value for the money they are prepared to pay.

The advantages of lean manufacturing include shorter lead times and lower operational costs, as well as increased product quality and less waste.

Lean manufacturing, often known as lean manufacturing, is based on certain manufacturing concepts that have affected production systems across the globe, as well as those in healthcare, software, and numerous service sectors.

Lean principles: Forging the foundations of today's lean manufacturing practises was Japan. When Eiji Toyoda set out to enhance Toyota's production procedures, he hoped to boost sales and profit. This collaboration with Taiichi no resulted in the design, development, and implementation of many lean manufacturing technologies. When James Womack and Daniel Jones published their book Lean

Solutions, they outlined the five principles of the Toyota Production System. (Panwar et al., 2015) (Prof & Kitaw, 2014)

The Five Lean Manufacturing Principles

Toyota's success may be attributed to the five lean manufacturing principles, which can be used by companies to make products that are tailored to their consumers' needs. (Goshime et al., 2019)

Figure 2: Five principles of Lean Manufacturing

3.1. Advantages of Lean Manufacturing

a) **Waste Minimization:-** A manufacturing facility's waste may be reduced to a minimum with the help of lean manufacturing. There are several advantages to lean manufacturing, but one is the most important. Anything that doesn't provide value to the process might be considered a waste of time. Transport and over-processing are all examples of places where trash is often generated. This technique removes obsolete or ageing inventory since organisations have a lot of inventory and trash to deal with. The operation's expenses are also reduced by this method.

b) **Enhanced Customer Relationships:-** Lean focuses on the problems and ideas of long-term consumers in order to eliminate some of the inefficient procedures. Instead of trying to please everyone, organisations may concentrate on their most loyal consumers in order to develop long-term, trusting relationships. As a result, your customer interactions will improve and your loyal consumers will provide you with a consistent stream of income.

c) **Lean Infrastructure:-** In a lean infrastructure, the building, tools, materials, equipment and personnel are all you need to meet short-term inventory needs. With the facility, the facility is able to get as near as possible to production efficiency.

3.2. Approaches of Lean

The “Toyota Production System (TPS)” has long been linked with lean production, which helped propel Toyota to international prominence. As a result of Eli Whitney's systemization, some scholars believe that it may be traced back to the Industrial Revolution. Lean manufacturing is often compared to the Six Sigma method of process improvement. If you're looking to adopt lean manufacturing, the TPS is an excellent approach.

That in mind, here are eight steps to help you implement lean manufacturing practises in your business:

Get rid of the trash immediately. In lean manufacturing, this is a foundational idea. A value stream analysis is a common tool for spotting inefficient processes in a manufacturing facility. Additionally, you may step up efforts to develop more efficient methods to improve the company's product range, which is a good strategy. (An example of waste is shown in the right-hand box.)

Reduce wasteful stock. In most cases, the expense of holding on to extra inventory surpasses the potential advantages. Slow reaction times and more complicated quality-control difficulties may be a result of this. If any of the inventories becomes outdated, as is often the case, then having too much on hand might be a real concern.

Process time may be reduced. It used to take days or even weeks to finish a task, but today it can be done in only a few hours. Put to good use the technical resources you now have. Lean manufacturing adherents advocate producing products in small quantities so that future iterations may be enhanced with “bells and whistles”.

Reduce response time. Manufacturers have been stressing the need of accurate market projections for years. Although this may be the best strategy in a fast-paced atmosphere, it isn't always the best option. You may instead build an agile system that can respond quickly to market changes.

Ensure that all components of the product have been thoroughly checked for quality. To catch issues at the earliest possible stage, implement testing and control methods at many checkpoints throughout the process. The system must be fine-tuned to discover flaws, rectify them, and move on.

Employees should have more freedom. Give more staff the power to make choices and equip them with the necessary tools and methods. You may take this a step further by forming teams to track success and improve your methods. Employees at all levels of a company are often able to come up with creative solutions to problems. It's also good for morale and productivity because of this sort of participation.

Ask for consumer input. Systematically get feedback from consumers after establishing the product's primary features. Over the course of the system's lifecycle, it should be able to adapt to new situations. In order to meet client demands within your fundamental framework, you need take this step.

Get in touch with your suppliers. Make suppliers "partners" in the lean manufacturing process when it is suitable. The advantages of lean manufacturing may be experienced by all stakeholders when suppliers cooperate with the application of lean manufacturing concepts. Strengthening current business contacts is also an important benefit.

4. CONCLUSION

"Lean Manufacturing" implementation may be hindered by the need for planning, dedication, method, learning, and safety. This study examines lean manufacturing principles and technologies. It also stresses the need of identifying the many sorts of waste in a company. Overall, the paper provided guidance and methods for exploring and implementing lean manufacturing ideas in an organisation in order to increase productivity, efficiency, and quality of the finished product. – As a result, the price of the product is kept lower. As a result, any firm may use lean manufacturing to cut down on unnecessary waste.

Despite the numerous advantages of lean, there are still several obstacles that might be used to prevent its adoption. Lean implementation is hindered by a number of factors, including poor psychology, lack of responsibility, financial difficulties, a lack of education and training, and volatile demand. Without a doubt, the instruments of lean principles must now be used by all sectors if they want to stay in business. It's time for every industry to get rid of their old ways and adopt lean approaches. In order to preserve their jobs, workers in the industrial sector need to modify their mindsets.

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TO STUDY THE SEISMIC ANALYSIS OF AN EXISTING RC STRUCTURE BY USING STAAD PRO

Siddhanth Sen[1*]

[1]*Research Scholar, Department of Civil Engineering, Medi-caps University, Indore, Madhya Pradesh*

Abstract

India is one of the most earthquake inclined nations on the planet and has encountered a few significant or moderate earthquakes during the most recent 15 years. Around 50-60 % of the absolute zone of the nation is defenseless against seismic movement of shifting forces. A live project of G+2 existing old structure, structure is modeled and analyzed in Staad.Pro with existing strength determine from NDT and then providing extra columns, thickness and struts at places where strength is at failure. Comparative analysis is done in between the existing structure and the proposed structure which can easily overcome the failures seen by existing structure proven in the results of NDT.

Keywords: Retrofitting, NDT, Staad.Pro, Axial Force, Storey Displacement, Shear Force, Bending Moment.

1. Introduction

The primary reason for seismic retrofitting is to ensure the building's safety in the event of a seismic event. In contrast to new planning, the planning of changes to existing buildings requires that the existing development be regarded as the starting point for all planning and construction operations. In the last 15 years, India, one of the world's most earthquake-prone countries, has seen a few large or moderate quakes. Around 50-60% of the country's absolute zone is vulnerable to seismic power shifts.

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Siddhanth Sen

Existing structures often fail to fulfil seismic quality requirements. Seismic retrofitting an existing building might arise for a variety of reasons, including the building not being designed to meet current building codes, a change in the building's intended use, or other structural changes that need retrofitting. There are many levels of structural and material survivability imposed by budgetary considerations in seismic retrofitting. As a part of dynamic disaster assistance, it has become more urgent to strengthen weak structures and find out how to increase their auxiliary performance in the event of an earthquake.

In this proposed work we are considering a live project of G+2 existing old structure, structure is modeled in staad with existing strength determine from NDT and then providing extra columns, thickness and struts at places where strength is at failure.

1.1. Strength and Stiffness

Buildings and different structures, and all parts thereof, will be planned and built with sufficient quality and solidness to give basic dependability, shield nonstructural segments and frameworks from unsuitable harm and meet the workableness prerequisites Acceptable quality will be shown utilizing at least one of the accompanying systems:

- The Strength Procedures
- The Allowable Stress Procedures of Section.
- Subject to the approval of the person's guardian. Activities, Section's procedures depending on presentation

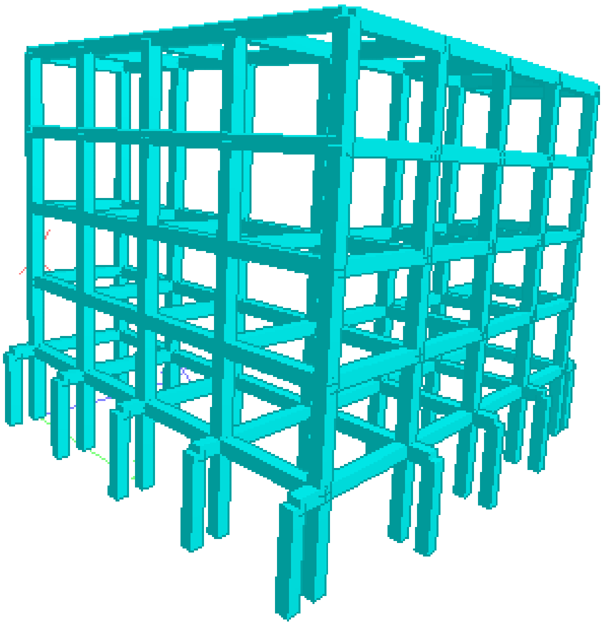

Figure 1: Retrofitting technique in staad

1.2. Scope of the Study

The design recommendations contained herein are applicable to the seismic design of structures that generally have the unique seismic response characteristics associated with tall buildings, including:

- A fundamental translational period of vibration considerably in excess of 1 second.
- Significant mass participation as well as lateral response in higher modes of vibration.

To counteract the sidelong float caused by hub twisted dividers and sections as opposed to shearing failure of the casings or dividers, a seismic-power opposing framework with a small angle proportion is used. Because of the high frequency of earthquakes in the western United States, the Pacific Earthquake Engineering Research Center developed these guidelines as an optional means of adhering to I.S. 1893 section 1's quality requirements for seismic load prevention for Risk Category II buildings. Because of the inelastic response of their fundamental segments, these structures are projected to resist massive seismic displacements. For buildings that don't display significant inelastic reactivity or that are located in places with seismicity to a degree that is not nearly the same as the Western United States, these recommendations may be of interest. In spite of this, it may be necessary to make a few changes.

1.3. NDT (Non-Destructive Testing)

The non-hazardous Rebound Hammer test is a method for evaluating a solid's compressive strength that provides an immediate and useful result. It is also known as a Schmidt hammer, which is a spring-loaded tool that glides along an unclogging in a circular chamber.

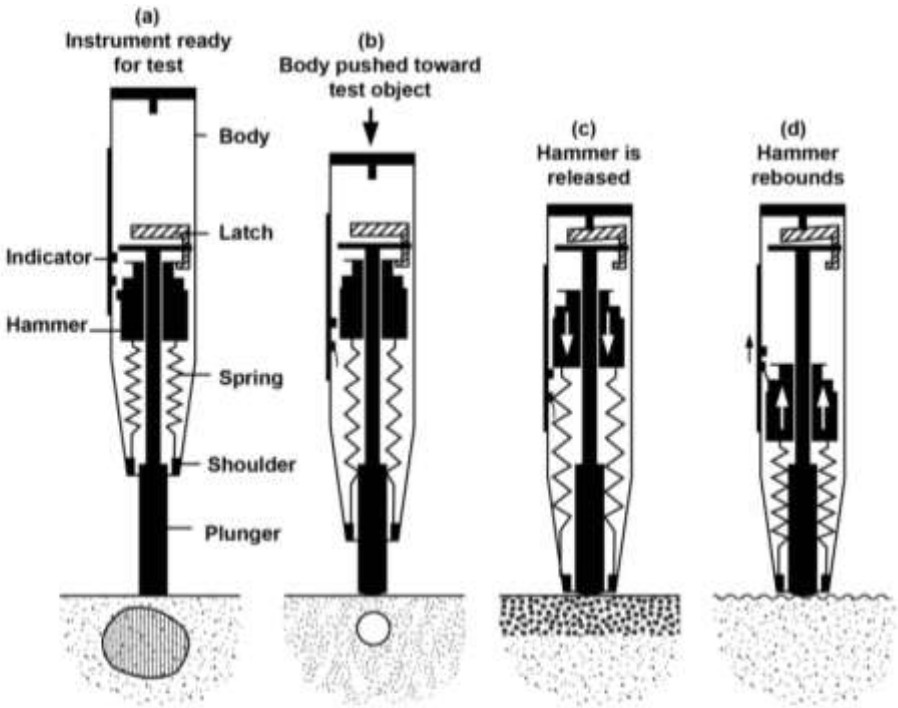

Figure 2: Operation of the rebound hammer

1.4. Objectives of the Study

These following are the primary objective of our research work:

- To determine the strength of an existing old structure using NDT (rebound hammer).
- To determine the effect of composite member on an old structure strengthening.
- To perform Non-linear (Time history analysis) over a strengthened old structure.
- To determine the cost of retrofitting as per SOR (CPWD)

2. LITERATURE REVIEW

Tsige and Zekaria (2018) An office building with a modest ascension was demolished for seismic power by considering three different types of fundamental framework. Exposed Frame structure, for example, or partially filled and totally filled outline framework. With the help of five different models, the viability of the work divider has been examined. The equal swagger approach was used to depict the infills. ETABS, 2015 programming was used to conduct nonlinear static evaluations of sidelong loads. Correlation of these models for numerous earthquake reaction parameters like the seismic interest in the exposed casing when infill firmness is not taken into account with larger removals is found to be significantly greater than that found when infill firmness is taken into account with smaller removals.

MAYORCA et. al. (2004) Seen that Masonry structures are generally utilized because of its minimal effort and development effortlessness particularly in creating nations. Regardless of the endeavors to give rules to the development of sound earthquake safe houses, each year setbacks due to falling stone work houses during earthquakes are accounted for. Despite the fact that plainly retrofitting the existing lodging stock is pressing, effective crusades situated toward this path are rare or inexistent. To defeat this circumstance, retrofitting strategies including modest development materials accessible in remote locales and low-expertise work just as forceful instructive crusades are required. This paper displays an imaginative retrofitting technique for brick work houses, which comprises of utilizing polypropylene groups masterminded in a work style and implanted in a mortar overlay.

U.Akguzelet. al. studied that three-dimensional (3D) beam-column junctions with and without floor slabs have been studied for their seismic performance under multiaxial stress in both their as-built and FRP retrofitted forms. Four 2/3 scale, inadequate RC beam-column junctions were tested for this purpose, with the findings being reported and inferences being taken based on the observed global and local performance. With the use of GFRP composites, the feasibility and efficiency of a retrofitting intervention are highlighted. A retrofit method based on performance is used, and the desired particular limit states or design goals are taken into account. There's also a computational research that compares the response of the 3D corner as-built joint under bidirectional loading with concurrently variable axial load to experimental data, in order to calibrate and build adaptable finite element (FE) models using micro plane concrete.

Amlan K. Sen Gupta et. al. all of these worldwide retrofitting procedures, including shear walls, infill bracings, etc., are shown to increase the structural integrity of a three-storey building.

Since the 1960s, experimental testing has been used to examine the behaviour of beam-column joints in plane frames subjected to seismic pressure. There has been far less experimental investigation into the behaviour of under-designed (e.g. following an older code of practise when compared to the current one and prior to the introduction of capacity design principles) beam column joints in space frames in as-built or retrofitted configurations than there has been for the majority of these studies to verify the design of new space frame joints.

(Hertanto, 2006; Chen, 2006; Akguzel et al., 2010b; Engindeniz, 2008) To investigate the behaviour of deficient full-scale RC buildings strengthened with FRPs using uni-directional and bi-directional pseudodynamic (Ludovico et al., 2008) or quasistatic lateral load tests, several experimental studies have been carried out in the past (Balsamo et al., 2005; Ludovico et al., 2008). (Della et al., 2006) Unidirectional shaking table tests on a full-scale, RC frame with insufficient detailing in the beam-column joints in the as-built and CFRP retrofitted configurations were also reported by Garcia et al. (2010)

A non-ductile 3-story 2/5 scale RC frame model structure was recently tested on the shake table of the University of Canterbury to evaluate the effectiveness of the proposed FRP retrofit technique and to validate the adopted design procedures (Akguzel et al., 2011a; Quintana-Gallo et al. 2011, 2012).

3. METHODOLOGY

This study shows comparative study of high-rise G+02 building R.C. frame considering seismic zone II with medium soil type Under the seismic effect (TIME HISTORY ELCENTRO) as per IS 1893(part I) -2016analysis. A comparison of analysis of results in terms of forces, moment, displacement and cost is presented in this study.

3.1. Two cases has been considered for comparative analysis

- First Existing “Building structure”
- Second Existing “building with retrofitting technique”

To accomplish this purpose, the following three steps must be taken:

- Modeling the frame using STAAD Pro.
- Calculations to determine the explanatory findings
- The framework's graphical interface provides all of the tools needed to verify results.

For the parametric analysis of critical load positions as per the superimposed loading standard, a building of specified size has been taken into consideration. The following are some possible next steps:

Step 1: In STAAD Pro or in the AUTO CAD, which can be imported into Staad-Pro as per the dimensions of beams, c/c distance of columns, expansion to expansion distance, and no. of diaphragm etc., the geometry of the superstructure may be selected.

Step 2: The building is modeled using the present strength, and a model with retrofitting is created using the same dimensions and loadings as per Indian norms. Modeling is done using finite elements in consideration of these factors.

3.2. Different types of cases considered

A. Existing Building:

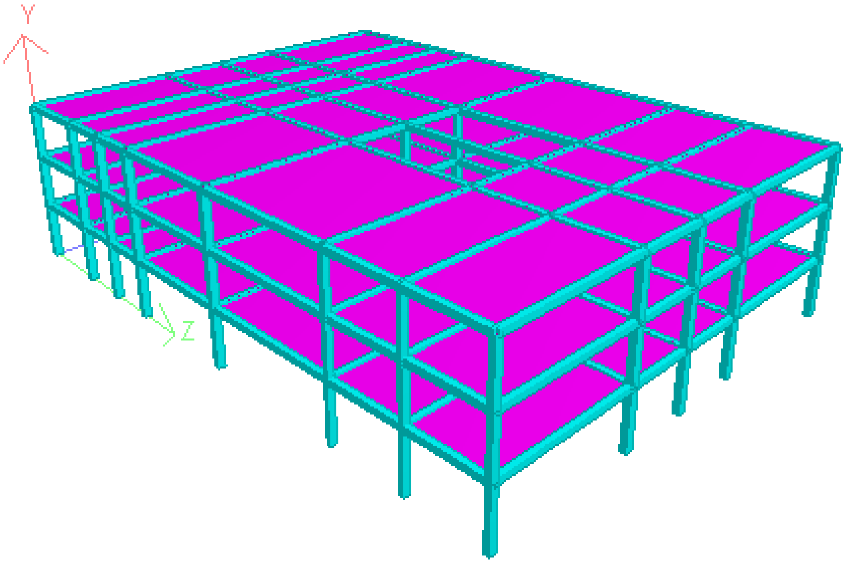

Figure 3: Existing building

B. Retrofitted Building:

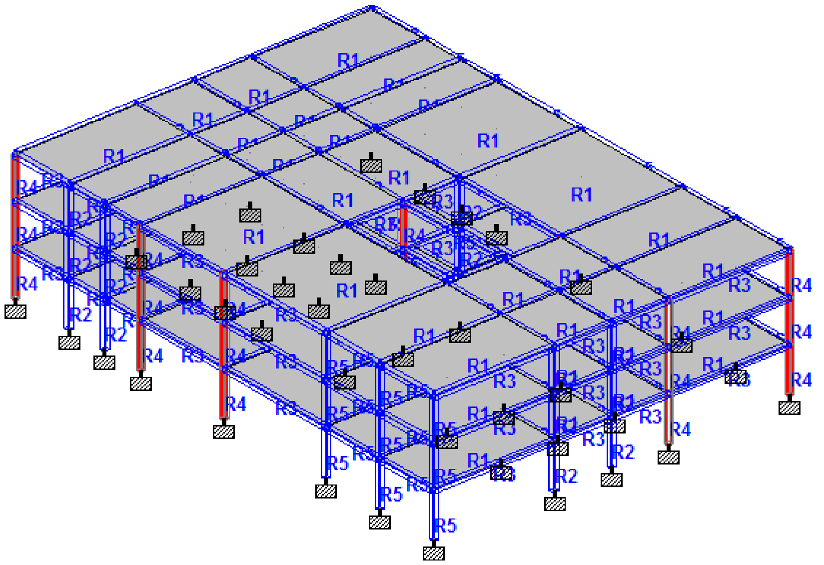

Figure 4: Retrofitted Building structure

In retrofitting technique we are assigning composite steel tubular sections for strengthening the existing weak structure.

Step 3: To establish the current state of the culvert, the NDT rebound hammer technique was used to calculate its actual reality.

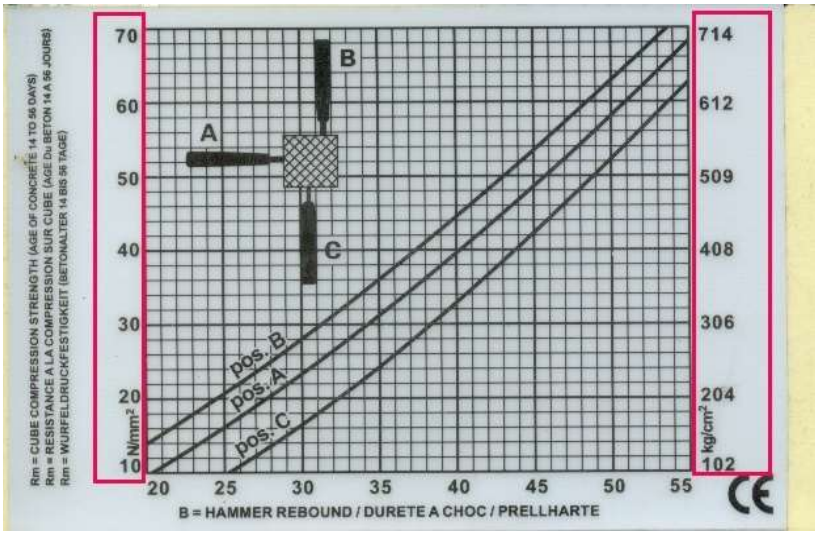

Figure 5: Rebound Hammer Graph

Step 4: After taking into account the support conditions at the pinned/hinged superstructure's bearing points and modelling for the same strength, the modeler next applies the material's properties.

Step 5: Once you've applied the support condition, the following step is to take into account the "self-weight" of the superstructure.

Step 6: Dead load applied, now the Super imposed load must be taken into account.

Step-7 Selection of Seismic zones (Zone II) and medium type soil as per IS- 1893(part I) -2016.

Step-8 load combination as per 875-part-V

Step-9 Analysis of building frames considering Time history Analysis (ELCENTRO CASE) method for seismic forces in X & Z direction and gravity load as shown in figure below.

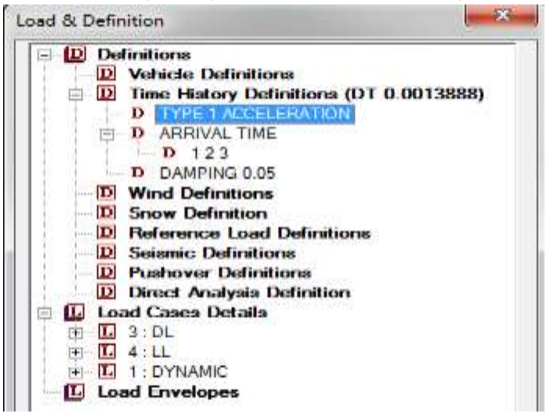

Figure 6: Schedule of Rates as per M.P.P.W.D. 2019

Step-10 Cost analysis of material quantity i.e. concrete in cubic meter and Steel casing in Kg using S.O.R. M.P.P.W.D. 2014.

Material	**S.O.R. Rate**	**Quantity**	**Total Rate**
Steel Casing	68 / kg	2200 kg	1,49,600/-
Concrete	5091 / cu. M.	56/ cu. M.	2,85,096/-

Step 11: In order to achieve results such as axial force, shear force, deflection and support responses, the model must be "Analyzed" after all the boundary conditions and forces have been applied to the model.

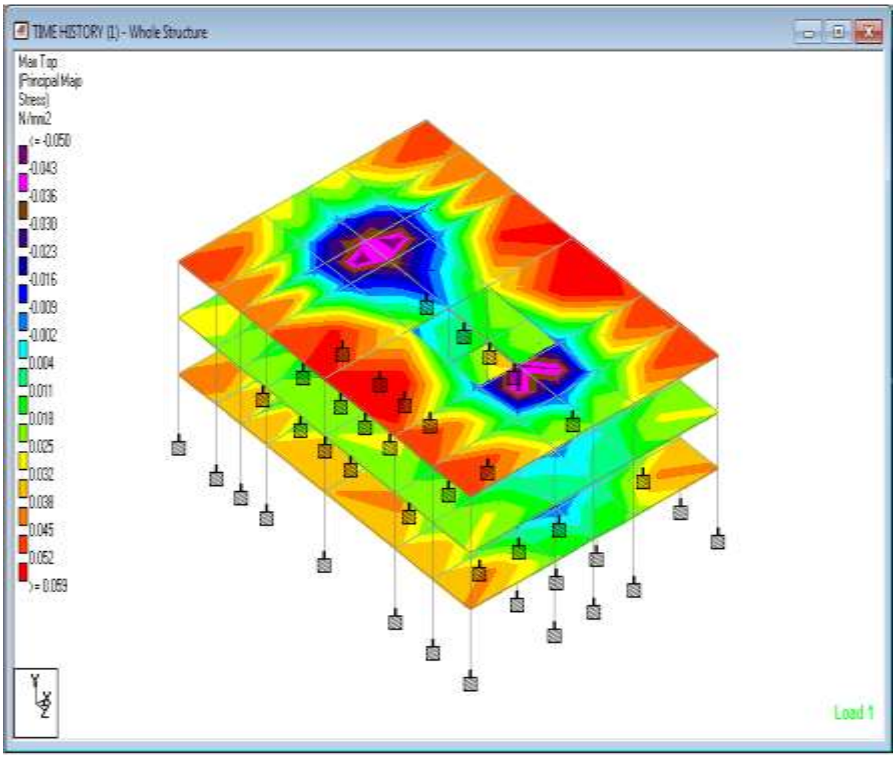

Figure 7: Stress Distribution

Step 12: After the optimization procedure, a graph utilising M.S. Excel is used to find the best outcomes in all circumstances.

4. RESULT AND DISCUSSION

4.1. Forces in Beams

Maximum Bending Moment kN-m

Table 1: Bending Moment KN-m

Beam No.	Bending moment Mz (KN-m) Case 1 (Existing Structure)	Case 2 (Proposed Structure)	Increase
41	60.567	178.293	117.726
42	60.567	177.954	117.387
43	59.481	175.619	116.138
47	59.481	174.038	114.557
48	57.8	157.366	99.566
49	57.8	155.381	97.581
53	57.348	154.918	97.57
54	57.348	149.755	92.407
55	56.391	149.752	93.361
59	56.391	146.266	89.875
60	56.327	141.877	85.55
63	56.327	137.989	81.662
64	56.125	136.598	80.473
67	56.125	136.316	80.191
68	55.946	133.821	77.875
69	55.945	132.503	76.558

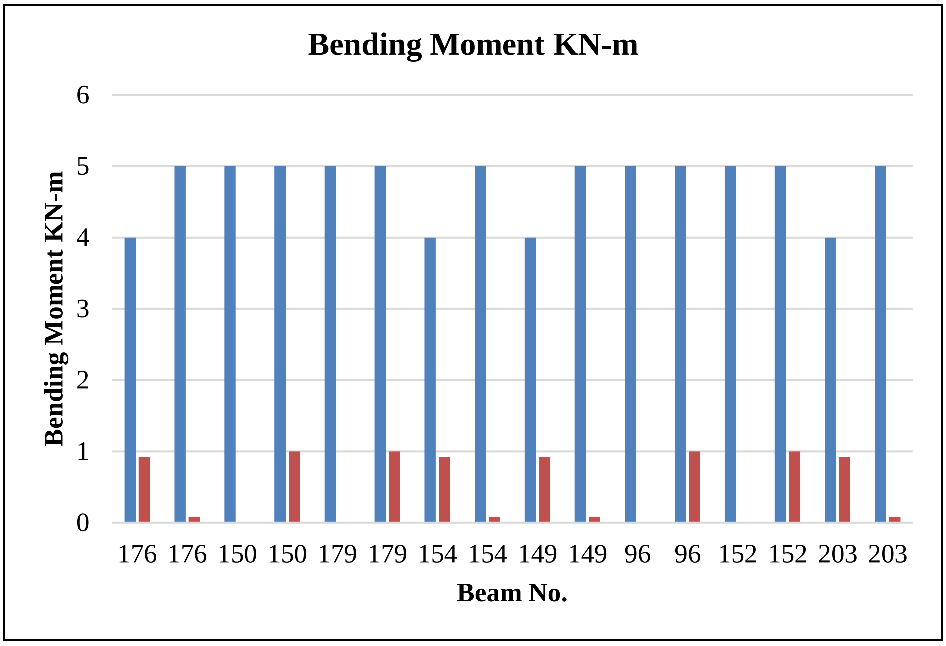

Figure 8: Bending Moment kN-m

Maximum Shear Force KN

Table 2: Shear Force kN

Beam No.	Shear force Fy (kN) Case 1 (Existing Structure)	Case 2 (Proposed Structure)	Increase
41	33.639	85.844	52.205
42	33.329	84.234	50.905
43	32.893	80.173	47.28
47	32.871	79.602	46.731
48	32.658	78.167	45.509
49	32.624	74.229	41.605
53	32.564	72.297	39.733
54	32.491	72.083	39.592
55	32.343	71.785	39.442
59	32.238	71.563	39.325
60	32.226	71.38	39.154
63	32.189	71.101	38.912
64	32.182	70.989	38.807

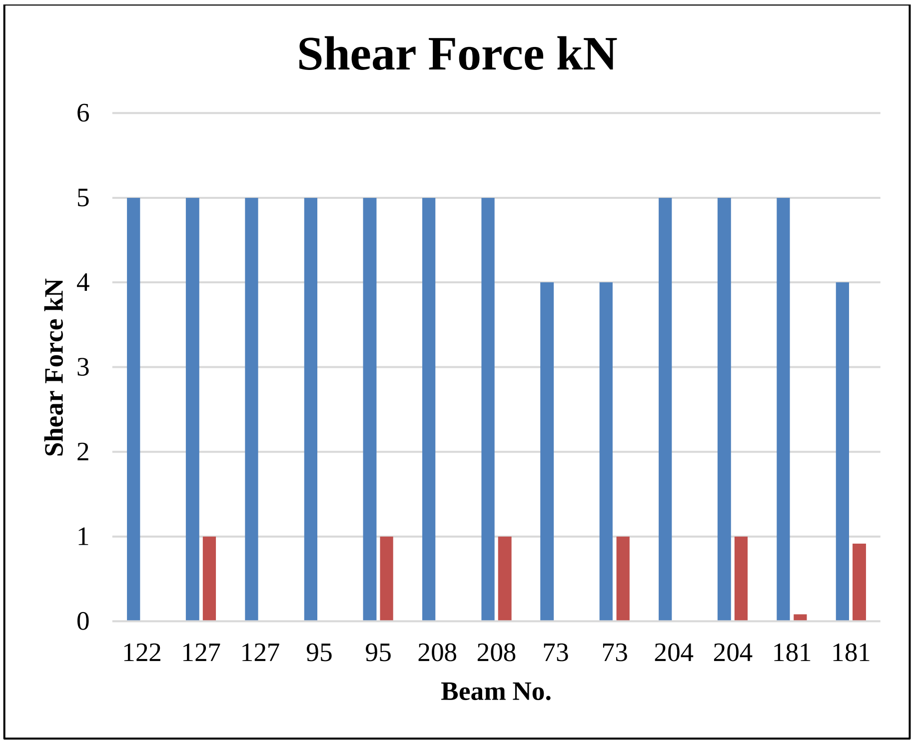

Figure 9: Shear Force KN

4.2. Forces in Columns

Analysis results of axial force Fx in columns obtained from Staad Pro

Table 3: Axial Force KN

Column No.	Axial force Fx (kN) Case 1 (Existing Structure)	Case 2 (Proposed Structure)	Increase
1	884.941	1159.076	274.135
2	884.939	1154.774	269.835
3	883.621	1150.472	266.851
4	883.62	1146.17	262.55
8	882.302	1141.869	259.567
9	882.3	1137.567	255.267
10	880.982	1133.265	252.283
11	880.981	1128.963	247.982
15	879.663	1124.661	244.998
16	879.661	1120.359	240.698
17	878.344	1116.057	237.713
18	878.342	1111.755	233.413
22	877.024	1107.453	230.429
23	877.023	1008.184	131.161
24	875.705	1005.219	129.514
25	875.703	1003.882	128.179
30	874.385	1000.918	126.533
31	874.384	999.58	125.196

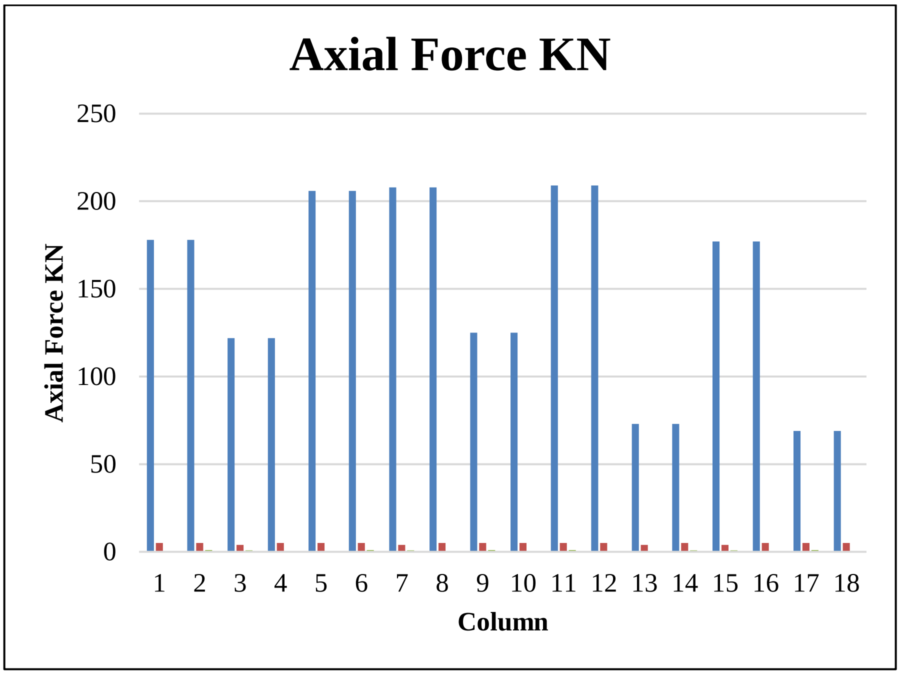

Figure 10: Axial Force KN

4.3. Storey Displacement mm

Table 4: Storey Displacement

Storey	(Existing Structure)	(Proposed Structure)
2nd Floor	6.093	2.436
1st Floor	4.628	1.683
G.F.	2.243	0.699

Figure 11: Storey Displacement mm

4.4. Cost Analysis

Table 5: Cost Analysis

Material	S.O.R. Rate	Quantity kg	Total Rate
Steel Casing	40 / kg	35953	14,38,120/-
Concrete	5091 / cu. M.	5.0208	25560/-

5. CONCLUSION

Following are the ends according to the examination

- In this investigation, it is seen that with the procedure of retrofitting, the soundness of a structure can be recovered without disassembling the structure utilizing fortifying steady individuals.
- It is seen that the retrofitting method can be 88.64% cost effective than destroying and developing another structure.
- It can be reasoned that product examination and site test work can be joined for the advancement of the framework, As we did in this investigation where we decided the

quality of the structure utilizing NDT (Non-destructive testing) though displaying and checking quality improvement should be possible utilizing investigation apparatus staad.pro.

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Advance Treatment of Leachate Generated from Solid Waste

Rahul Gupta[1], Farhin Khan[1*] and Dr. Sarita Sharma[2]

[1]*Assistant Professor, Department of Chemical Engineering, Indore Institute of Science and Technology, Indore*

[2]*Professor, Department of Chemical Engineering, Ujjain Engineering College, Ujjain*

Abstract

As we all know that several of tons municipal solid waste (MSW) is generated in India per year which is very difficult to handle and treat. Organic and inorganic waste, e-waste, used papers, wood, plastic glass, leather, rubber etc. comes under the municipal solid waste (MSW). For the treatment of the MSW we use landfill method which causes threat to the water bodies, eventually harming the environment, ecosystem as well as living beings. The most common and most focused studies observed in many technical papers related to this problem mostly deals with the management and treatment efficiency of solid waste leachate. This review paper aims to put forward an overview of solid waste leachate, it's characteristics, composition, contaminants to the ground water, effects on mankind and environment, current scenario of landfill technology in India, various treatment methods.

Keywords: Biogas; electricity; landfill; leachate; treatment; solid wastes.

1. Introduction

Excessive generation of Solid waste leachate and its handling and treatment is one of the most common problem arises during disposal for solid waste. It can be defined as a method of disposing of wastes on lands without creating bother or risk to health or safety of the people. The solid waste leachate can cause severe impacts on the environment as well as human health. These wastes include mainly biodegradable wastes, composite wastes such as clothing, electronic and electronic wastes such

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as wires and cells, medical wastes and hazardous wastes like paints, chemicals, sprays. The biodegradable wastes like garden waste and food waste contains a little amount of moisture in it. This moisture present in municipal solid waste leads to the generation of leachate, commonly known as "solid waste leachate." (Ayilara et al.; 2020). Other than this, it normally comes from rain water or melting of snow. Leachate is mostly formed through:

- Decaying of the organic matter, either aerobically or anaerobically.
- Oxidation of waste materials chemically.
- Emission of various gases from the landfills.
- Disintegrating and draining of organic and inorganic waste matter by water and leachate transporting through the land.
- The flow of disintegrated matters by osmosis and concentration gradients (Akram et al.; 2018).

Leachate is commonly considered as an extremely contaminating liquid because it is consisting of high concentration of suspended organic compounds, inorganic compounds, and heavy metals having high biological oxygen demand (BOD) and high chemical oxygen demand (COD) (Schiopu and Gavrilescu 2010). It contains a mixture of chemicals due to the diverse nature of the waste and is undoubtedly the worst contaminants to aquifers as if emitted, it can release a combination of pollutants to the groundwater through transportation of leachate, mostly for the unlined and no collection of leachates and destroying system landfills. The solid waste leachate pollutes the water bodies by three ways: (a) the seeping of leachate in land contaminates groundwater; (b) the outward flow results in leachate leaks out at the verge of the landfill that affects water sources at the surface; (c) polluted groundwater discharge to surface water (Fatta et al,;1999). Since solid waste management becomes an essential issue and the leachate is considered as very hazardous substance, this study is done to list out some efficient ways to minimize its effects on the environment.

1.1. Characteristics

The effect of environment in terms of the quality of water stored in different water sources depends on the characteristics of solid waste leachate. The calcium content and alkalinity of leachate from active landfills depends on the waste matter disposed, moisture content and its age. Ash monofill leachates generally have high calcium concentration while municipal solid waste leachate when combined with combustion residue are more alkaline. These leachates are more likely to form mineral precipitate as they have enough quantities of substances which can act as a co precipitate like calcium, iron, magnesium and sulphate (Levine et al.; 2005).

1.2. Indian Scenario of Leachate Treatment Technology

Scientific strong waste landfills lessen the chances of waste leaching beneath the ground as the base layer is constructed of 90m of clay, consequently arresting any seepage or leakage in the landfill. On top of the bottom layer, a drainage layer fabricated from soil, measuring 15m in period and a vegetative layer of 45cm to decrease soil erosion. The life of these layers guarantee that the leachate is amassed before it leaches into the ground. Delhi, is considered one of India’s biggest municipal stable waste turbines which have been reeling with the problem of landfills for years. The predominant problems in creation of clinical landfills across India is being accessibility of land, technical expertise and availability of money for established order. It's so unlucky that majority of personal agencies are not wanting to invest within the production of clinical landfills. Also, number of engineers with proper know-how of growing above noted base layers of scientific landfills are much less. Thinking about land required for the development of clinical landfills turned into undetermined until recently, the quantity of engineers or know-how with technical knowledge of improvement stays comparatively much less.

1.3. Composition of Leachate and their Negative Impact on the Environment

The composition of leachate depends on some factors, like properties of waste products, their location, seasons and climate conditions, age and structure of landfill, recollection time of waste at incineration plants, modes of operation of transfer stations, etc. Commonly, very low concentrations of heavy metals are observed in leachate. Comparatively, ammonia concentration does not decrease and often add up to a major long-term pollutant in the leachate (Jase et al.; 2014). MSW landfill leachate pollutants are classified into four different groups:

a) Dissolved organic matter, measured as COD/TOC, volatile fatty acids that are collected through the waste stabilization in acidic phase and various refractory compounds like fulvic and humic-like compounds.
b) Inorganic macro components: NH4+, Ca2+, Mg2+, Fe2+, Na+, Cl-, K+, SO42-, Mn2+ and HCO3-.
c) Heavy metals: Cd2+, Zn2+, Cr3+, Ni2+, Cu2+ and Pb2+.
d) Xenobiotic organic compounds which are derived from homely or commercial chemical matter and are present in comparatively low concentrations. These compounds include among others a different variety of phenols, aromatic hydrocarbons, pesticides, chlorinated aliphatic and plasticizers (Kamaruddin et al.; 2017).

Other chemical compounds can be observed in leachate from landfills such as Co, BO33-, Ba, SeO42-, H2S, Li and Hg. Commonly, they are found in little concentrations and are not the main concern.

In a well-managed landfill site with composite liners, the obstruction tends to get damaged with time, hence leachate possibly can get leaked and discharge through the soil. Inorganic cations and anions like Ca^{2+}, Na^+, Cl^-, SO_4^{3-}, etc. leach through the leachate and mix into the groundwater and soil. These inorganic compounds are not adapted by the type of the soil and remain as a contaminant of both the water and the soil (Guangyu 2011). Zinc, which is generally present in the upper layer of the soil and iron has the highest rate of separation. The exposure of leachate in soil decreases its hydraulic conductivity resulting in soil clogging and this can differ the properties of the soil such as water retention, field capacity, many more. The soil microbial community gets altered and the emergence of biofilms with metal precipitation may start occurring (Leuther *et al.;* 2019).

2. Description and Evaluation of Leachate Treatment Methods

Technologies that are meant for the treatment of leachate can be categorized as: 1. biological, 2. Physicochemical methods and 3. membrane technology.

2.1. Biological Treatment Methods-

(a) Rotating biological contactors- Rotating biological contactor, also known as rotating biological filter is an example of biological filter technology. It consists of a sequence of plastic disc parallel to each other mounted centrally on a common horizontal rotating shaft which is supported just above the surface of wastewater so that the discs are approximately half immersed. These discs are about 40% immersed in a tank consisting waste water and then they are slowly rotated by a mechanical or a compressed air drive. Microorganisms from the wastewater grow on the surface of the discs, within and rotation of the shaft brings them into contact with the liquid allowing the digestion of the organic matter. As the discs start to rotate out the waste water, the biofilm gets oxygenated as they get exposed to air, the pollutants are decomposed aerobically. When the discs reach a specific critical thickness and new microorganisms grow on it, some portion of that biofilm falls off from the disc. (Wiszniowski et al.; 2006).

(b) Aerobic activated sludge- In this method, a variety of microorganisms with organic matter and oxygen is regularly supplied in a reactor tank. This organic matter and oxygen are directly consumed by the microorganisms and transform it into a purified effluent (microbial biomass, CO_2, minerals and water) with the help of aerobic metabolism. These microorganisms form particles that are clump together also known as flocks. These flocks slowly settle down in the tank and hence they are easily removed from the tank. The removed part of the sludge is again processed to provide biomass for the treatment of the new influent. This method is mostly used for the domestic wastewater treatment. Organic carbon, ammonia content, and nutrients can be effectively removed through this process (Wiszniowski et al.; 2006).

2.2. Physicochemical Methods-

(a) Flotation- Flotation utilizes the capability of some compounds to float on the surface of the leachate by themselves or with the help of air bubbles from below. Floatation has been mostly used for removal of ions, colloids, fibers, microorganisms and macromolecules. However, recently an investigation has been carried out for the observation of outcome of this process for the removal of humic acid (non-biodegradable compounds) from landfill leachate after biological treatment. Which showed efficiency in treatment by reaching almost 99% of humic acid removal (Wiszniowski et al.; 2006).

(b) Coagulation Flocculation- In this process, the attraction between the particles is increased so that they can aggregate together forming heavy floc that can settle down in the tank. Compounds like ferrous sulphate, aluminum sulphate, ferric chloro-sulphate and ferric chloride are used as the coagulants in the process. This process may be successfully used in the treatment of stable and old landfill leachate. This process is basically a pre-treatment process. For COD removal from new or young leachate is about 25-38% effective while for aged or stable leachate with low concentration of COD/BOD, it is about 75% effective (Wiszniowski 2006).

2.3. Membrane Technology-

Membrane technology in the treatment of leachate is one of the applications of membrane materials used for physicochemical processes. The main objective of this process is to separate two solutions with variant concentrations by the help of a semipermeable membrane. The semipermeable membrane acts like a barrier between the two solutions where pressure is induced on the more concentrated liquid (leachate), this pressure forces the water to one of lower concentration while majority of the leachate compounds are reserved. The retention capacity depends on the membrane. Some of the examples of membrane treatment are: reverse osmosis (RO), micro-filtration (MF), ultra-filtration (UF), Nano-filtration (NF) (Eaux 2015).

3. Conclusion

MSW landfill is one of the significant problems for the municipal corporation of India. The leachate which is being generated through these landfills should be treated before exposed in the environment. Various treatment methods have been reviewed in this paper like physicochemical processes, biological processes as well as membrane technology. The paper has briefly reviewed a sustainable approach for treatment of landfill leachate which is, the generation of electricity in microbial fuel cell. Construction of scientific landfills is also an effective major for minimizing its effects on environment. In order to minimize its negative impacts on the environment, the proposal of optimal treatment methods is one of the biggest challenges. Landfill leachate composition varies according to the time and site. In order to overcome this, an easy and universally adaptable technique is required.

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To compare the strength of metal fiber rope and natural fiber rope using FEM

Dinesh Kumar Rathour[1*]

[1] *Research Scholar, Department of Mechanical Engineering, NRI Institute Research and Technology, Bhopal*

Abstract

Fiber ropes are improved in strength throughout time to the point that they are beginning to replace wire ropes in certain applications. Fiber ropes are risen in durability. The development of high-tensile fibres and developments in fibre rope structures have been key contributions. It began with high-strength nylon and polyester fibre ropes, ropes made of both of those fibres, polyester and polypropylene ropes, as well as polypropylene and polyethylene ropes. As a consequence, stronger and stronger ropes can be manufactured, with a fibre strength component providing a "10-to-one strength-to-weight ratio" advantage over wire rope as the final outcome. Wire rope made from steel, jute fibre, and Kans fibre is subjected to FEM analysis in this work. When using the "ANSYS structural model simulation software", findings are assessed in terms of equivalent stresses, maximum principal stresses (MPS), bending stresses (ETS), and equivalence strains (EQT) & total deformation. The study's main goal is to determine how efficient natural fibres may be in substitute of steel as a wire rope.

Keywords: High tensile fibre; fiber ropes; FEM analysis; Equivalence strains; strength to weight ratio.

1. Introduction

Construction of important offshore materials and structures, including welded girder beams, tube columns, deck panels as well as finished jacket / module modules sometimes involves heavy lifting. "Offshore steel platforms" cannot be properly produced without massive lifting equipment.

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The elevators, lifting crane, suspension bridge, and mines hoisting all require wire ropes. Additionally, due to its low twist and torsional rigidity, the rope can be twisted more easily around a sheave or winding drum, simplifying the structures that the rope is used in. This is an advantage. Many wire ropes, such as hoisting ropes, are effective even when loaded with big objects. Any problem with the rope might have catastrophic implications, demonstrating the need of rope research.

1.1. Components of steel wire Rope

Because of the way its numerous components work together to achieve a similar purpose, a wire rope is frequently compared to a machine. If you want to make a simple rope, you just need three wires, but for most applications, you'll need far more complex ropes. Steel wire rope's constituent components may be seen in this cross-section.

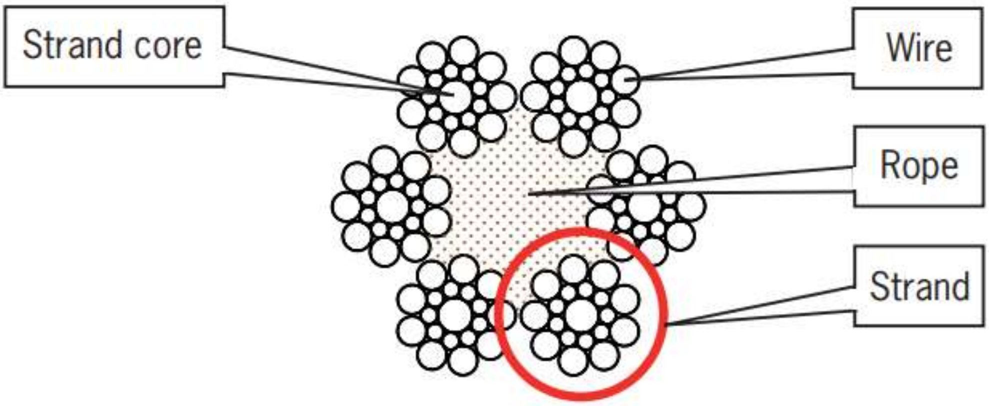

Figure 1: Cross section of a steel wire rope with the components of the rope clearly indicated

1.2. Composite Material

As the name suggests, composite materials combine the physical and chemical features of two distinct materials. You may develop materials that specialise in certain jobs by mixing and matching different types of carbon fibres. They're also good for increasing stiffness and strength. This is because they increase the qualities of their underlying materials and may be used in a wide range of settings, as opposed to standard materials.

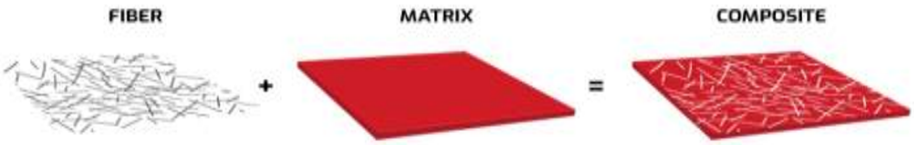

Figure 2: Composite material

1.3. Advantages of fiber over conventional materials

- A fiber core can be made of natural or synthetic polypropylene fibers. Fiber cores offer greater elasticity than a steel core.
- Fiber material is nonconductive.
- Fiber material provides better strength with less weight as compared to steel wire rope.
- Fiber wire rope is more flexible and durable.
- Fiber wire rope is less costly and easy to manufacture as compared to steel wire rope.

1.4. Objectives

- To study the behaviors of wire rope using FEM Analysis
- The conventional material will be replaced using natural fiber material.
- The result of conversional material and natural fiber will be brought under comparison.
- To apply different amount of load and to calculate the behavior.

2. LITERATURE REVIEW

Zhang, Zhang and Pan[1] "Magnetic flux leakage testing" has issues when trying to find flaws in wire rope. Excitation devices are bulky and cumbersome, and damage signals generally have a poor signal-to-noise ratio. These are the most evident drawbacks. The tiny detector proposed in this study is described in detail. A simple construction, ease of installation, low weight, and excellent mobility distinguish the presented device from existing detecting systems. The gadget is light and thin, weighing just 508 grams. The wires and strands on the wire rope's surface give it its unique appearance. Wire rope's distinctive helical structure generates a magnetic strand-waveform signal that has a higher amplitude than the defect signal.

Guerra-Fuentes et al.,[2] A catastrophic breakdown happened during execution after 53 days of service for a steel wire rope in a 12-ton overhead crane system. When the wire rope failed, it was dissected on both ends and examined for damage on both ends. "Visual examination, stereoscopic analysis, scanning electron microscopy, and micro hardness tests" have been used to investigate the cause of the failure. For the purpose of correlating operational circumstances with suspected failure reasons, data was gathered from spread sheets.

Ivanov et al.,[3] For example, pin sling behaviour when bent across small diameter rigid bodies was tested to identify the bending-induced loss in sling statistic strength. Papailiou's model was improved by including plasticity into the material behaviour and increasing the number of strands in the friction model from one to multiples of two. Additional research has showed that the diameter ratio isn't the only element that affects sling bending strength decrease; friction between wires as well as rope geometry, such as lay angle and number of wires, were also shown to be significant factors.

Liu, Zheng and Liu,[4] Depending on Love's thin rod theory, the impact of individual wire lay direction on the mechanical behaviour of multi-strand wire ropes under axial stress is being studied. We'll use a standard 7 x 7 wire rope with a separate rope core for this experiment. There are eight possible wire rope lay directions to examine, with a focus on the double helix wires' lay direction. The internal forces of the rope are calculated using two theoretical models: the hierarchical calculation approach and the direct calculation method. The “finite element analysis” of the “multi-strand rope” is used to evaluate the numerical findings based on the two models. As previously mentioned, the hierarchical computation approach yields result that are more closely aligned with those obtained using “finite element modelling (FEM)”.

Zhao et al., [5] A high sample size is necessary for wire rope fatigue life prediction, and there are a lot of unknowns. The study item for this work is a 40 6 31SW FC type wire rope. The fatigue life prediction of wire rope based on grey theory is accomplished under the situation of limited sample size fatigue life data. For starters, this research develops a better GM model and estimates the durability life facts of wire rope under small sample size conditions to address the issues with current fatigue life prediction. As a result, the reliability stress-life curve of the crucial rope sites is calculated by combining this data with the corresponding alternating stress applied to the important wire rope locations during a fatigue test.

Miao et al., [6] A technology for reinforcing stone slabs using pre-stressed near-surface mounted (NSM) steel wire ropes is presented to improve the flexural behaviour of stone building structures. Using the reinforcement ratio, pre-stress level, as well as bonding agent as measurement methods, six reinforced stone slabs were flexed under four-point bending. Furthermore, for the sake of comparison, a plain stone slab was included in the test procedure. A ductile failure mechanism with noticeable deflection was discovered via experimental examination on the enhanced stone slabs.

Battini et al., 2020 [7] For predicting metallic rope fatigue life, this research provides a thermal technique. Rope specimens are subjected to rotating bending fatigue tests, and also the temperature development of the ropes is tracked until the specimens fail. Using thermally dissipated energy and mechanical degradation as justification, the suggested technique is sound. To carry out experimental fatigue testing, the bending load and rotating speed are varied in various situations. A theoretical model based on temperature data allows for damage progression and rope life to be estimated based on experimental findings.

3. RESEARCH METHODOLOGY

3.1. Steps of Methodology

For analyzing stress and strain in wire rope, ANSYS software is used. And in ANSYS workbench, static structural model is selected which defines and calculate physical properties and stress, strain and deformation. For design of wire rope or jute rope, CATIA software is used because of its easy interface and easy process. The by importing the design into ANSYS model, process is followed by giving the materials which will be used in analysis. Then by applying boundary condition according to defined parameters and according to base paper, results are evaluated in form of equivalent stress, strain and total deformation. [8] [9] [10]

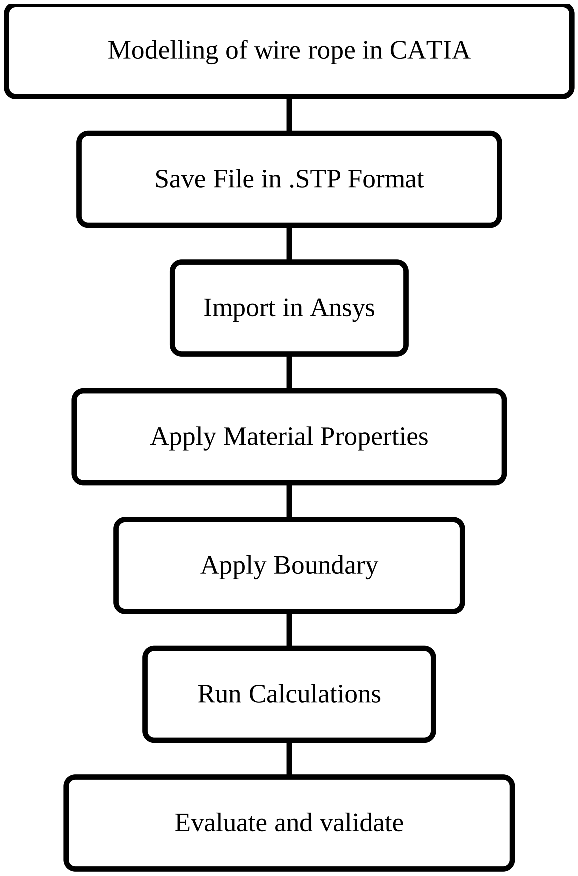

Figure 3: Working Methodology

4. Material property

The property of Stainless steel, Jute fiber, Kans fiber is determined with respect to their Young's modulus, density and Poisson's ratio and their separate values are listed in table below: [11] [12]

Table 1: Properties of stainless steel

Properties	**Value**
Young's modulus(GPa)	180
Density (Kg/m^3)	7850
Poisson's ratio	0.3

Table 2: Properties of Jute fiber

Properties	Value
Young's modulus(GPa)	20
Density (Kg/m^3)	1450
Poisson's ratio	0.38

Table 3: Properties of Kans fiber

Properties	Value
Young's modulus(GPa)	9.5
Density (Kg/m^3)	441
Poisson's ratio	0.33

5. RESULTS AND DISCUSSION

5.1. Comparative values in all materials

In below mentioned table, Maximum stress, stain and total deformation is defined and compared for all the cases. Which shows value of maximum stress is maximum in Jute fiber because of its mechanical properties and value of strain is maximum in Kans fiber. And in the total deformation case as well Kans fiber got the maximum deformation. And jute fiber got the maximum principal stress in comparison to other materials.

Table 4: Maximum value obtained of each parameter with each material with 2000 N

parameter	Stainless Steel	Jute fiber	Kans fiber
Stress(MPa)	2375.8	2568.7	2448.4
Strain	0.012637	0.12844	0.25772
Total Deformation(mm)	0.31073	2.9235	6.1514
Maximum principal stress(MPa)	3002.9	3582.6	3194.4
Shear stress(MPa)	297.81	389.76	331
Strain energy(mJ)	0.021481	0.20079	0.4253
$\boldsymbol{\sigma_T = \sigma(1+\varepsilon)}$	2405.822	2898.623	3078.12848
$\boldsymbol{\varepsilon_T = ln(1+\varepsilon)}$	0.0125578	0.120836	0.22887

Table 5: Maximum value obtained of each parameter with each material with 4000 N

Parameters	Stainless Steel	Jute fiber	Kans fiber
Stress(MPa)	4751.5	5137.5	4897.7
Strain	0.025274	0.25687	0.51545
Total Deformation(mm)	0.62146	5.847	12.303
Maximum principal stress(MPa)	6005.8	7165.1	6388.7
Shear stress(MPa)	595.61	779.52	661.99

Strain energy(mJ)	0.085926	0.80317	1.7012
$\boldsymbol{\sigma_T} = \boldsymbol{\sigma}(\mathbf{1}+\boldsymbol{\varepsilon})$	4871.5894	6457.169	7421.97
$\boldsymbol{\varepsilon_T} = \boldsymbol{ln}(\mathbf{1}+\boldsymbol{\varepsilon})$	0.02495	0.22862	0.4157

Table 6: Maximum value obtained of each parameter with each material with 6000 N

Parameters	**Stainless Steel**	**Jute fiber**	**Kans fiber**
Stress(MPa)	7127.3	7706.2	7345.1
Strain	0.037911	0.38531	0.77317
Total Deformation(mm)	0.9322	8.7704	18.454
Maximum principal stress(MPa)	9008.6	10748	9583.1
Shear stress(MPa)	893.42	1169.3	992.99
Strain energy(mJ)	0.19333	1.8071	3.8277
$\boldsymbol{\sigma_T} = \boldsymbol{\sigma}(\mathbf{1}+\boldsymbol{\varepsilon})$	7397.503	10675.47	13024.11
$\boldsymbol{\varepsilon_T} = \boldsymbol{ln}(\mathbf{1}+\boldsymbol{\varepsilon})$	0.03721	0.325923	0.572768

5.2. Comparison of stress

Equivalent stress comparison in all materials

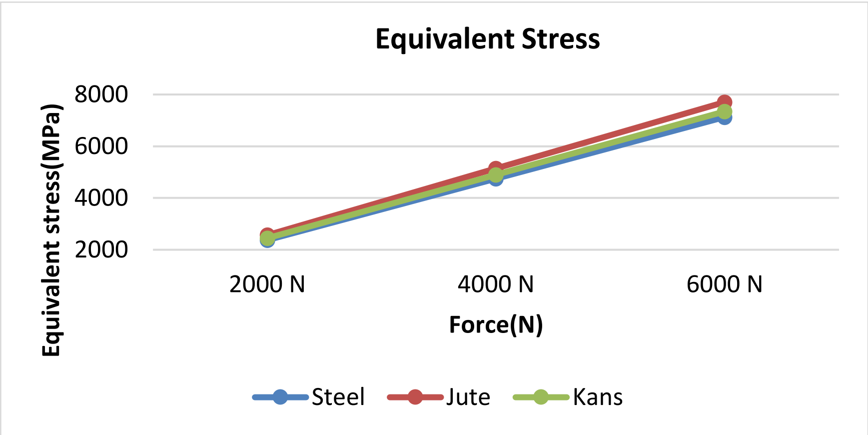

Figure 4: Equivalent stress with respect to force (N)

Maximum principal stress comparison in all materials

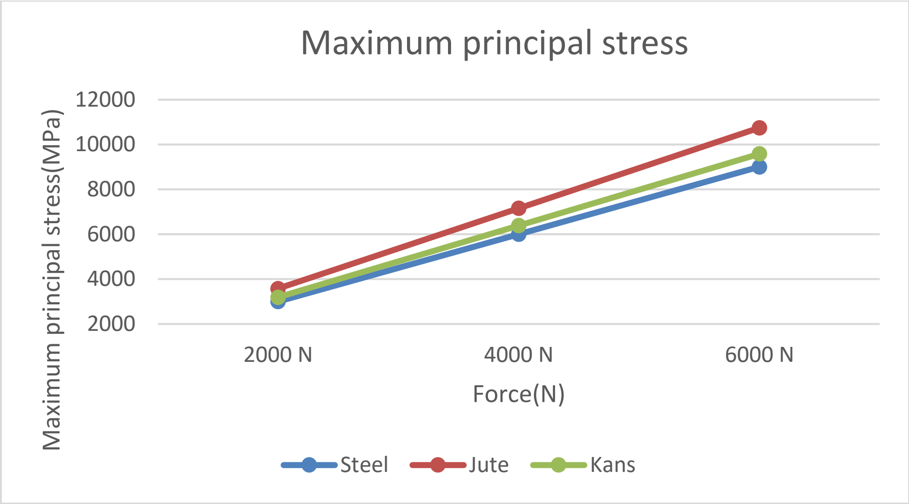

Figure 5: Maximum principal stress with respect to force (N)

Shear stress comparison in all materials

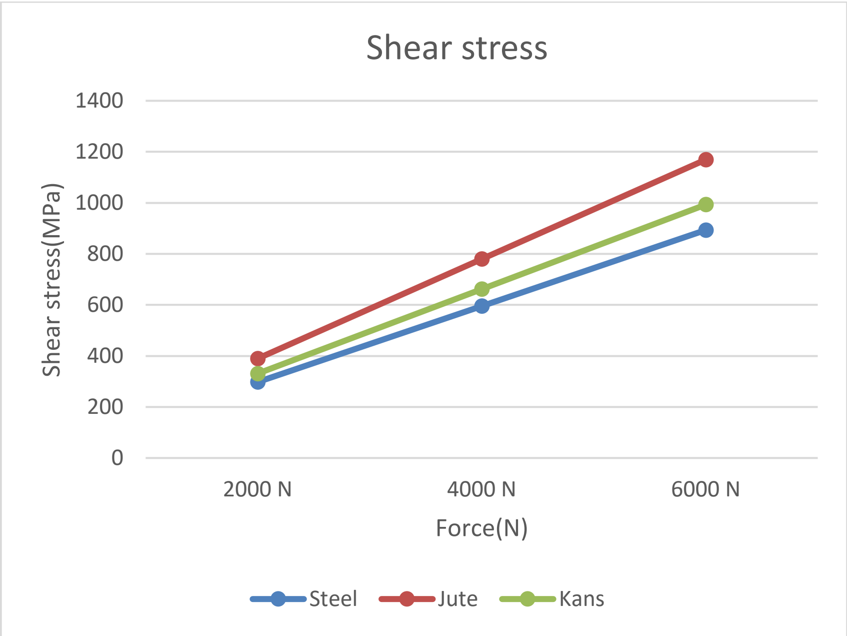

Figure 6: Shear stress with respect to force (N)

5.3. Comparison of Strain

Equivalent elastic strain comparison in all materials

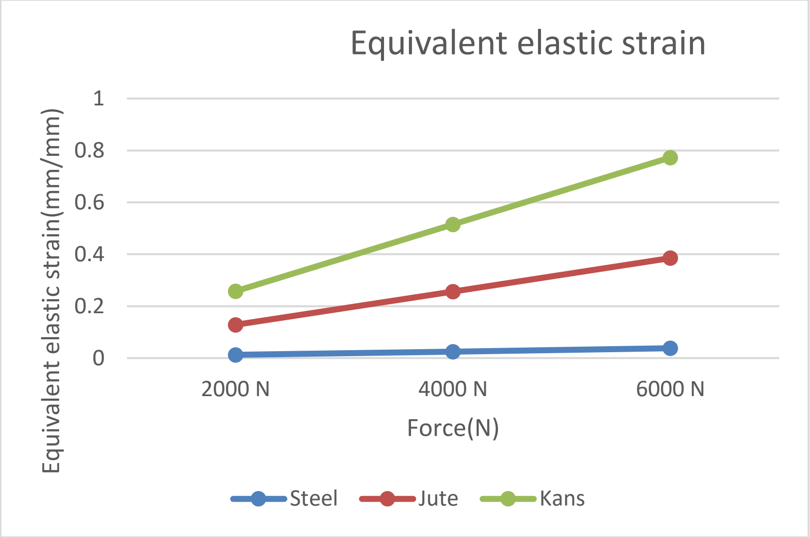

Figure 7: Equivalent elastic strain with respect to force (N)

Strain energy comparison in all materials

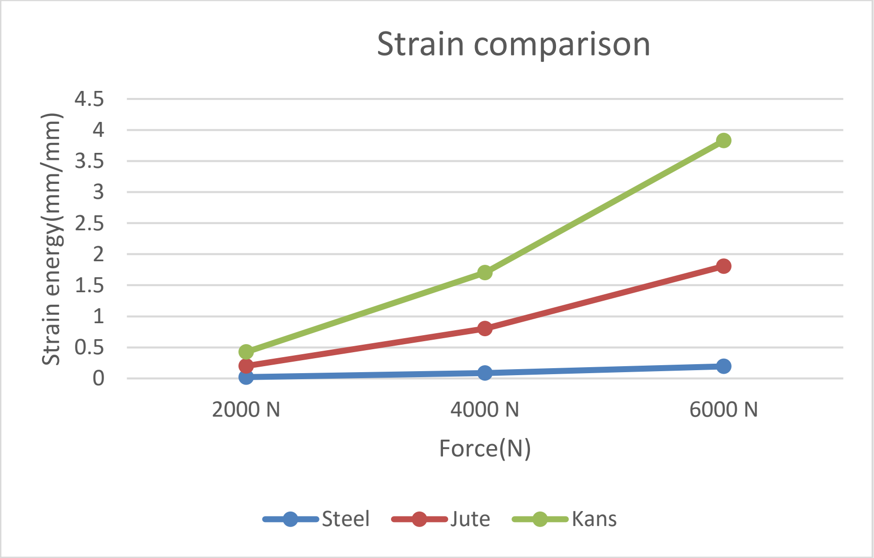

Figure 8: Strain energy with respect to force (N)

5.4. Comparison of total deformation

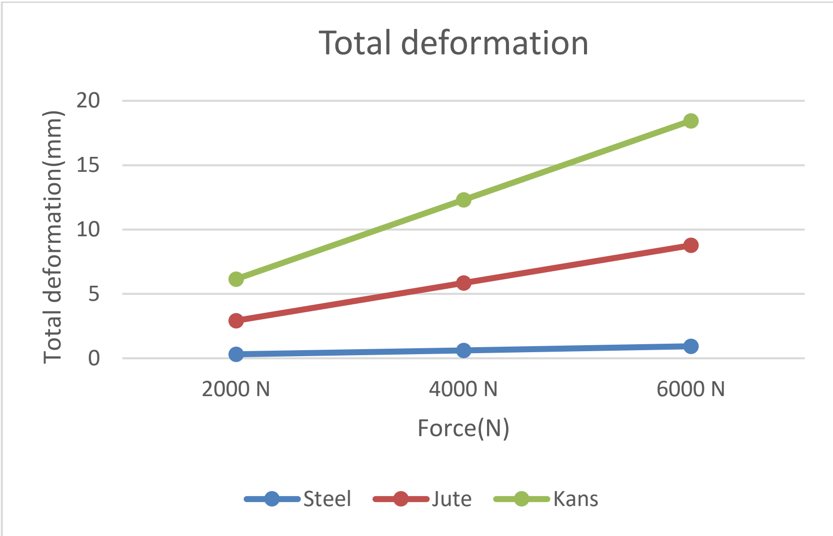

Figure 9: Total deformation with respect to force (N)

6. CONCLUSION

In this study, stress and stain analysis is performed to find out the better material for wire rope material which can bare same strength with more easy way. And for that steel is replaced with naturally available fiber which is jute fiber and Kans fiber. And they are analysed with same boundary condition and with same load applied which were applied on steel wire rope. Values of stress is found maximum by using jute fiber whereas value of total deformation is found maximum by using Kans fiber. As per the results it can be calculated that natural fibers like jute fiber, Kans fiber can be a good replacement for steel ropes because natural fiber also fulfilling the required strength of the wire rope. And according to the comparison of results it can be concluded that kans fiber is a better replacement of steel as it provides better results as compare to jute fiber.

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A STUDY ON MANUFACTURING OF FLANGE JOINT USED IN TRANSPORTATION VEHICLE

Harsh Kumar Sharma[1*]

[1]*Research Scholar, Department of Mechanical Engineering, SIRTE, Bhopal*

Abstract

Flange and flange connecting it to a commercial vehicle are processed in this investigation. Assemblies of Companion Flanges and Universal Drive shafts are also available. When the flange was brought in use in the commercial vehicles, it was seen that because if heavy friction, the part is deteriorating. To prevent this issue, a design was made which was further manufactured for accomplishing the goals of this study. When the product was ready, it was tested on CMM machine to find any type of error between the designed and manufactured product. The outcome obtained from the CMM machine showed a very small percentage of error. The new manufactured product had comparatively less amount of friction loss.

Keywords: Companion Flange; Drive shaft; Lath machine; Universal drive shaft, Industrial Manufacturing.

1. Introduction

In a vehicle with rear-wheel drive, the engine's output is sent to the differential via a drive shaft. Since “the bending natural frequency of a shaft is inversely proportional to the square of the beam length and proportionate to the square root of the specific modulus”, the driving shaft is often made in two parts to raise the fundamental bending natural frequency. It is thus preferable to utilise a one-piece stainless steel drive shaft for this application, which is why stainless steel is the material of choice. As

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torque carriers, drive shafts experience torsional and shear stress equal to the difference between input torque and output torque. As a result, they must be capable of withstanding the pressure. Individual companion flanges or whole assemblies with universal drive shafts are available. For adequate torque transmission, a flanged yoke may be connected to another form of connection.

In "front-wheel drive, four-wheel drive, and the previously described front-engine rear-wheel drive systems", drive shafts are employed differently. Other vehicles, such as motorbikes, locomotives, and maritime vessels, also use drive shafts. Drive shafts for a typical front engine, rear wheel drive vehicle are shown below (some cars have the transmission at the back).

1.1. Flange Joint

A pipeline system's components, such as pipes, valves, pumps, and other equipment, are linked together using flanges. Cleaning, inspecting, and modifying are all made much easier as a result. Most flanges are attached with screws or by welding. To create a tight seal, two flanges are bolted together and a gasket is sandwiched in between.

Flange ASME B16.5 comes in a variety of sizes. Welding Neck flange NPS 6, Class 150, Schedule 40 ASME B16.5 is referred to as such in Japan, Canada, and Australia.

It is possible to block or connect other components such as valves, nozzles, and special items using a pipe flange which is a disc-shaped piping component. After welding, piping flanges are the most popular as joining methods. Wherever, any dismantling of components is required for maintenance, inspection, replacement, or operational purposes piping flanged joints are preferred. Pipe flanges use bolts and gasket in between to ensure leakage-free piping joints. Piping flanges are selected based on pressure-temperature rating and pipe class following ASME B 16.5 or ASME B 16.47 standard. However, custom made pipe flanges can be manufactured but not preferred in industries. Piping flanges are the best alternative to welding or threading and manufactured by forging.

The most used flange types ASME B16.5 are: "Welding Neck, Slip On, Socket Weld, Lap Joint, Threaded and Blind flange".

1.2. Process Flow Diagram

Diagrams describing the interactions between main plant components are shown in a Process Flow Diagram (PFD). Though its techniques are commonly applied to other processes as well, chemical engineering and process engineering are the most common fields in which it is used. To record a process, refine a process, or model a new one, it's utilised. If you want to name it anything else, you may call it anything from Process Flow Chart to Flow-sheet to Macro-flowchart to Top-down flowchart to Piping and Instrument Diagram to System Diagram, depending on what you want to call it and what it is used for. They represent a process using a set of symbols and notations. From crude, hand-drawn scribble to professional-looking, expanding detail diagrams, the symbols and diagrams vary in various parts of the world.

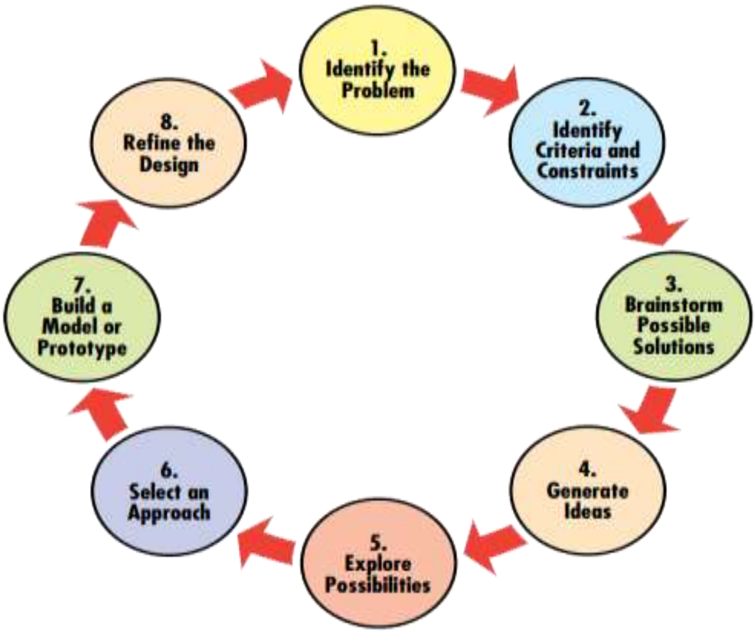

Figure 1: Process Flow Diagram

1.3. Objectives of the Study

- Analysis of problems in manufacturing process(s).
- The Design will be optimized as per analysis for DFM.
- To achieve the reduction in the non-conformance of final output.
- The jigs and fixtures will be introduced for quality improvement.
- Establishing new/advanced methods for measurement of parts.
- Creating Standard operation procedures for workstations and checking procedures.
- Better productivity will be achieved by reduction on rejection rate.

2. LITERATURE REVIEW

(Karaoğlu and Sefa Kuralay, 2002) [1] By using the finite element method (FEM), a vehicle chassis with riveted joints was studied for stress. Side member thickness, connection plate thickness and connection plate length were altered to reduce stress around the riveted junction of the chassis frame.. The strains on the side member may be decreased by increasing the thickness of the side member locally, according to computer simulations. If changing the thickness isn't an option, expanding the length of the connecting plate can be. A vehicle's static and dynamic loads are the same for everybody. Inertia forces caused by driving on uneven roads contribute to dynamic loads. Because the total weight of the chassis frame rises with increasing thickness, it is necessary to keep in mind.

(Kirkemo, 2002) [2] A wide variety of flange joints for high-pressure applications in industrial piping, pressure vessels, pipes, risers, and related equipment have been utilised widely with self seating and pressure actuated seal rings. Compact flange joints are often lighter and smaller, with smaller bolts, than regular gasketed flange joints of the same rating. To build small flange joints that can withstand pressure and external stresses, this document gives all the essential information. Also included in this document are instructions on how to design the seal ring, flange and bolts. Weld neck flanges with a homogeneous hub thickness are thoroughly examined.

(Sivakandhan and Prabhu, 2011) [3] Composite drive shafts for power transmission have been studied and optimised in this study. E-glass/epoxy and high modulus carbon/epoxy composites are used to make a one-piece composite drive shaft for automobiles. An ansys-based method for optimising the design of composite drive shafts is discussed here. As a result of the constraints imposed by torque transmission, the weight of a shaft must be minimised by employing ansys. Torsion strength, torsion buckling, and natural frequency of bending are the primary considerations. The draught shaft is designed in such a way that it is lightest and most cost-effective while yet meeting the aforementioned load criteria. Optimal laminated plate and shell designs exposed to buckling stresses and fundamental natural frequencies were evaluated. For symmetric angle-ply shells of uniform thickness, methods were suggested to determine the best ply angle variation across the thickness.

(Abel et al., 2012) [4] "Mechatronic shifting simulation of automated commercial vehicle transmissions" is utilised in Daimler's truck engineering divisions for optimization and development today. To demonstrate new functional mock-up interfaces in the ITEA2 project Modelisar, this application was used in conjunction with ITI GmbH and SIM-PACK AG (FMI). Models from a variety of different tools may be used to create the overall system for the mechanical shifting simulation by using these common interfaces. It was possible to transfer control modules from MATLAB/Simulink to a "SimulationX powertrain model using FMI for Model Exchange", and then from the SimulationX 1D-multiphysics powertrain model to a multi-body vehicle model in SIMPACK via this method.

(Zulfadhli Bin and Zaki, 2012) [5] Transaxles are a standard feature on all cars, at least those with rear-wheel drive and a front-engine layout. If the weight reduction of the drive shaft can be accomplished without an increase in cost and a drop in quality and dependability, this is a much desired aim. Composite drive shafts may be made lighter by increasing the first natural frequency and decreasing the bending stresses of the shaft utilising varied stacking sequence. This is doable. The transmission of torque and torsional buckling capabilities are also improved by performing the same thing. "High Strength Carbon drive shafts" are being used in lieu of traditional steel drive shafts in a car. In order to reduce vehicle weight while maintaining the same level of quality and dependability, the automotive industry is turning to composite material technologies for structural component fabrication.

(Sagar R Dharmadhikari, Sachin G Mahakalkar, Jayant P Giri, 2013) [6] The focus of this research is on the evaluation of drive shaft optimization using ANSYS and the Genetic Algorithm. For the drive shaft, using a composite material rather than traditional steel gives designers more flexibility in their designs because of the material's higher specific stiffness and strength. The drive shaft is the most important part of an automobile's drive system. Many drawbacks, such as poor specific stiffness and strength, come with using standard steel in the manufacture of drive shafts. If the design variables are not continuous, these approaches are not applicable. Structural engineering optimization, on the other hand, relies heavily on the use of discrete design factors. Constraints on building and manufacturing techniques have led to a lack of standard components.

3. RESEARCH METHODOLOGY

3.1. Steps of working

- Problem identified by using root cause analysis.
- Collect raw material for manufacturing process
- Outer Diameter & Face clean cut will be occurred in the companion flange on Lath Machine
- CNC machining
- Hardening process by using induction hardening.
- Flange spline is created by using Broaching operation
- VMC machine for maintaining the PCD
- Plunge Grinding
- Inspection report of part

3.2. Collecting raw material

First of all for manufacturing companion flange, Raw material is selected as from different type of materials. Different tests were performed on raw material for better strength and better durability of companion flange. [7] [8]Different dimensions are considered and material grade report is an important aspect that was looked according to report given by the raw material supplier. And after that it was tested in lab for confirming the grade and other parameters to choose the final material for next process. [9] [10] [11]

Table: Material collection

S.N.	CHARACTERSTIC		SPL	PRODUCT/PROCESS	EVALUTION/	SAMPLE	
	PRODUCT	PROCESS	CHAR CLASS	SPECIFICATION	MEASUREMENT TECHNIQUE	SIZE	FREQ.
1.	Surface			Smooth & Rustles	Visual	5 Per Lot	
2.	All Dimension			As per forging drawing	Respective gage	5 Per Lot	
3.	Material grade			EN8D/BS970	Lab report	1 Per Lot	
4.	Material grade			EN8D/BS970	Supplier report		

4. **RESULTS AND DISCUSSION**

4.1. Material Testing report

Material Testing report

MATERIAL SPEC. EN8D						HEAT CODE(I/H):-AF	
Element		C%	Mg%	Si%	P%	S%	REMARKS
SPECIFD.	MIN	0.40	0.60	0.15	--	--	OK
	MAX	0.50	0.90	0.35	0.06	0.06	
ACTUAL		0.45	0.76	0.23	0.031	0.023	

METALLOGRAPHIC OBSERVATIONS: -

TEST	SPECIFICATION	OBSERVATIONS	REMARK
Case microstructure	Fine Tempered martensite	Fine tempered martensite without ferrite	OK
Core microstructure	Hardened and tempered	Tempered martensite	OK
Inclusion Rating	≤ 2 ABCD IS: 4163	1.0 A,0.5B,0.5C,1.0D	OK
Grain size	ASTM- 5 to 8	6.5– 7 ASTM	OK

MECHANICAL PROPERTIES:-

TEST	SPECIFICATION	OBSERVATIONS	REMARK
Surf. hardness	500-570Hv	‘560-565 Hv(53/54 HRC)	OK
Core hardness	300-400HV	370-380 HV	OK
Effective case depth	1.5±1mm	1.7-2.0mm	OK
Effective case depth at oil groove	1.5±1mm	0.8mm-1.0mm	OK
Magnafluxing/ acid etching/ visual	Shall be free from cracks, fold, seams etc.	No Cracks and free from other defects	OK

4.2. M.P.I. Check Sheet

MPI CHECK SHEET

Testing standard	: AWS D1.1	Equipment	: SONATEST MY-2 AC YOKE
Acceptance Criteria	: SECTION 6, PART C	Magnetizing Current	: AC
Thickness	: AS PER DRAWING	Method of Magnetizing	: WET, CONTINUOUS
Surface Prepration	: GRINDING	Magnetic particle	: BELLING MAG CHECK B
Surface Temperature	: AMBIENT	White Contrast Paint	: BELLING MAG CHECK A
Method of applcation	: 13H11K	Inspection Method	: CONTINUOUS
Magnetic particle	: SPRAY	Lighting Equipment	: Hand Lamp
Excess Particle Removal	: LIGHT AIR BLOW		

TEST RESULT

No.		Evaluation: Accept	Evaluation: Reject
	MAGNETIC PARTICLE INSPECTION WAS CARRIED-OUT ON SKYLIGHT AT LEVEL 5.		
	DRAWING NO ARE AS FOLLOWS:		
1	WPS/REK/X16/2021	X	
2	WPS/REK/X24/2021	X	

Remarks
MPI was carried out 100% surface area
No relevance indicate was found during time of inspection

Cheked by: Aavesh Bandekar   Approved by: Ramesh talpade

MPI testing report of Companion flange

4.3. CMM Report

The report was extracted from JJ precision and it showed the maximum deviation of less than 0.05mm. This deviation is under acceptable condition.

JJ PRECISION
T BLOCK165/1/18 MIDC BHOSARI, PUNE 411026

Drawing No	Date	Temperature workpiece
* drawingno *	May 16, 2021	
	Time: 2:29:01 pm	Order
Operator: Master	CMM: C32Bit	Incremental Part Number: 3

Name	ID	Aktual	Nominal	pos Tol	neg Tol	Diff	<--|-->
Overall Result							
All Characteristics:		25					
in Tolerance:		12					
Out of tolerance:		13					
Over Warning Limit:		0					
Not Calculated:		0					
Total Coord. systems:		1					
Not Calculated:		0					
Total Text elements:		0					
Z Value_Symmetry wrt Ø12	Z	-0.0076	0.0000	0.0100	-0.0100	-0.0076	—|
X Value_Slot1	X	0.0145	0.0000	0.0100	-0.0100	0.0145	0.0045
Z Value_Slot1	Z	0.0134	0.0000	0.0100	-0.0100	0.0134	0.0034
X Value_Cylinder Ø14.0	X	-74.9844	-75.0000	0.0250	-0.0250	0.0156	|—
Y Value_Cylinder Ø14.0	Y	-20.9712	-21.0000	-20.9600	-20.9930	0.0288	|-
Parallelism Ø14.0 wrt C	Par	0.0100	0.0000	0.0100		0.0100	|—
Parallelism Ø14.0 wrt A	Par	0.0064	0.0000	0.0100		0.0064	|-
Perpendicularity Ø14.0 wrt B	Perp	0.0277	0.0000	0.0100		0.0277	0.0177
X Value_Cylinder Ø14.0 wrt	CartDist	11.0063	11.0000	11.0030	10.9830	0.0063	0.0033
Diameter_Cylinder3	D	14.0038	14.0120	14.0210	14.0030	-0.0082	—|
Diameter_Cylinder1	D	12.0026	12.0000	0.0110	0.0000	0.0026	—|
Width_Slot1	Width	10.0240	10.0000	10.0300	9.9940	0.0240	|—
Distance Ø14.0 To 12.0_To	CartDist	150.0019	150.0000	-0.0100	-0.0320	0.0019	0.0119
Distance Ø14.0 To 12.0_Be	CartDist	149.9939	150.0000	-0.0100	-0.0320	-0.0061	0.0039
Y Value_Cylinder Ø12.0	Y	-20.9430	-20.9765	-20.9600	-20.9930	0.0335	0.0170
Parallelism Ø12.0 wrt A	Par	0.0070	0.0000	0.0100		0.0070	|—
Parallelism Ø12.0 wrt C	Par	0.0003	0.0000	0.0100		0.0003	|-
Diameter_Cylinder2	D	11.9970	12.0000	12.0110	11.9890	-0.0030	—|
Cartesian Distance1	CartDist	45.9856	45.9310	45.9560	45.9060	0.0546	0.0296
Z Value_Symmetry2	Z	-0.0008	0.0000	0.0100	-0.0100	-0.0008	-|
Cartesian Distance2	CartDist	47.9966	48.0850	48.0940	48.0440	-0.0884	-0.0474
Z Value_Symmetry3	Z	-0.0114	0.0000	0.0100	-0.0100	-0.0114	-0.0014
Cartesian Distance3	CartDist	26.8897	27.0000	0.1000	-0.1000	-0.1103	-0.0103
Cartesian Distance4	CartDist	119.2420	119.0000	0.1000	-0.1000	0.2420	0.1420
Cartesian Distance5	CartDist	25.8783	26.0000	0.1000	-0.1000	-0.1217	-0.0217

5. CONCLUSION

All the procedures of manufacturing have been successfully operated and the design proposed with the help of this study can be manufactured and successfully used in commercial vehicles on the results provided by this study. With the help of the CMM machine, the deviation in the proposed design and actual products was evaluated. The maximum deviation obtained was less than 0.05mm. previously, the rejection rate was 31, which with help of the present study has been reduced to 19. On the other hand, the productivity of the product has increased from 84.5% to 90.5%.

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A Review on Heat Transfer and Fluid Flow Characteristics through Double-Pipe U-Tube Heat Exchanger

Sonu Kumar Kushwaha[1*]

[1]Research scholar, Department of Mechanical engineering, Sagar Institute of research & technology Bhopal

Abstract

In the current context more and more efficient heat transfer system are required. The solution based on turbulent flow through heat exchangers has proven successful in terms of high heat transfer rate. All past studies on this topic was experimental based. The present approach is based on CFD (Computational Fluid Dynamics) technique. As a starting point, this study examines how various characteristics, such as the kind of fins, orientation, forms, and positions, might be used to optimise heat exchanger thermal performance. The purpose of this review is to explain how each of the parameters listed affects thermal performance.

Keywords: Heat exchanger, Twisted tube insert, Nano Material, Heat transfer mechanism.

1. INTRODUCTION

It is commonplace across a wide range of industries to make use of various kinds of heat exchangers. Heat exchangers composed of metals, such as copper, aluminium, and steel, are common. Plastics, on the other hand, were selected as a practical material for heat exchangers because they are resistant to chemicals and corrosion. Chemically resistant and lighter than corrosion-resistant alloys, they are less expensive. [1] Plastic heat exchangers aren't only for corrosive environments; they're also

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employed in the food processing sector, biotechnology, and the automobile and aerospace industries. Because metal heat exchangers have a long history of use, well-designed manufacturing systems, and established procedures, enterprises are reluctant to modify their methods. No matter how much progress has been made in the world of material science and technology, we still believe that the potential for plastic heat exchangers to be used must be reexamined.[2]

There are three basic kinds of heat transfer augmentation methods: active, passive, and compound. DPHE was thoroughly reviewed by Mohamad et al., who covered in depth the aforementioned heat transfer augmentation strategies [3]. An external force is used to boost heat transmission when using active techniques, the authors noted. The use of reciprocating plungers, a magnetic field, surface or flow vibration, and electromagnetic fields are a few examples. There are no external forces employed to increase heat transmission in passive techniques. For heat transmission, surface or geometric modifications are used. Because of their simplicity, cheap cost, and ease of installation and maintenance, modifications such as twisted tape inserts or fins are quite popular. However, surface alterations may improve the heat transfer coefficient and hence the rate of heat transfer, but they can also cause an increase in pressure drop.[4]

1.1. Double-Pipe Heat Exchangers

The inner pipe of this exchanger is generally plain or finned, as seen in Figure. To get the best possible performance for the given surface area, one fluid runs through the inner pipe while the other flows through the annulus between the pipes. It is possible for fluids to flow in a parallel flow direction if the application demands a nearly constant temperature on the wall. The simplest heat exchanger is this one. By disassembly, cleaning is a breeze, and flow distribution isn't an issue. If one or both of the fluids is at a high pressure, this design is also a good choice. [5]

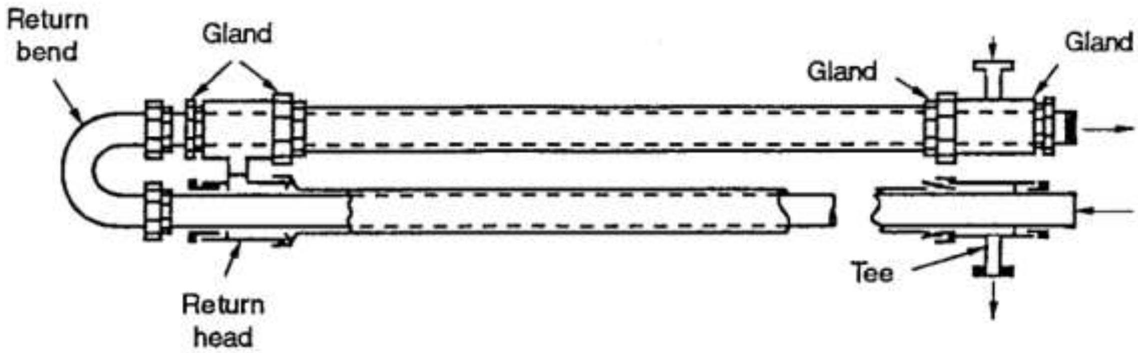

Figure 1: Double pipe heat exchanger[6]

1.2. Nanofluids

An entirely new kind of heat transfer fluid, nanofluids, is a product of nanotechnology and is made by dispersing and suspending nanoparticles with typical diameters of 10 nm or less. It was Choi (1995) who developed the name "Nanofluids" to characterise this novel class of heat transfer fluids based on nanotechnology that have enhanced thermal characteristics, which are superior to those of their own hosting liquids as well as traditional particle fluid suspensions.[7]

Nanofluids aim to disperse and suspend nanoparticles (ideally 10 nm in size) in host fluids in a homogeneous and stable manner to attain the greatest possible thermal characteristics at the lowest possible concentrations (preferably 1% by volume). Because nanoparticles promote energy transmission in liquids, it is essential to understand how they work.[8]

Procedures for preparing Nanofluids:

There are two ways to prepare Nanofluids and that is mentioned below:

Two step Method

Two-step approach is most common: dry powders or other nanomaterials are first created using chemical or physical methods to create the nanoparticles, fibre or tube. It is then distributed into the host fluid in the second stage using one of the following methods: vigorous magnetic force agitation, ultrasonic and high-shear mixing and homogenizing. As Nano powder synthesis methods have already been scaled up to industrial production levels, this is the most cost-effective way to create nanofluids on a wide scale. Nanoparticles prefer to agglomerate because of their large surface area and strong surface activity. The one-step approach was designed to circumvent the challenge of making stable nanofluids using the technology that was previously used.[9]

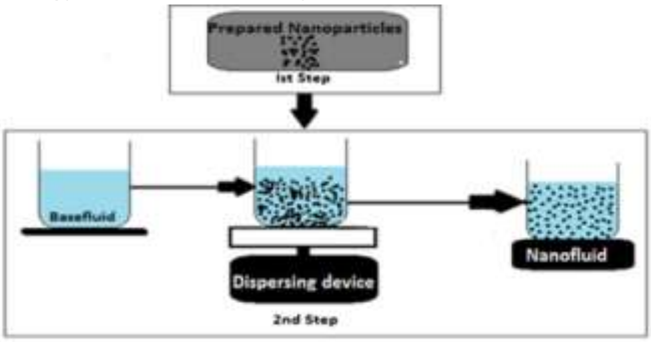

Figure 2: Two-step Nanofluids Preparation

One step Method

Particles are made and dispersed in the fluid simultaneously in a one-step process. There are less agglomerations of nanoparticles using this approach, which avoids operations such as drying, transporting, and dispersion of the nanoparticles. It is possible to make nanoparticles that are perfectly disseminated in the base fluid using one-step methods.[10]

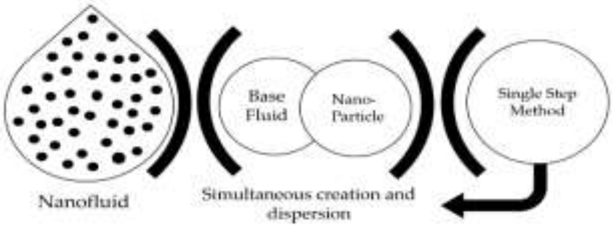

Figure 3: One-step Nanofluids Preparation

1.3. THEORY

The “double-pipe heat exchanger” is one of the most straightforward forms of heat exchangers. When two pipes are connected, one fluid runs within the first while the other flows between and around the first. This is known as a “double-pipe exchanger”. Co-current or counter-current flow is possible in a heat exchanger with two pipes.

Double-pipe heat exchanger theory is discussed in “Incropera and Dewitt (1996)”. Using the same textbook, we can figure out how to handle transient behaviour in terms of heat transfer.

1.4. Trapezoidal-Cut Twisted Tapes

Using 1.00 mm thick aluminium strips, the trapezoidal-cut twisted tapes have a 1 mm smaller width than the test section tube's interior diameter. On a lathe, the strips are manually twisted by rotating the chuck. The twist ratio (y) for this strip may be calculated by dividing the diameter by the length of one twist (or pitch). The trapezoidal-cut measurements of the full-length twisted tape are 6 mm deep, 6 mm at the base, and 10 mm wide at the top. For better fluid mixing along the pipe's inner walls, a trapezoidal-cut is made on both the tape's top and bottom surfaces. Figure shown below depicts the trapezoidal cut test portion.

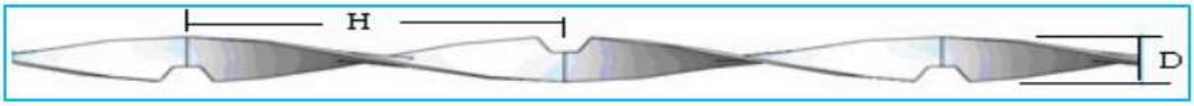

Figure 4: Schematic representation of trapezoidal-cut twisted tape [11]

2. LITERATURE REVIEW

(Ngo et al., 2021) [12] A two-dimensional (2D) gas-solid Eulerian “computational fluid dynamics (CFD) model” is used to analyse the hydrodynamic and heat transport properties of a BFB reactor with “immersed heat exchange tubes for CO2 methanation”. The CFD model was combined with a reaction kinetics model for a Ni-based catalyst. For the bed growth of Geldart B particles, the 2D-CFD model with Huilin and Gidaspow drag was verified using experimental data.

(Bahiraei, Naseri and monavari, 2021) [13] A two-dimensional (2D) “gas-solid Eulerian computational fluid dynamics (CFD) model” is used to analyse the hydrodynamic and heat transport properties of a BFB reactor with immersed heat exchange tubes for CO2 methanation. The CFD model was combined with a reaction kinetics model for a Ni-based catalyst. For the bed growth of Geldart B particles, the 2D-CFD model with Huilin and Gidaspow drag was verified using experimental data. The heat of reaction was efficiently eliminated in the BFB reactor with a 25% heat exchange area, and the reactor maintained isothermal conditions, according to the results.

(Calvino et al., 2021) [14] This material's thermal characteristics have been well documented and are enhanced by the fact that graphene nanoplatelets are multi-layered (GnP). A functionalization of these hydrophobic carbon nanostructures is necessary to determine their long-term stability in aqueous solutions. “Polycarboxylate chemically modified GnP dispersion” in water at 0.50 wt % is tested for convective heat transfer performance in this work. To test the nanofluids thermal conductivity, density, isobaric heat capacity, and isothermal viscosity across a broad temperature range, researchers use rotational rheometry, the transient hot-wire method, differential scanning calorimetry, and the vibrating U-tube method. The thermo physical and rheological characteristics of the material have been verified by two separate labs.

(Dube kerme and Fung, 2020) [15] Modeling the transient heat transfer in “a twin U-tube borehole heat exchanger (BHE)” with either varying or equal mass flow rate and intake fluid temperature has been proposed in this study. Using previously available data, we were able to test the suggested model. As part of the vertical BHE optimization and efficiency testing as well as a rapid assessment of how borehole characteristics and thermal properties affect overall performance, the modelling, simulation, and analysis are critical. In the design, optimization, and performance analysis of ground source heat pump and borehole thermal energy storage systems, the model is essential.

(Pandey, Prajapati and singh, 2020) [16] The current study's goal is to see whether a Y-shaped insert within a circular tube heat exchanger may improve heat transmission and fluid flow. With four different values of Perforation Index (PI) ranging from zero to 30 percent, air is employed as the working fluid in the “RNG K- Turbulence model”. The Reynolds number (Re) varies from 3000 to 21000. Larger PI results in a higher friction factor, whereas lower PI results in a lower friction factor and a higher heat transfer. At Re = 3000, the non-perforated insert case has the maximum heat transfer and “Thermal Performance Factor (TPF)” of 5.05 times and 2.88 times, respectively, above the smooth tube.

(Jahanbin, 2020) [17] Building climate control and residential hot water generation may benefit from the use of “Ground-Coupled Heat Pumps (GCHPs)”. Drilling and installation costs are the primary impediment to their use in urban settings. “Ground-source heat pump (GCHP)” systems may benefit from an innovative and simple design of the GHE, particularly the vertical GHE with an elliptical U-tube. Elongated U-tubes may significantly increase heat transmission and reduce borehole thermal resistance compared to single U-tubes, according to the findings. When the form factor is greater, heat transmission is enhanced more effectively. In this study, it was shown that “elliptical U-tubes” have the ability to reduce borehole thermal resistance and increase GCHP system COP.

(Serageldin et al., 2020) [18] Spacers that may be used to maintain the distance between the legs of a single U-tube with an oval cross section have been developed in this research. The ground source heat pump system was subjected to short-term and long-term transient numerical simulations in order to assess its thermal and energy performance using a single oval-section U-tube linked with a new spacer and a “traditional circular-section single U-tube system”. Different spacer cross-sections (circular, oval, and oval with fins, double circular cross-section spacers), materials, and length were evaluated for their effect on thermal performance.

(Kerme and Fung, 2020) [19] The heat transfer in a “single U-tube borehole heat exchanger” is the subject of this paper's investigation, modelling, and performance evaluation. The heat transmission mechanism within and outside the borehole was studied using an unsteady heat transfer approach. Based on energy balance equations, coupled with thermal resistance model, implicit numerical technique was utilised to find solution. It was determined how the temperatures of the fluid, the wall of the hole, the grouts, and the ground around the hole changed with time and depth. It was also necessary to do a dynamic simulation in order to determine the effect of various factors.

(Naldi and Zanchini, 2020) [20] For both short-term and long-term fluid-to-ground thermal response factors, a novel cylindrical model is provided, which may be used to calculate both (BHE). It is possible to simulate a BHE using a cylinder with the same radius and heat capacity as a real-world comparable cylinder. There is a "heat-generating cylindrical surface with an equivalent radius (req)" that has been tuned by repeated 2D finite-element simulations of the cylinder's homogenous material. There is a layer between req and BHE radius, and its thermal resistance is equal to BHE's thermal resistance. A correlation is shown that yields the optimal values of req.

(Luo, Yan and Yu, 2020) [21] For geothermal energy usage, seasonal energy storage, etc., ground heat exchanger (GHE) is essential. U-tube GHE's asymmetric form and complicated heat interaction between fluid, grout, and soil make the "transient heat transfer analytical model" a problem. A new analytical model for "U-tube GHE" was developed in this work using a composite media technique. The novel modelling is aided by inspiration from the heat transmission of GHE in multilayer soil. A novel analytical model for U-tube GHE has been developed by combining the methodologies of tackling non-uniform pipe wall temperature/heat flux and the influence of ground surface flux. Models are verified using both experimental and other simulation data. With the use of visualization, we've been able to examine how the temperature changes in longitudinal and cross sections of GHE. Some novel findings were discovered during the investigation of grout material selection and borehole depth design.

3. CONCLUSION

In this review study, a variety of fins were employed to improve heat transmission. To analyse the "heat transfer rate and pressure drop" of different fin shapes such as rectangular (rectangular), triangular (triangular), trapezoidal (trapezoidal), wavy (wavy), offset strip (offset strip), louvred (louvred), and perforated (perforated) are employed. "Trapezoidal-cut twisted tape" inserts have a significant impact on the thermal performance factor because they promote heat transmission. Because of their high thermal conductivity, Al2O3 nanoparticles seem to have a significant impact on nanofluids' thermal performance. Therefore, it can be concluded that the good effects of improved heat transmission outweigh the negative effects of increased friction loss in the range studied.

Sonu Kumar Kushwaha

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To study the thermal performance of Shell and Tube Heat Exchanger by Using Different Tubes Materials

Ravi Kumar Gupta[1*]

[1] *Research Scholar, Department of Mechanical Engineering, Lakshmi Narayan College of Technology, Bhopal*

Abstract

In this work, a brief research background is provided over the tube and shell heat exchangers. Heat exchangers are very extensively brought in use for applications like heat transfer in the industries. Tube and shell heat exchanger are among such heat exchangers and provides more areas for transferring heat among the two fluids in comparison with other kinds of heat exchangers. "Tube heat exchanger and shell heat exchanger" are very extensively brought in use for applications like liquid to liquid heat transfer constituting of high-density working flute. The focus of this study is over the utilization of tube and shell heat exchangers with different materials: copper, steel and aluminium. Further with the help of ANSYS, a computational model was implemented for the same heat exchanger. This study has conducted investigations over the tube and shell heat exchanger with assessment off exchanger's effectiveness and temperature. Steel, copper and aluminum showed effectiveness of 0.738, 0.748 and 0.747 respectively. This result showed that copper has the maximum effectiveness and steel has the lowest effectiveness.

Keywords: Heat Exchanger; Tube and shell heat exchanger; ANSYS; CFD.

* ISBN No. 978-81-953278-8-1

1. INTRODUCTION

A heat exchanger is a device that transfers heat between two fluids. Different types of exchangers call for different types of fluids, which might be either separate or in direct touch. Even though many of the principals involved in their construction are similar to those used in nuclear-fuel pins or fired heaters, heat exchangers are not typically considered to be devices that utilise energy sources. Temperature differences between two fluids may be advantageous in many industrial applications. To do this double duty, a heat exchanger saves money.

Some examples of its uses include chilling one petroleum fraction while warming another, preheating combustion air supplied to a boiler furnace with hot flue gas, and cooling air or other gases with water between compression stages. Metals may be used to transmit heat to water inside atomic reactors, while compressed air from a gas turbine can be used to recover heat from exhaust. Heat exchangers are used widely in power plants, gas turbines, heating and air conditioning, refrigeration, and the chemical industry, among other uses.

1.1. Computational Fluid Dynamics

If you'd want to better understand the numerous components of a CFD simulation, here is an overview of how it's done. The technique is broken down into the following steps:

- “Flow Problem is formulated”
- “Geometry & Flow Domain are modelled”
- “Establishment of the Boundary and Initial Conditions”
- “Generation of the Grid”
- “Establishment of the Simulation Strategy”
- “Establishment of the Input Parameters and Files”
- “Perform the Simulations”
- “Monitoring the Simulations for Completion”
- “Post-process the Simulation to get the Results”
- “Make Comparisons of the Results”
- “Repeat the Process to Examine Sensitivities”
- “Document”

1.2. Principles of Heat Exchanger

Heat flows from higher to lower temperatures on their own, which is how heat exchangers function. To put it another way, heat may be transferred from hot to cold fluids by use of heat conducting surfaces.

The rate of heat flow (kW/m2 of transfer surface) at any given position relies on the following factors:

- The heat transfer coefficient (U) is a function of the fluid characteristics, fluid velocity, building materials, geometry, as well as hygiene of the heat exchanger.
- Differences among cold and Hot streams temperature

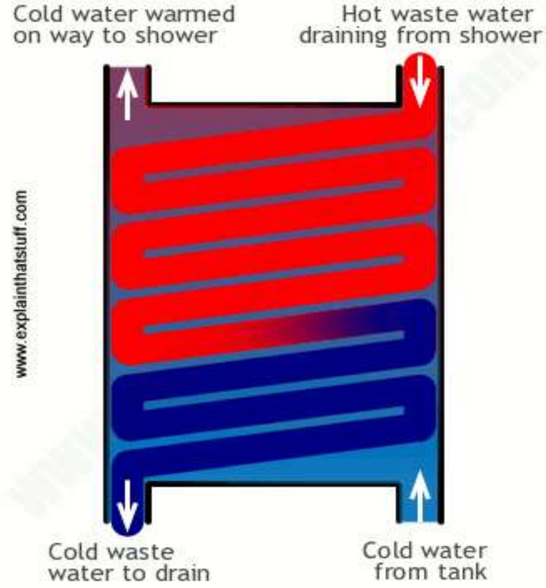

Figure 1: Simplified Heat Exchangers

1.3. Objects of Research

The main aim of this research work is to ascertain the following changes in relation to the response of a Shell and Tube Heat Exchanger pipe materials on Steel, Copper and Aluminium.

1. To performed the CFD analysis of "shell and tube heat exchanger" using ANSYS software.
2. To check the Hot and Cold water outlet temperature using different pipe material.
3. To calculate the effectiveness of "shell and tube heat exchanger" and compare all three materials result.
4. To suggest the best material for manufacturing "shell and tube heat exchanger" by using CFD investigation.

2. LITERATURE REVIEW

(Du, Jiang and Wang, 2020) [1] Among the most energy-efficient but also good for the environment construction of support services is the geothermal heat exchanger system. This study used a CuO/water nanofluid as the heat transfer fluid to improve the energy efficiency of "geothermal heat exchangers". A 3D model, well-validated against actual data on nanofluids in geothermal heat exchangers, was used to study the effect of nanoparticle diameter and circularity on the thermal performance of the "geothermal heat exchanger".

(Sunil and Kumar, 2019) [2] Laminar and turbulent regimes of alumina-water nanofluid convection and pressure drop were studied using viscous laminar models and the conventional k-model. There is a micro-channel heat exchanger (0.1 m length and 0.5-mm inner diameter) with an Al2O3 water nanofluid flow of 0 to 5 percent and cold water pouring out, with constant wall temperatures, within the spherical micro-channel. The experiment revealed that when the quantity of nanoparticles rose, convection heat transfer dramatically increased at different Reynolds numbers. The heat transfer coefficient improved 15% in the laminar regime and 12% in the turbulent zone as compared to pure water at 5% volume concentration (Nusselt number decreased about 2.5 percent).

(Krishnakanth, Aravind and Ashok, 2019) [3] Heat exchangers with two tubes or concentric tubes have been used in power plants, refrigeration, and chemical facilities to enhance heat transfer rates and efficiency. Throughout this research, an examination of a twin tube heat exchanger with variable flow rates as well as nanoparticle concentrations will be carried out. The heat transfer rate in a heat exchanger was increased by using Al2O3 nanofluid as a base fluid. The assessment will be carried out using ANSYS Fluent 14.0 and CFD technique. For the counter current flow pattern, the heat transfer rate is changed. The heat transmission rate is increased by using nanofluids as a base fluid.

(KISHORKUMAR, MEHTA and SHAH, 2019) [4] In this research contain the analysis and comparison between plain tubes used Shell and tube heat exchanger and corrugated tubed used shell and tube heat exchanger system with different thickness. In this research, thermal analysis of the shell and tube heat exchanger. In this solid works 2014 is used for geometrical modelling. And also, TEMA standards are used for starting the experimental structure. Which are validating in ANSYS. Create a sample experiment model of a shell and tube heat exchanger inside which plain & corrugated tubes are used sequentially, as well as taking readings for thermal analysis calculations, and comparing the results of the experiment with the results of the CFD simulation for affirmation. Utilize Solid Works for geometry & design, ICEM CFD (ANSYS) for meshing, as well as Fluent for analysis in Computational Fluid Dynamics (CFD) Analysis Software.

(B, Lakshmi and Krishna, 2019) [5] **"**Tube and Shell heat exchangers" are the most prevalent types of heat exchangers now in use. These heat exchangers are often used to generate energy, cool hydraulic fluid or oil in motors, gearboxes or hydraulic power packs and to cool hydraulic fluid or oil used in motors and transmissions. These heat exchangers are constructed of a casing and a number of tubes with an inner core. In this study, the goal is to determine out how fast heat can be transferred using hot water. A tube and shell heat exchanger is the focus of this research, which uses the Ansys programme to simulate the heat exchanger and measure blood flow and temperature from the tubes and the shell. "Computational fluid dynamics (CFD)" is used to model and mesh the cross section of a tube and shell heat exchanger for the simulation.

(Pavani and Kumar, 2018) [6] Heat exchangers serve an important role in energy conservation, conversion, and recovery. Shell-and-tube heat exchangers are among the most widely used in numerous technological applications for the transmission of thermal energy. A number of industries employ them because to their ability to convey large amounts of heat in relatively low-cost, easily maintained designs without mingling hot and old fluids. Nanofluid physical characteristics and numerical simulation volume fractions are used to analyse the heat exchanger's thermal and CFD properties. CATIA is used to create a 3-Dimensional model of the proposed heat exchanger, as well as Ansys fluent is used to analyse it. There are 2 materials used for making the tubes of the heat exchanger: copper and aluminium.

(Santhakumar, B.Meganathan and M.Sanjeevkumar, 2018) [7] Development of nanofluids is aimed at improving heat transfer coefficient and reducing the size of thermal fluids used in heat exchangers. Thermal conductivity, viscosity, specific heat, as well as density are some of the major elements that determine the heat transfer characteristics of nanofluids. Nanofluids' thermo-physical characteristics are also influenced by their operating temperature. As a result, precise temperature-dependent property measurements of nanofluids are critical. The scope of this study is to review recent advances in nanofluid research and to do cfd analysis on nanofluids.

(Kumar et al., 2018) [8] Additionally, it is important to note that in this study, the researchers used the Ansys software tool for a heat exchanger with segmental baffles to explore the flow and temperature within the shell and tubes and to calculate total heat transfer for each design. The heat exchanger with 6 baffles is positioned along the shell and tube heat exchanger angles & orientations for establishing flow routes between tubes in this research, which analyzed both water & water and TiO2. The geometric model is compared by varying baffle inclination i.e. 450 and 900. The fundamental geometry of the heat exchanger is modeled by using CFD package ansys 15.0 in the modelling process. The complete heat transport is depicted in this diagram.

3. METHODOLOGY

3.1. Step of working

During the course of the study, the following procedures should be followed:[9]

1. Modeling of a Shell and Tube heat exchanger using the chosen base paper as a starting point.
2. For compatibility in the simulation process, the file has to be further converted.
3. Ansys Fluent is used to do the simulation.
4. Identifying the various sections of the Shell and Tube type heat exchanger by their names.
5. For CFD study, mesh the cross flow heat exchanger.
6. Providing the appropriate boundary conditions based on the chosen base paper for the experiment.
7. Defining the material's attributes.
8. Setting up the CFD analysis technique in the correct manner.
9. After the simulation has been completed, evaluate the findings.

3.2. Calculating the required length of the heat exchanger

The determination of the rate of mass flow of the hot fluid stream m_h) should be made with properly known Temperatures at outlet and inlet from equation: [10]

$$m_h = \rho_h \times v_{tube} \times A_{tube}$$

where the density of the hot fluid is signified by ρ_h, velocity of the fluid inside the tubes is signified byv_{tube} and cross sectional area of the tubes is signified by A_{tube}. Equation can then be brought in use for calculating the heat load (q) extracted from the hot fluid or acquired by the cold fluid.

$$q = mc_{ph}(T_{h,i} - T_{h,o}) = mc_{pc}(T_{c,i} - T_{c,o})$$

where T is the temperature and I and o are the intake and exit conditions, respectively. Following that, the shell design and tube bank layout were examined.

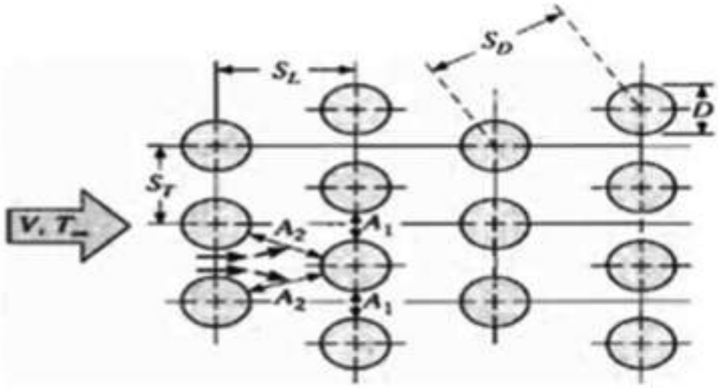

Figure 2: Staggered tube bank arrangement

3.3. Meshing

Meshing is a step in the engineering analysis method that uses breaking down complex geometries into simple parts which can be used as discrete local estimates to the wider domain. The mesh has an impact on the simulation's accuracy, resolution, and efficiency. [11] [12]

Table 1: Nodes and Element

Number of Nodes	242206
Number of element	720686

3.4. Boundary condition

- Water liquid is selected as fluid flow through both cold and hot fluid.
- For 3 different cases, different material is used for pipe:-
  - Steel
  - Copper
  - Aluminium
- 2.465 kg/s mass flow inlet is selected for cold inlet with inlet temperature of 20°C.
- 1.219 kg/s mass flow inlet is selected for hot inlet with inlet temperature of 100°C.

4. RESULTS AND DISCUSSION

4.1. A Case-1 Steel

The temperature at the hot outlet of the heat exchanger is shown in the below mentioned figure, that is 343.3K. In case 1, steel is used as the material for the pipe. There are two temperature ranges: the blue colour indicates the lowest and red colour indicates the highest.

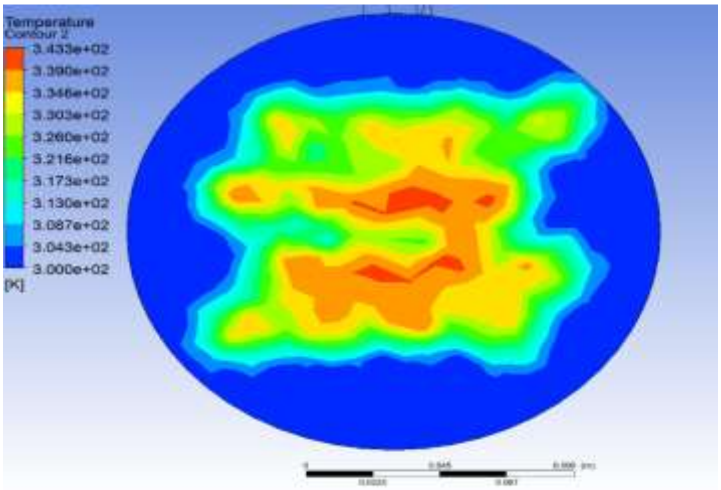

Figure 3: Case 1 hot outlet temperature

The temperature at the cold outlet of the heat exchanger is shown in the below mentioned figure, that is 307.6K. In case 1, steel is used as the material for the pipe. Blue represents the lowest temperature and red represents the highest temperature.

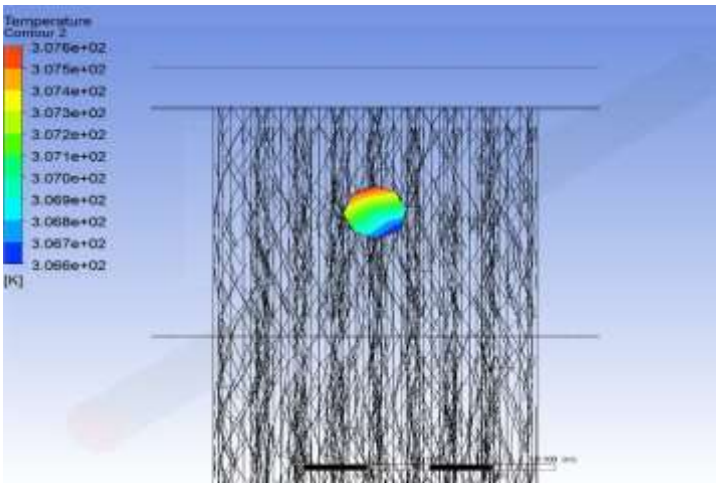

Figure 4: Case 1 cold outlet temperature

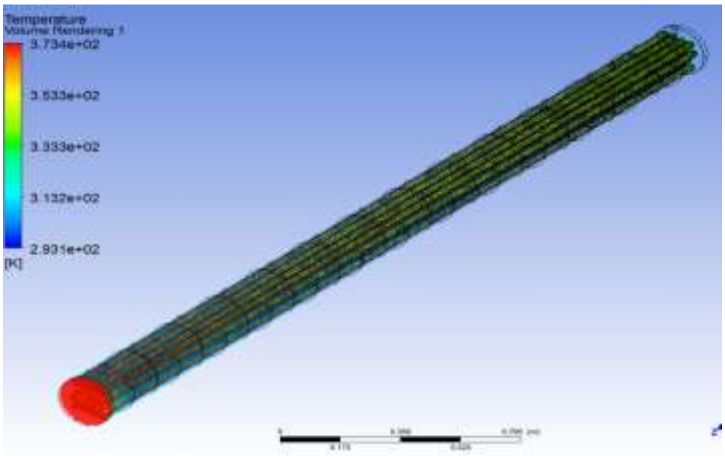

Figure 5: Case 1 temperature volume rendering

4.2. Case-2 Copper

The temperature at the hot outlet of the heat exchanger is shown in the below mentioned figure, that is 340.3K. In case 2, copper is used as the material for the pipe. Blue represents the lowest temperature and red represents the highest temperature possible.

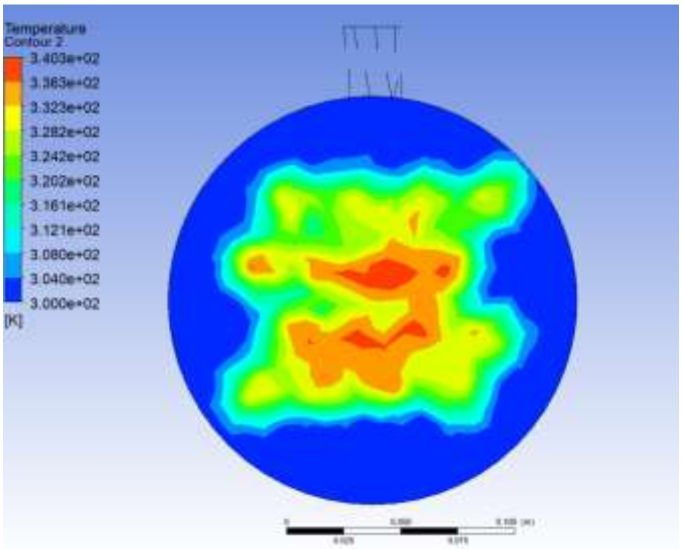

Figure 6: Case 2 hot outlet temperature

The temperature at the cold outlet of the heat exchanger is shown in the below mentioned figure, that is 309.1K. In case 2, copper is used as the material for the pipe. The blue colour represents the lowest temperature range, while the red colour represents the highest temperature range.

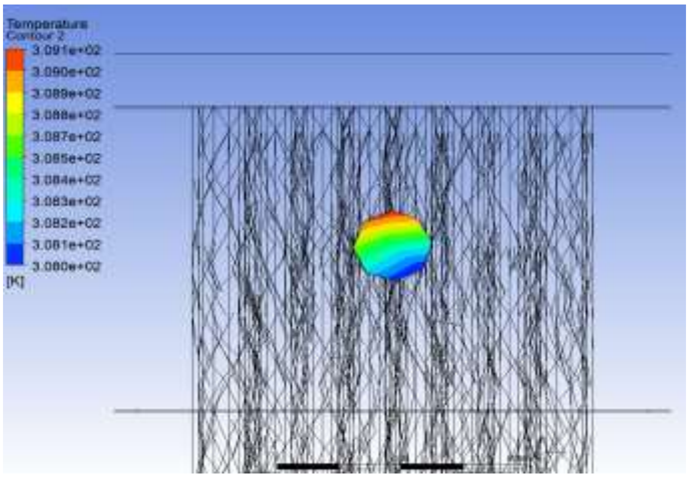

Figure 7: Case 2 cold outlet temperature

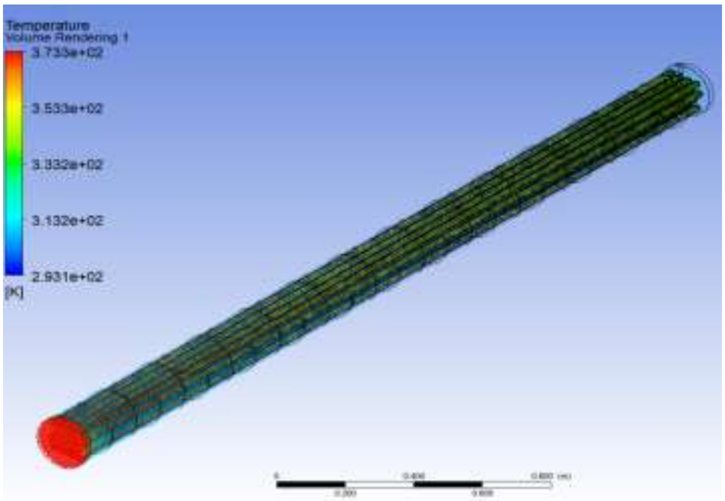

Figure 8: Case 2 temperature volume rendering

4.3. Case-3 Aluminium

The temperature at the hot outlet of the heat exchanger is shown in the below mentioned figure, that is 340.6K. In case 3, aluminium is used as the material for the pipe. There are two temperature ranges: the blue colour indicates the lowest and red colour indicates the highest.

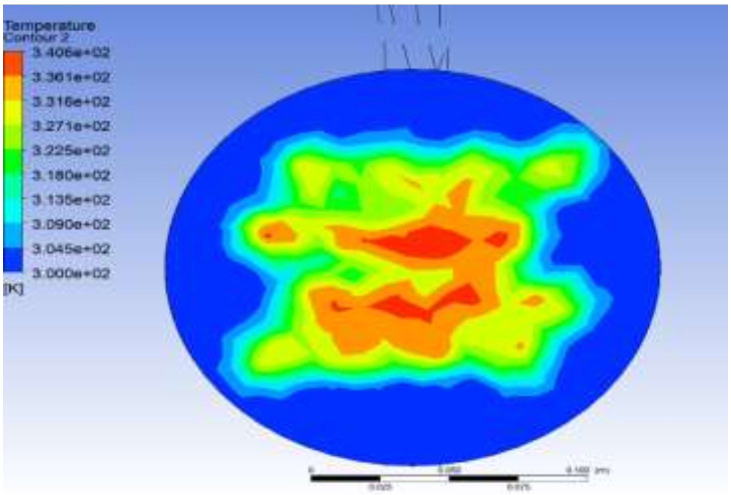

Figure 9: Case 3 hot outlet temperature

The temperature at the cold outlet of the heat exchanger is shown in the below mentioned figure, that is 309.0K. In case 3, aluminium is used as the material for the pipe. Blue represents the lowest temperature and red represents the highest temperature.

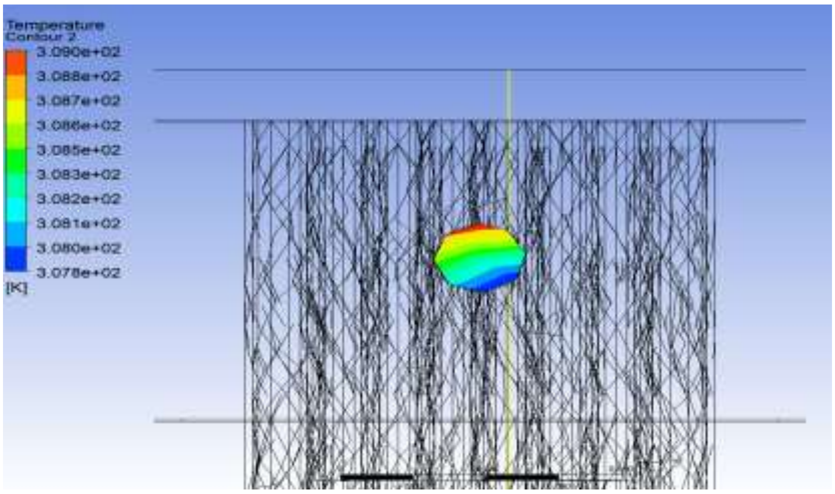

Figure 10: Case 3 cold outlet temperature

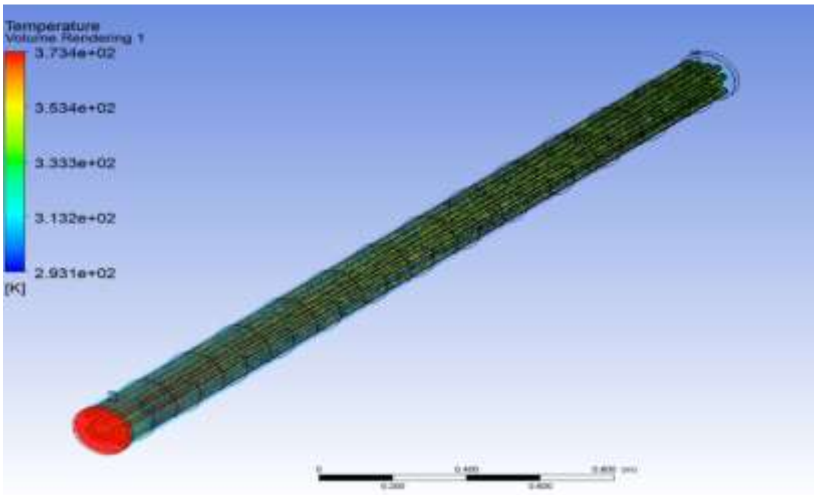

Figure 11: Case 3 temperature volume rendering

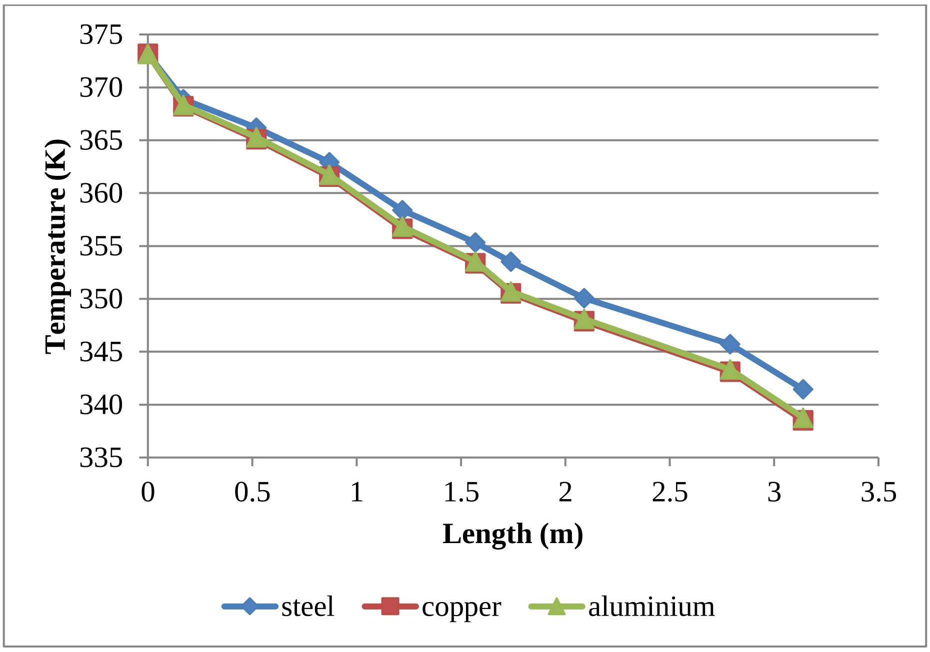

Figure 12: Hot tube temperature comparision graph

Table 2: Hot and cold outlet temperature

Condition	Inlet	steel	copper	aluminium
Cold Temperature(k)	293.15	307.041	308.415	308.276
Hot Temperature(k)	373.15	314.072	313.246	313.32

Table 3: Effectiveness

Case	Effectiveness
Steel	0.738
Copper	0.748
Aluminium	0.747

From the results, it can be concluded that copper is highly effective, and steel is least effective after comparing all three cases such as: steel, copper and aluminum. Overall, The findings obtained from this study exhibits a positive agreement among the CFD and the theoretical outcomes. In addition, it is observed that CFD is a very promising tool for designing compact heat exchangers through optimizing the performances When brought in use with use an appropriate theoretical validation.

5. **CONCLUSION**

Extensive applications of tube and shell heat exchangers in the industrial sector were found and taken as the key topic by numerous researchers to research on. For increasing performances of these heat exchangers, simulations were conducted with the help of ANSYS through using three different materials.

The findings of the study are as follows:

- Copper attained the cold and hot temperature of 308.415K and 313.246K respectively. Copper provided the best results among all the 3 materials on the basis of temperature.
- Steel, copper and aluminum showed effectiveness of 0.738, 0.748 and 0.747 respectively. This result showed that copper has the maximum effectiveness and steel has the lowest effectiveness.

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Recent Energy Trends in India

Umanand Kumar Singh[1*], Kushal Sharma[1]

[1]*Assistant Professor, Mechanical Engineering Department, Dr. A.P.J. Abdul Kalam UIT Jhabua*

Abstract

Today in the professional world energy consumption is the most important factor for a progressive and developed nation in the world. Presently India is the 3rd largest producer as well as consumer of power generation & one of the most powerful progressive nations in the world. Most of the countries in the world change their thinking in terms of power generation from conventional energy to renewable energy like Solar, Wind, Geothermal, Small Hydel power, etc. Recently in India, power generation from conventional types of energy like fossil fuel gradually decreased and power generation from renewable energy rapidly increased in the last few years. Now a day's every sector in India slowly increasing its dependency on renewable energy sources in concern of depleting conventional energy sources and protecting its climate.

Keywords: World Energy, Energy senerio, Natural Resources, Renewable Energy.

1. INTRODUCTION

India plays significant role in the global energy economy. Energy consumption has doubled since 2000, impelled upwards by a growing population earlier to be World's largest & a duration of quick economy growth. India's continued industrialization and urbanization will attain huge demands of its energy sector. Energy use on a per capita basis is well under half of the global average, & between rural and urban area. The affordability and reliability of energy supply are key concerns for India's consumers. The Covid-19 pandemic has disrupted use of energy due to lockdown in India so our energy consumption fall down of energy consumption in across the country. Now in India's energy uses rapidly growing in terms of renewable energy.[2]

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India ranks 2nd in terms of population (17% of the world) after China [5]. India is globally ranked 3rd in terms of installed capacity for power generation from renewable energy [1]. In this regard on 30th November 2015, at the 21st session of the United Nations Climate Change Conference of the Parties (COP-21) in Paris, France "**The International Solar Alliance"** (**ISA**)of 120 countries, initiated by India is formed, to achieve specific goals in terms solar energy utilization till 2030. Recently on 1st November 2021, at the 26th session of UN COP-26 in Glasgow, Scotland to reduce global emissions target that aligns with reaching the goal of net-zero by mid-century and achieve the 1.5^{o}C global warming limit [4].

1.1. India's Pledge for the Society: [4]

In COP-26,The prime minister of India gave the gift of '*Panchamrit*'to the World Community which includes:

(i) India will increase its non-fossil energy capacity to 500 GW by 2030.
(ii) India will fulfil 50 % of its energy consumption through renewable energy by 2030.
(iii) India will decrease net projected carbon emission by 1 billion tonsby 2030.
(iv) India will decreasethe carbon intensity of its economy by more than 45 % by 2030.
(v) India will become carbon neutral (net-zero carbon emission) by 2070.

1.2. Objectives for the utilization of Green Energy:

- Reduce the carbon footprint,
- Reduce the global warming gases,
- Accelerate the phase-out of coal,
- Curtail deforestation,
- Speed up the switch to electric vehicles,
- Protect and restore ecosystems,
- Stabilize the global energy crisis,
- Boost the public health,
- Become self-reliant in terms of power generation, etc.

2. Scope of Renewable Energy:

Presently India is 2nd populated country in the world after China but in terms of power production as well consumption it stands 3rd in the world after USA &China. The Population of India is increasing & will reach max in the world by 2026 [5].So to attain the above objectives along with the increasing energy demand, renewable energy resources has to be increased because of the following prospective reasons.

- Replacement of fossil fuels, Diesel, Petrol, etc.,

- Replacement of Conventional type of vehicles by Electric Vehicles,
- Requirement of huge amount of electric energy,
- Improve Climate conditions,
- Growing Indian Economy,
- To make self-reliant in energy production, etc.

3. Energy Scenario: [6,8]

- India Energy Outlook 2021 Report published by the International Energy Agency (IEA) says to explore the scope and challenges for the growing population of India as it seeks to assure reliable, affordable, and sustainable energy.
- India's energy consumption is expected to nearly double by 2040 as the nation's Gross Domestic Product (GDP) expands to an estimated USD 8.6 trillion.
- Before the global pandemic (COVID-19), India's energy demand was estimated to increase by almost 50% between 2019 and 2030.
- Total power generation capacity in India is 388.85 GW by 30 September 2021.

Table 1 Power generation in fossil fuel and non-fossil fuel

Power Generation	Fossil Fuel			Non-Fossil Fuel			Total
	Coal	Gas	Diesel	Hydro	Other Renewable	Nuclear	
In MW	208615	24900	510	46512	101533	6780	388850
In Percentage	53.65 %	6.4 %	0.13 %	12 %	26.1 %	1.74 %	100 %

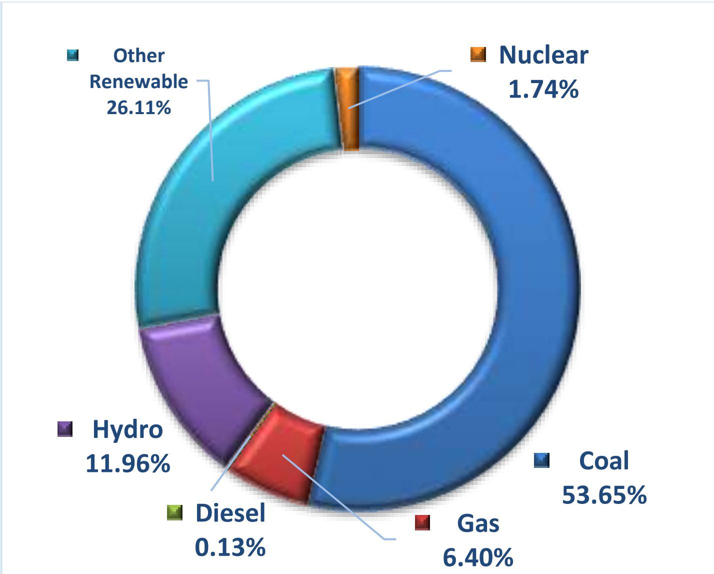

Figure 1. Electric energy production source

3.1. State-wise Power Generation from Renewable Energy Source: [9]

The maximum power generation state from renewable energy sources till June 2021 is Karnataka followed by Tamil Nādu while the Minimum power generated from renewable energy sources is by Lakshadweep followed by Dadar & Nagar Haveli.

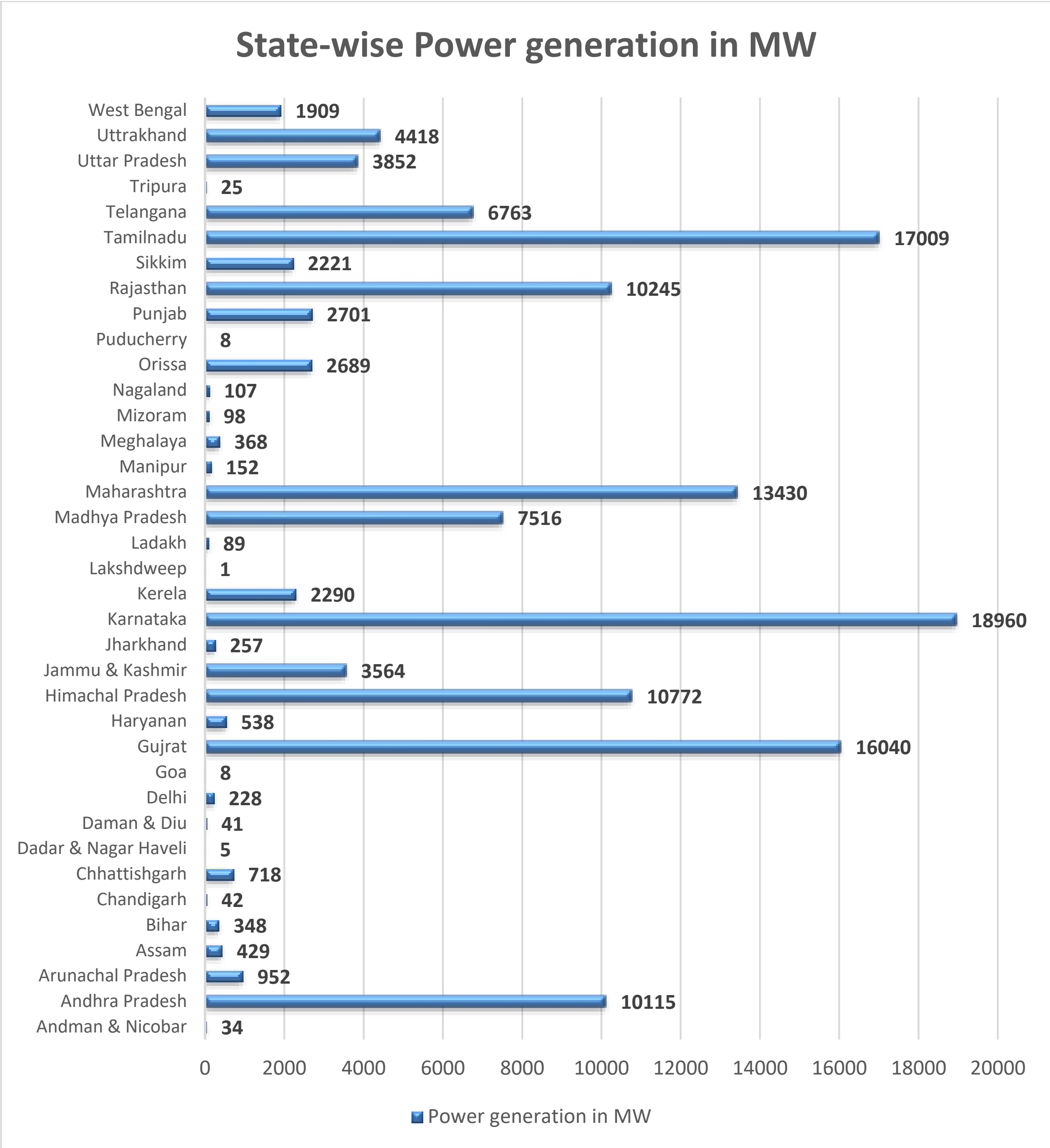

Figure 2. State wise power generation

Renewable Energy Growth: Power generation from Renewable Energy in India including hydel energy from December 1947 till March 2021 is given below. [7,8]

Table 2 Power generation Capacity in MW

S.No.	Year of Generation	Installed Generation Capacity in MW
1	31 Dec. 1947	508
2	31 Dec. 1950	560
3	31 March 1956	1061
4	31 March 1961	1917
5	31 March 1966	4124
6	31 March 1974	6966
7	31 March 1979	10833
8	31 March 1985	14460
9	31 March 1990	18307
10	31 March 1997	22560
11	31 March 2002	27897
12	31 March 2007	42414
13	31 March 2012	63493
14	31 March 2017	101138
15	31 March 2018	114315
16	31 March 2019	123040
17	31 March 2020	132427
18	31 March 2021	140642

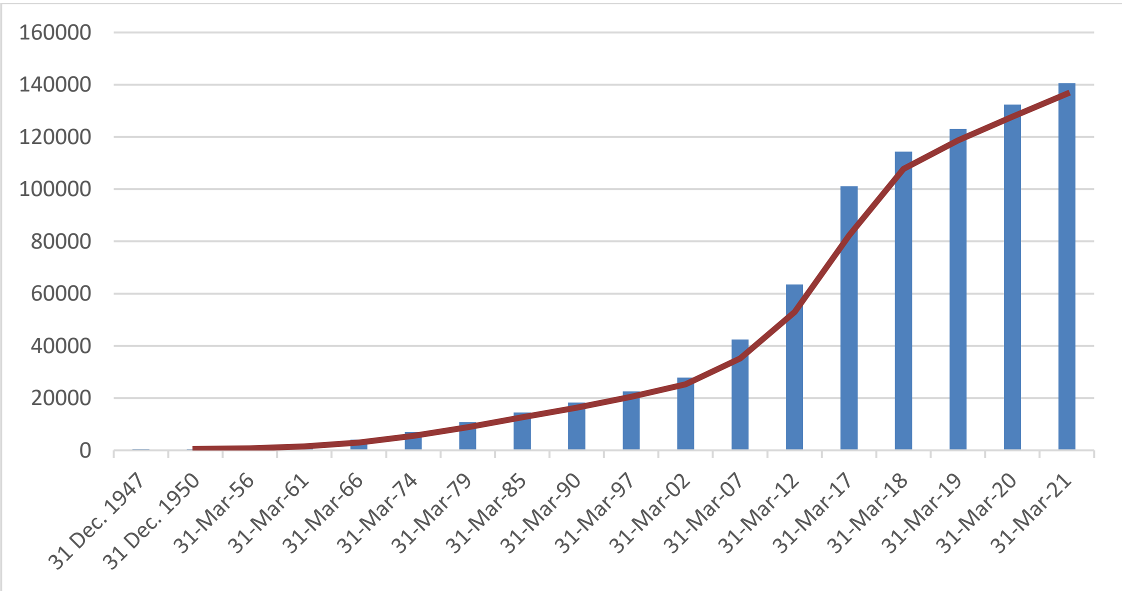

Figure 3. Growth of energy demand in India

Renewable energy scenario in the World: Till 2020, 29% of total energy production in the world is renewable energy (including Hydel power): [10]

Table 3 Source and their installed capacity

S.No.	Name of Source	Installed Capacity in GW
1	Hydropower	1211
2	Wind Energy	733
3	Solar Energy	714
4	Bio-energy	127
5	Geothermal Energy	14

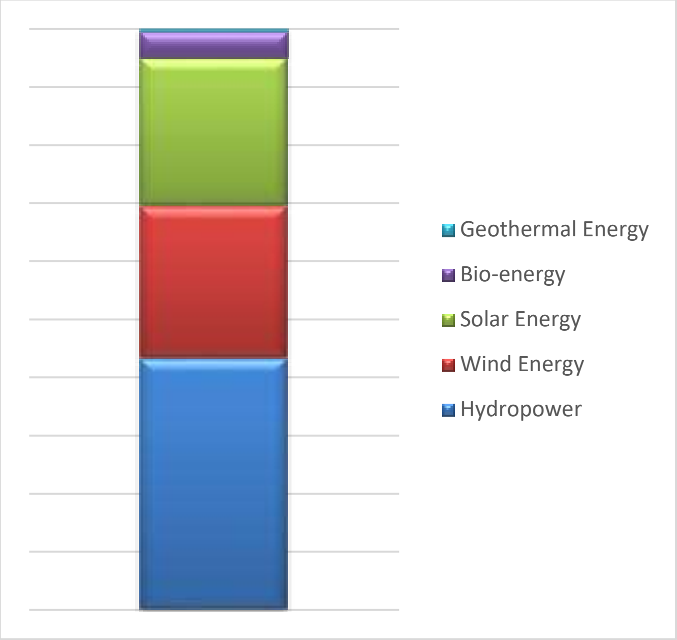

Figure 4. Uses of renewable energy

4. Greenhouse Gas Emission:

According to WRI CAIT, India’s GHG emissions increased by 2,060 MtCO2e (180%) from 1990 to 2014. Energy emissions grew by 1,563 MtCO2e (246 percent) between 1990 and 2014, according to WRI CAIT. According to statistics from the International Energy Agency, overall energy production increased fourfold between 1991 and 2014, with coal accounting for a growing percentage and hydropower accounting for a declining part. Coal produced 74% of the nation's power in 2014, followed by natural gas (5%) and hydro (11%), biofuels (2%), wind (3%), and nuclear (3%). As the third biggest power generator in the world, India has among of the lowest per-capita energy consumption rates. Industries use 42% of the power produced, followed by agriculture and forestry (15%), homes (26%), businesses and public institutions (10%), and other 1% each (8 percent). The number of industries more than doubled between 2000 and 2014, resulting in a 406% increase in industrial fuel use. [11]

Table 4 Gas emission in different sector

S.No.	Different Sector	Emission(MtCO2e) At FY2014	In Percentage
1.	Energy	2198.71	68.7
2.	Agriculture	626.86	19.6
3.	Industrial Process	193.19	6
4.	Deforestation	122.50	3.8
5.	Waste	61.05	1.9

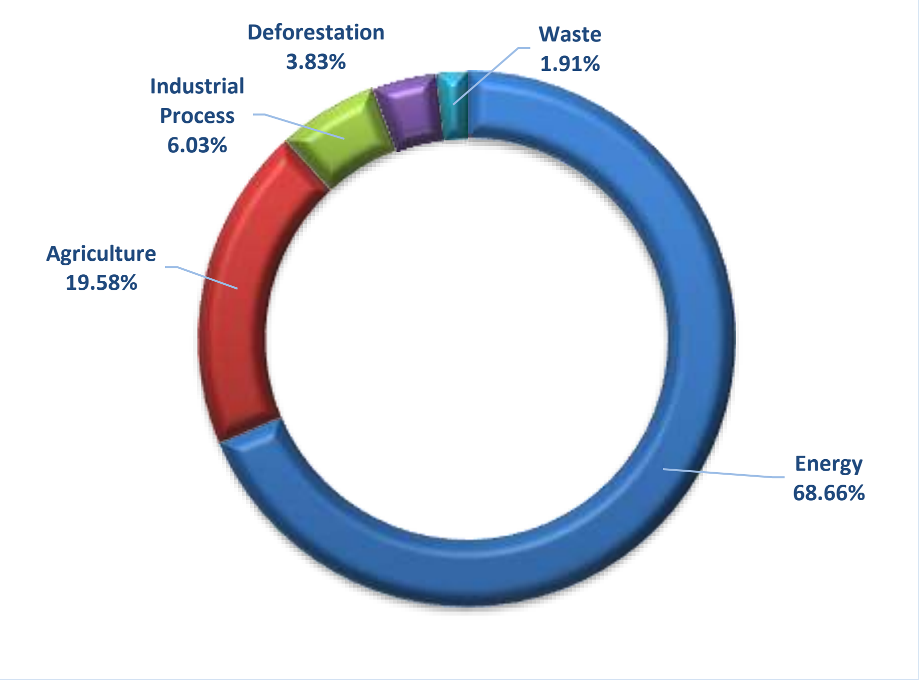

Figure 5. Greenhouse Gas emission in different sector

5. Emission related to Gross Domestic Product (GDP):

GDP in India grew by 357 percent between 1990 and 2014, according to WRI CAIT statistics. GHG emissions rose by 180 percent. In 2014, India released more GHGs per capita than any other country in the world. With that said, the Indian government has made major measures toward implementing a low carbon economy across multiple sectors and vowed in its Intended Nationally Determined Contribution (INDC) to cut GDP emissions intensity between 33 to 35 percent by 2030 from 2005 levels.[11]

Author thoughts: India is the most growing country in the field of renewable energy utilization in the world. It will be the great allies of self-reliant India to achieve the goal of one of the largest economies in the world.

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To analyze the Temperature distribution of Helical Fin Profile of engine through CFD investigation

Saurabh Bachakaiyan[1*]

[1]*Research Scholar, Department of Mechanical Engineering, Sagar Institute of Research and Technology, Bhopal*

Abstract

In order to convert the non-circular ducts into circular pipes, hydraulic diameter is used. This phrase, which refers to a circular tube, may be used to compute a variety of different things. The area of the cross-section and the perimeter of the wetted cross-section are represented by A and P in the equation below. 2D design is changed to 3D design for this study, and CFD results have been compared. Within the fins, water as well as ethylene glycol was also circulated, and also the effects were examined. As a result, the current study contributes to revealing and expanding the potential of helical fins with ethylene glycol in improving total heat exchanger performance while also lowering material costs for design engineers as well as manufactures

Keywords: CFD, internal combustion engine, FLUENT Software, helical fin.

1. INTRODUCTION

After the fuel has burnt up, there is additional heat created by the friction between the moving elements of the engines. Only around 30% to 35% of the energy released is actually used for labour. The remainder (65% to 70%) of the engine was removed to prevent the pieces from melting. Limited big vehicles employ water-cooling methods and virtually all two-bike engines use air-cooled engines, which have advantages such as reduced weight and a smaller space need, making them the sole choice

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for this purpose. While it's important to keep the heat generated during combustion in an internal combustion engine at a high level in order to improve its thermal efficiency, removing some of that heat is necessary in order to protect engine components from thermal damage. Fins, which are externally stretched surfaces, are used to enhance heat transmission in an air-cooled engine's cylinders. For IC engines, fins are a common method of cooling. The outer extended surfaces of the engine cylinder fins are designed to evacuate heat from the area. The quantity of heat transferred by an item is determined by its conduction, convection, and radiation properties.

1.1. Fins in engine

Conduction heat transmissions from inside and convection dissipation into an ambient at T are both supported by a temperature gradient in the x direction. Conduction and convection are the primary modes of energy transmission between a solid and its environment. [1]

$$Q = A_s(T_s - T_\infty)$$

Where h= convection heat transfer coefficient

A_s= Heat transfer area of the surface

There are only two ways to improve the "heat transfer coefficient" when the temperatures TS and T are fixed due to design considerations: (i) to increase the surface area, A ; (ii) to enhance the convection coefficient h. To improve heat transfer rates in situations when boosting h is either feasible or cost-effective, such as when building a pump or fan or replacing an existing fan with a bigger one, increasing the surface area may be used. [2]

1.2. Material used in fins

To achieve maximum heat transfer rates, the best material to choose is one with the highest thermal conductivity and sufficient thickness. Thermal resistance, corrosion resistance, as well as material weight all seems to be critical considerations, particularly at high temperatures. [3]

Aluminum alloy is the most often utilised material for fin production. Aluminum alloys 6063 and 7068 are now being used to replace the current aluminium alloys.

Table 1 Chemical composition of AL alloy

Element	**Weight %**
C	0.29
Mn	0.9
P	0.03
S	0.04
Si	0.15-0.30
Mo	0.45-0.60
Ni	0.05

1.3. Objectives of the Study

Both liquid and air cooled engines may be used to dissipate heat. Although liquid cooled engines are more complicated and need more area and control, air cooled engines are more often used in smaller vehicles because of these difficulties. The following are the goals of this research:

- CFD result will be validated with the selected base paper.
- The 2d design will be converted in 3d and the CFD result of both will be brought under comparison.
- The 3d design will be modified and fins design will be converted into spiral shape
- Water will be passed through the spiral fins.
- Water and ethylene glycol will be circulated inside the fins and both the result will be compared.

2. LITERATURE REVIEW

(Zargoushi et al., 2020) [4] ANSYS FLUENT is used in this work to construct a CFD model of a plate-fin heat exchanger in a gas refining firm to better understand transport phenomena, particularly phase change. The computational geometry takes into account the cold box's flow channels, ducts, and passages. As a result of an excessive rise in the number of computational grids in the numerical domain, the porous media approach is introduced in the computational domain. Analysis of chemical species in a cold box is done using a combination of CFD and flash calculations (FC). “Local thermal equilibrium (LTE-non mass), local thermal equilibrium (LTE) and local thermal non equilibrium (LTNE)” between the porous media and fluid flow with mass transfer are examined in the modelling of an industrial cold box in this research.

(Santosa et al., 2019) [5] CO_2 gas coolers' total heat transfer coefficients were studied using experiment and CFD simulations (CFD). For the total heat transfer coefficient, the CFD model predicted accuracy with a maximum error of 9 percent compared to CFD predictions. Experimental and computer modelling evidence suggests that optimizing the gas cooler circuit design may boost performance by up to 20% when comparing the two different types of gas coolers. 8 percent more heat is transferred through the gas cooler's fins when the first and second rows of tubes are sliced horizontally.

(Zhang et al., 2019) [6] The finned-tube CO_2 gas cooler is a critical component of a refrigeration system and so must be extensively examined. Computational Fluid Dynamics (CFD) models and simulations are used to forecast and analyse the CO_2 and air fluid velocity fields, temperature profiles, and heat transfer characteristics under various operating situations. Conventional empirical correlations can't reliably estimate the local heat transfer coefficients of both air and refrigerant. CFD modelling can. Based on a CFD model, this research examines various operational parameters on the heat transfer coefficients and temperature profiles of working fluids in a finned-tube CO_2 gas cooler.

(Effendi et al., 2018) [7] "Natural convection around hollow hybrid fin heat sinks" is the focus of this investigation. Hollow pin fins are concatenated with radially-placed plate fins in a staggered array in the HHFHS. A commercial CFD software tool was utilised to create 3-D computational thermal models, which were then correlated to forecast Nusselt numbers in the vicinity of HHFHSs.

(Lindqvist & Næss, 2018) [8] In this paper, a computational fluid dynamics model of helically wrapped fin tube bundles is presented and shown for its capacity to forecast thermal-hydraulic performance. For four distinct fin tube designs, two with plain fins and two with serrated fins, a consistent validation against experimental data is provided. With a maximum RMS error of 13.8 percent and 14.4 percent, the predicted heat transfer and pressure drop measurements are within or very near to the experimental uncertainty. When three fin efficiency models are evaluated using their predicted temperature distribution, it is shown that correction equations might be significantly incorrect for tall plain fins.

(Effendi & Kim, 2017) [9] Computational and experimental studies study the impact of orientation on the thermal performance of hybrid fin heat sinks (HFHSs) under natural convection. As an example of an HFHS, a hollow and solid hybrid fin heat sink is compared to a pin fin heat sink of the same size (PFHS). In the "hollow hybrid fin heat sink", perforations in the area of the fin bases are found in the staggered array of hollow pin fins merged with radially-oriented plate heat sinks. The solid hybrid fin heat sink is made up of a staggered array of solid pin fins and extruded radially-oriented plate fins. Using CFD models of the "HHFHS, the SHFHS, and the PFHS", we study the thermal performance implications of orientations ranging from zero to 180 degrees.

(Liu et al., 2017) [10] To construct a plate-fin heat exchanger for the hydraulic retarder, a theoretical optimization was performed. In order to increase the original heat exchanger's performance, CFD simulation and multi-objective optimization were used in conjunction. Multi-objective optimization was used to the optimizations of the friction factor f and Colburn factor j because of the competing goals. The form of the heat exchanger was optimized using the second generation "Non-Dominated Sorting Genetic Algorithm (NSGA-II)".

(S. Singh et al., 2017) [11] Thermal energy system design management is an important aspect of establishing fundamental designs that fulfil large-scale user demand under certain operational parameters. Thermal energy systems using fin and tube heat exchangers are becoming more popular, thanks in part to the increasing attention being paid to their design and development. A cost-effective operation may be achieved with enough performance data from various fin designs. It is the goal of this study to investigate three different fin patterns, namely rectangular, polynomial and sinusoidal, in a fin and tube heat exchanger. Fin and tube heat exchanger models with varied fin patterns are constructed to explore the fin pattern's effect on heat transfer and pressure loss data.

3. RESEARCH METHODOLOGY

3.1. Steps of working

- Design and modeling in CAD software according to the selected base paper.
- Further converting the CAD File in .step format for importing it in ANSYS Fluent work bench.
- Designating the name choice to the various parts.
- Meshing is used to carry out the simulation procedure.
- Creating appropriate boundary conditions based on the chosen base paper.
- Assigning the qualities of the material
- Creating the ideal environment for the CFD analysis technique.
- After the simulation work is completed, evaluating the outcomes.

3.2. Material properties

Table 2 Thermal properties of water

Properties	**Value**
Thermal conductivity($Wm^{-1}K^{-1}$)	0.6
Density (Kg/m^3)	998.2
Specific heat(J/KgK)	4182

Table 3 Thermal properties of ethylene glycol

Properties	**Value**
Thermal conductivity($Wm^{-1}K^{-1}$)	0.252
Density (Kg/m^3)	1111.4
Specific heat(J/KgK)	2415

Table 4 Thermal properties of aluminum

Properties	**Value**
Thermal conductivity($Wm^{-1}K^{-1}$)	202.4
Density (Kg/m^3)	2719
Specific heat(J/KgK)	871

Table 5 Number of cases

Case-1	Validation 2d design
Case-2	3D design
Case-3	Spiral fins, solid
Case-4	Spiral hollow fins with water flowing through it
Case-5	Spiral hollow fins with ethylene glycol flowing through it

3.3. Model design

The fin has a rectangular shape with a length of 26 mm, a width of 65 mm, and a thickness of 3 mm.

Table 6 Dimensional specifications of IC engine

Engine Specifications	**Dimensions(m)**
outer diameter	0.062
bore diameter	0.050
thickness	0.006
No of fins	8
Length of fins	0.026
thickness of the fins	0.003
Pitch length b/w fins	0.004

3.4. Meshing

“Computer-aided engineering (CAE)” is a simulation method in which meshing is a key component. The precision, convergence, and speed of the solution are all affected by the mesh. As a consequence, the time it takes to produce a mesh model is often a significant percentage of the time it takes to get CAE results back. It follows that improved meshing tools and automated meshing methods lead to a better solution.

3.5. Boundary condition

- “Constant and homogeneous convective heat transfer coefficient over the entire fin surface (Taken as 30 W/m^2 K)”
- Expansion process is selected for analysis
- Engine inside temperature is taken as 1387.34 °C.
- Steady state condition is selected
- Radiation from the fin surface is negligible
- Ambient temperature is 27°C.
- For hollow fins cases velocity inlet condition is taken with 0.5 m/s velocity.
- Outlet is taken as constant pressure outlet.

4. RESULTS AND DISCUSSION

Calculated results are used to estimate heat transfer coefficients for different configurations based on Newton's cooling law using numerical temperature field computations Initial conditions, such as input temperatures and mass flow rates of the working fluids, are assumed to be the same for all simulations, regardless of fin spacing. Afterwards, the results are studied and evaluated in terms of the process phases.

4.1. Case-1 Validation 2d design

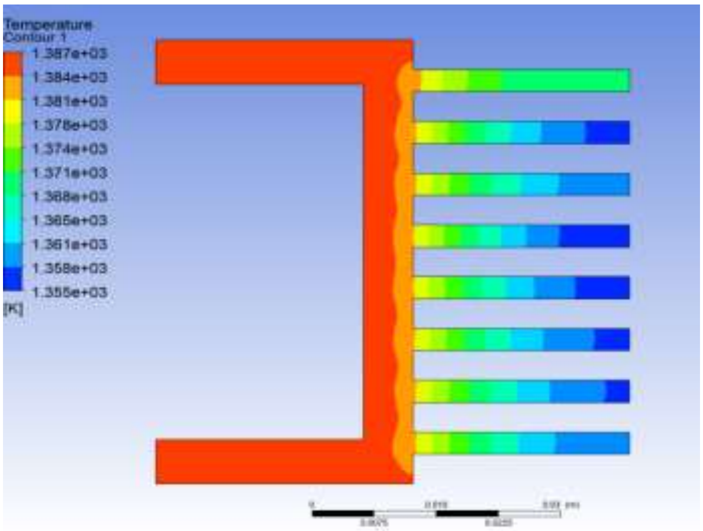

Figure 1: Temperature variation at surface

Above figure shows variation of temperature in engine because of fins. And the maximum and minimum temperature is 1387 and 1355 K respectively.

3D design

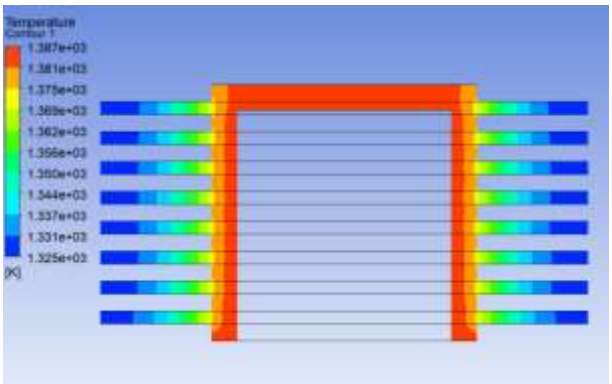

Figure 2: temperature variation at mid plane

4.2. Spiral fins, solid

Shape of fins are modified in spiral shape and the variation in temperature is shown in below figure. Here maximum and minimum temperature is found 1387 and 1318 K respectively. As it shows the lower temperature is less as compare to the above design results which shows spiral shape is better in heat transfer rate.

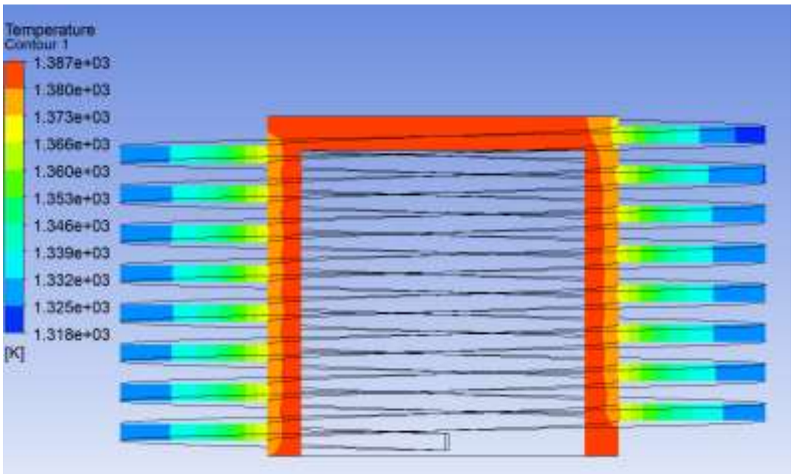

Figure 3: Temperature variation at mid plane

4.3. Spiral hollow fins with water flowing through it

For better cooling of engine through fins, fins are modified in spiral shape and water is flowed through them, in which water can absorb heat. Below figure shows variation in temperature in case of hollow fins with water flowing through it, and the maximum and minimum temperature is found 1387 and 301.6 K respectively.

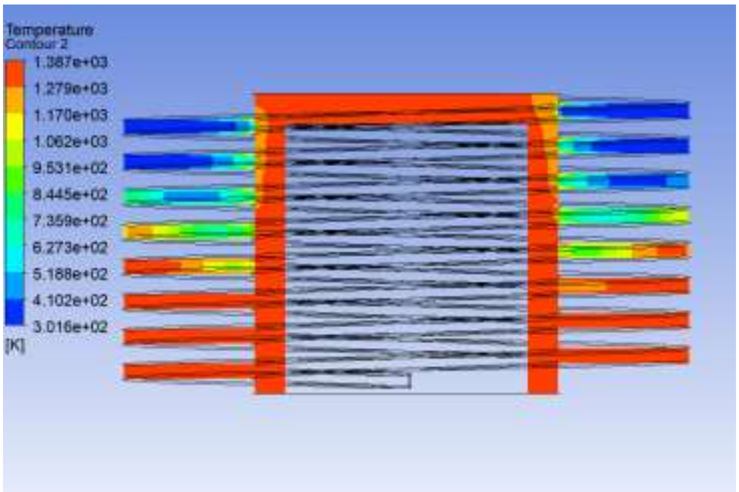

Figure 4: temperature variation at mid plane

Figure 5 shows velocity of flow of water through fins. Water is flowing from upward to downwards direction so the heat absorption rate of water will be high at the top of engine. As it shows water is flowing linearly with almost constant velocity.

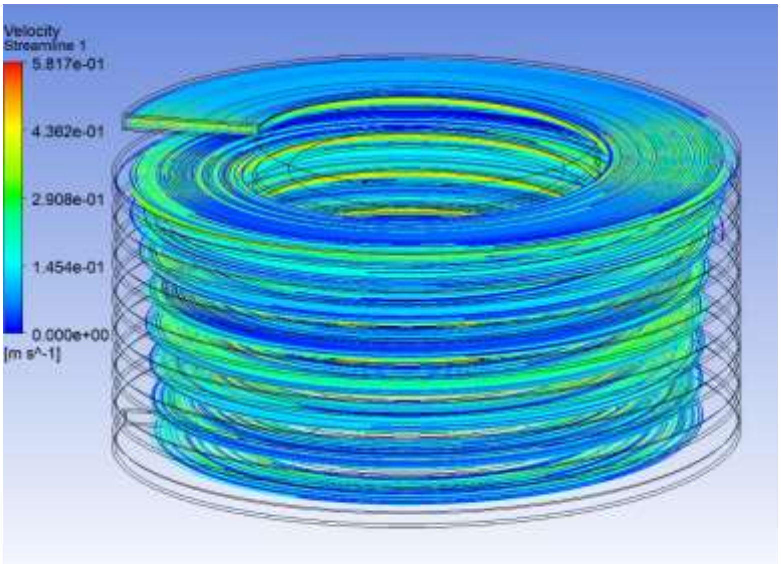

Figure 5: velocity flow of water

4.4. Spiral hollow fins with ethylene glycol flowing through it

Figure 6 shows variation in temperature at mid plane of engine having hollow fins with flowing ethylene glycol inside them. Maximum and minimum temperature is found 1387 and 308.2 K respectively.

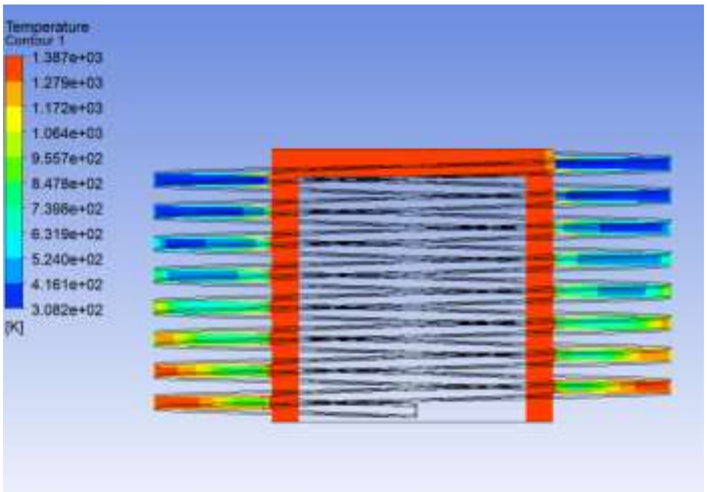

Figure 6: temperature variation at mid plane

Figure 7 shows velocity of flow of water through fins. Ethylene glycol is flowing from upward to downwards direction so the heat absorption rate of ethylene glycol will be high at the top of engine. As it shows water is flowing linearly with almost constant velocity.

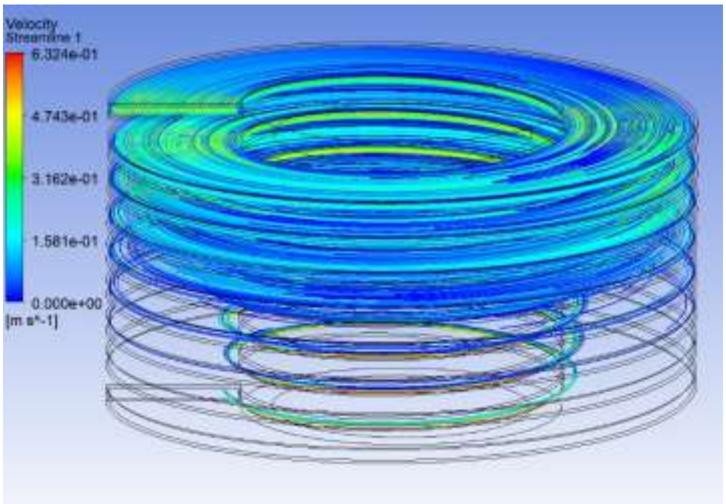

Figure 7: velocity flow of ethylene glycol

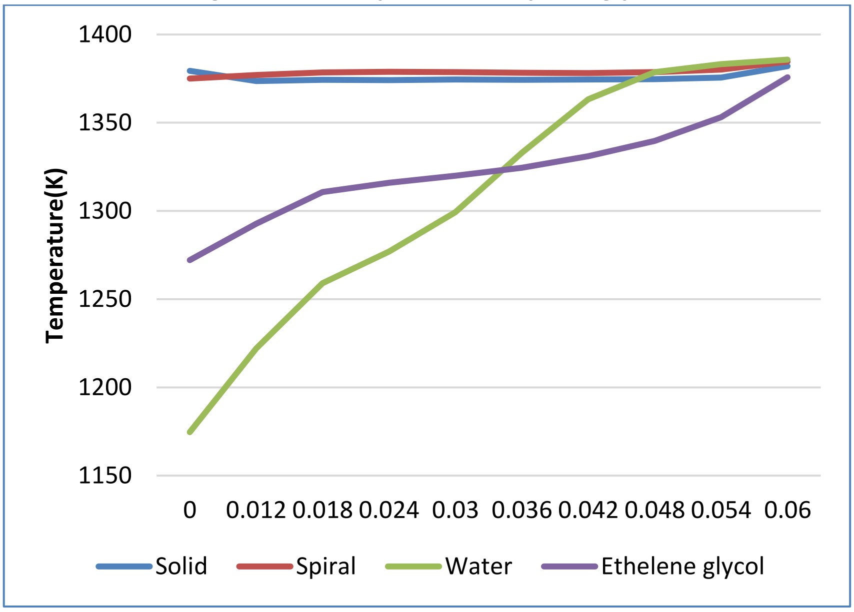

Figure 8: Line graph in all cases with respect to temperature

Above figure shows graph of temperature with respect to vertical length of engine. A line is selected near the fins inside the engine and the variation of temperature is noted down in all the cases at same location which can be seen in above figure. Fins having hollow design with flowing of fluid perform better as compare to solid fins. And ethylene glycol keeps the temperature of engine much lower as compare to all other cases.

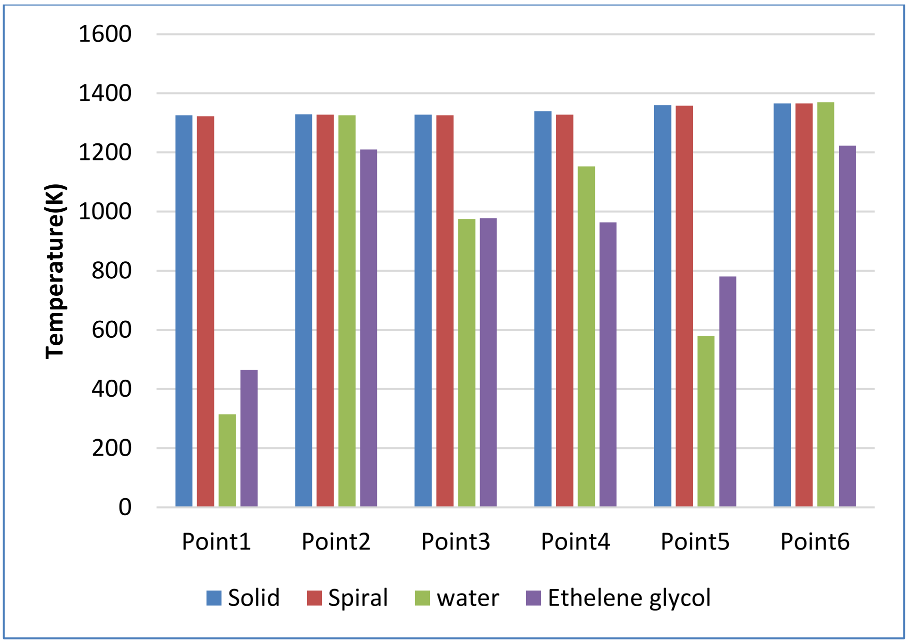

Figure 10: velocity flow of ethylene glycol

6 points are selected inside the fins and the temperature is noted at these points in all 4 cases which can be seen in above mentioned figure. As the figure shows, fins having solid design show almost same results at all the points whether it's simple solid or spiral solid. But fins having hollow shape with flow of fluid through them keep the temperature cool. Lowest temperature is observed in case of hollow fins having ethylene glycol flowing through it.

5. CONCLUSION

The space, maintenance, and high cost of a liquid-cooled engine are all taken into account in this analysis. The results of water and ethylene glycol are compared in the present study. After comparing the results, it was observed that water and ethylene glycol shows better results in comparison with solid and spiral geometry. After selecting the six different points, it can be concluded that water and ethylene glycol are showing better results and among them, ethylene glycol absorbs more heat and shows excellent results.

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ANALYSIS OF TUNED LIQUID DAMPER IN CONTROLLING EARTHQUAKE RESPONSE OF MULTISTOREY BUILDING

Rahamat Ali Ansari[1*]

[1]*Research scholar, Department of civil engineering, VEC, Ambikapur*

Abstract

Most buildings were constructed in the past with various laws depending on which nation you were in, thus retrofitting is required nowadays. New kinds of structures and uses are emerging, and rules are being revised at the same time. This means that the traditional techniques of constructing earthquake-resistant buildings may not be as effective as they once were. This paper aims to provide a comprehensive review on the most common triggering factors of progressive collapse of RC structures such as blast, fire, earthquake, gas explosion, etc. Different zones are studied and compared here.

Keywords: building collapse, post-disaster management, earthquake.

1. INTRODUCTION

Earthquakes are a major concern because of the devastation they cause, including the breakdown and collapse of structures, the loss of human life, and the destruction of property. Earthquakes can have significant economic consequences, such as the destruction of constructed structures and the resulting recovery expenses for those structures and infrastructure that are destroyed. Figures 1.1 and 1.2 show the damage earthquakes do to buildings.

Studies on buildings' seismic resistance have been conducted all through the years, and the results show that structures that do not meet the criteria of sustainable structures in seismic resistant design

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suffer harm. Because of this, rules and standards have been established to enhance structures' ductility and stiffness in order to withstand earthquakes. In earthquake-prone areas, seismic design rules and methods of analysis are used in the design and construction of structures and civil engineering projects. [1]

Most buildings were constructed in the past with various laws depending on which nation you were in, thus retrofitting is required nowadays. New kinds of structures and uses are emerging, and rules are being revised at the same time. This means that the traditional techniques of constructing earthquake-resistant buildings may not be as effective as they once were. Furthermore, the frequency and intensity of earthquakes may change over time due to changes in the ground's shape and climate. As a result, the knowledge a nation has on earthquakes may vary, and engineers will need to design buildings that are more efficient to meet the existing standards.

1.1. Multi storey building

It is a 3d or light weight steel structure with a large number of storeys and vertical circulation through elevators and stairways that is called a multi-storey building. Buildings of different heights have been designed using a variety of methods, each based on the results of early study and verification. A multi-story structure is often used to house a hospital, a shopping centre, or a complex of apartments.

Using high-level pre-fabrication materials, precise design, highest quality checks, and risk-free construction, multistory buildings are an ideal commercial building option because of their quicker construction speed than other traditional structures.

Figure 1: the structure of multi storey building

Multi-storey building construction is reliant on a variety of factors, including the accessibility of building materials, construction techniques, including building services, like elevators. People in ancient Rome utilised wood to construct multi-story buildings throughout the city-state. When Nero was constructing new structures following the Great Fire of Rome, he made use of brick and a concrete-like substance. Wood was a weak construction material for structures with greater than five storeys, and it was also a fire danger. However, brick and stone structures took up a lot of room due to the sheer size of their walls. The creation of high strength & structurally more efficient materials like wrought iron & later steel was a technological response to the limitations of traditional building materials. Hotel Oberoi Sheraton, India's tallest skyscraper is 35 stories high and made of reinforced concrete (116 m). Despite the fact that India has built many multi-story structures in the past two decades, tall building technology, especially in structural steel, is still in its infancy in the country.

2. LITERATURE REVIEW

(Ishak, Hamid and Amin, 2021) [2] Earthquakes may damage buildings in various ways, resulting in building collapses and the deaths of people. Reduce structural reaction by introducing a damping system to buildings, which gradually reduces system energy until all vibration is removed and the system is brought to rest. This is one method of reducing structural response. While there are numerous techniques to choose from these days, passive control systems have an advantage in terms of cost, especially in Malaysia where earthquakes aren't as common as they are in Japan. However, existing water tanks can be tuned to function as passive dampers if necessary, so long as the situation calls for it. Utilizing SAP2000, the goal of this study is to examine the feasibility of using numerous water tanks as a passive Multiple Tuned Liquid Damper and determine the optimum location for water tanks to decrease the structure's peak reaction to seismic forces.

(Konar and Ghosh, 2021) [3] The efficacy of tuned liquid dampers (TLDs) has been shown, however liquid storage tanks with poor inherent damping, such as those found in deep wells, are seldom used for vibration control of laterally-excited structures. In addition, when the liquid level fluctuates in these tanks, the fundamental sloshing frequency changes which resulting into detuning. We suggest a new TLD with floating base to address these issues, which maintains a constant and shallow liquid level between the free liquid surface and the floating base in order to solve these issues.

(Ubair Gull Khan, 2020) [4] There have been many elevated structures constructed throughout the globe, and the total keeps growing. Instead than being concerned about dense populations in cities, commercial districts, and the need for more room to develop landmarks, this is a result of space constraints. Because the seismic load following a structure is a part of the structure's own load, these structures are built light and adaptable with a fairly low common damping, and so as a result, the structures become more wind and tremor vibration inclined. Tall buildings need many plan modifications to ensure efficient execution, ranging from optional fundamental frameworks to the employment of passive and active control devices. An overview of cutting-edge methods to reduce the fundamental response of tall buildings is presented in this article, including a discussion of seismic tremor and wind-initiated movement of structures and dampening devices for moderating them.

(Gowda, N and Sindgi, 2020) [5] Current trends in the construction sector call for buildings that are both higher and lighter, as well as more flexible and with a lower damping value. This raises the risk of disappointing results, as well as posing problems from the standpoint of utility. There are now a few processes available to restrict the structure's vibration, and the concept of using TLD is the most up-to-date one of the few vibration control techniques available today. “Tuned Liquid Dampers (TLD)” are being investigated for their potential to reduce seismic vibration in buildings that are subjected to horizontal stimulation.

(Tanveer et al., 2019) [6] Vibrations in buildings caused by wind or earthquakes may be reduced using a TLCBD (tuned liquid column ball damper). The above modified tuned liquid column damper is known as a TLCD. A four-storey steel frame building is examined in this article to see how TLCBD affects it. The TLCBD's performance is also compared to that of a traditional TLCD. Both the TLCD and the TLCBD analytical models are given here. Testing the efficacy of these mathematical models on a shaking table with various excitation levels, including harmonic loadings and seismic excitations, is a good way to find out. The use of a steel ball as a moving orifice in TLCBD reduces vibration considerably as compared to TLCD.

(Rana, Bista and Sunagar, 2018) [7] Through the use of "horizontal sinusoidal stimulation and tuned liquid dampers (TLD)", this research will test the efficacy of these dampers in minimising seismic vibration in buildings. An excitation reduces a structure's dynamic response by using a water-confined container, which may be thought of as an enormous water tank. This research proposes a process for creating a building's TLD and a way for simulating the TLD in SAP2000 software. After then, many studies were performed to determine the impact of various TLD factors that may have an impact on the software's performance.

3. METHODOLOGY

3.1. Flow Chart of the study

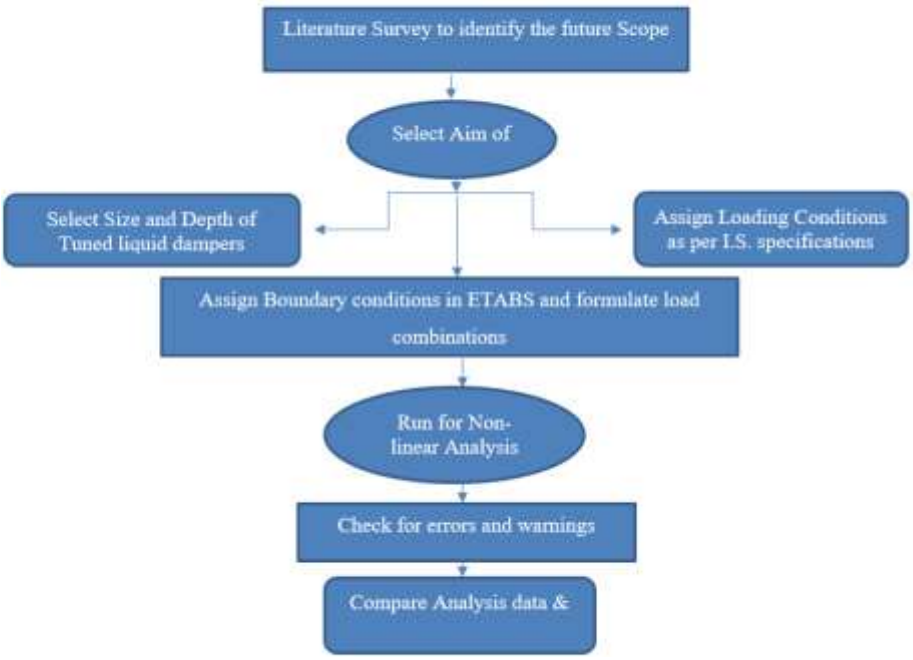

Figure 2: Flow chart of the study

4. RESULTS AND DISCUSSION

This chapter describe software analysis results and discussion from above analysis of modeling of general structure and tuned liquid damper (TLD) structure using ETABS software in zone III & zone V. We observed the following results:

4.1. Comparative Results and Discussion:

Comparison between general structure and TLD structure in Zone III & V

- Maximum Shear Force in Zone III & V
- Maximum Axial Force in Zone III & V
- Maximum Story displacement in Zone III
- Maximum Story displacement in zone V
- Plate Stresses in TLD structure
- Plate Stresses in general structure

4.2. Maximum Shear Force:

Table 1: Max. Shear Force

Zone	General structure	TLD structure
III	490.34	443.2
V	877.4	794.55

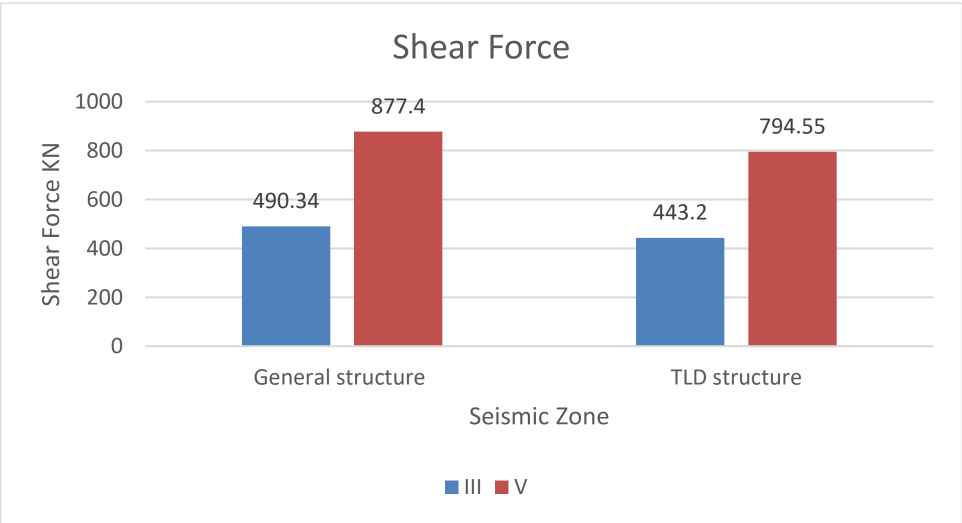

Fig 3: Max. Shear Force

Discussion:

Unbalanced forces generally develop due to rigidity in joints which cause un-proper distribution of load, In fig 6.1 it has been observed that TLD steel structures are distributing lateral and vertical loads properly which cause low unbalance forces at the joints.

4.3. Maximum Axial Force:

Table 2: Max. Axial Force

Zone	General structure	TLD structure
III	1076.5	1021.05
V	1013.21	1063.22

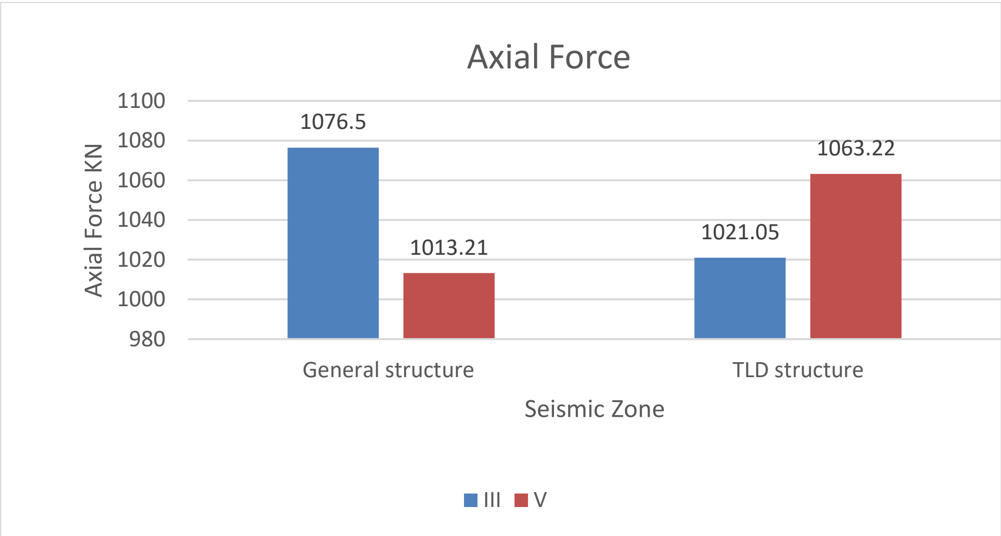

Fig 4: Max. Axial Force

Inferences:

Axial forces are the vertical distribution of forces in column to distribute the building “load to the footing”. In this study ISMB 200 section is considered as structural members with the help of liquid dampers it is become more convenient for “individual column to distribute the load properly to the footing”.

4.4. Storey Displacement in Zone III:

Table 3: Storey displacement in zone III (MM)

S.NO.	Storey displacement in Zone III	
	Conventional	TLD
10 STOREY	31.045	18.351
9 STOREY	28.21	16.44
8 STOREY	25.307	14.537
7 STOREY	22.358	12.647
6 STOREY	19.379	10.788
5 STOREY	16.387	8.969
4 STOREY	13.396	7.225
3 STOREY	10.42	5.59
2 STOREY	7.472	4.075
1 STOREY	4.571	2.706
GF	1.809	1.512
BASE	0	0

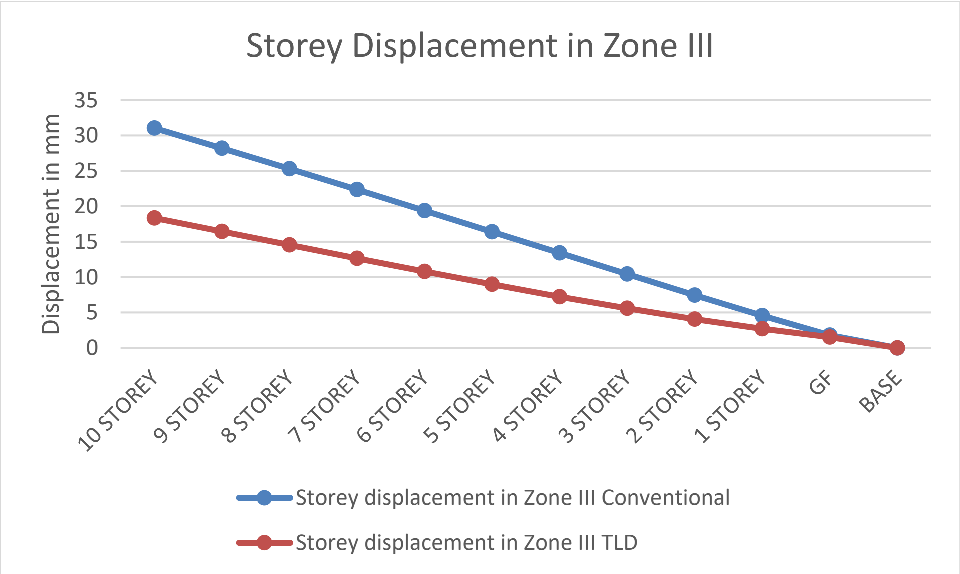

Fig 5: Storey Displacement in Zone III

Inferences:

As observed on Above fig 6.3 it can be said that displacement is comparatively less in TLD steel structure due to its stiffness and stability to resist the structure in lateral pressure.

4.5. Max. Storey Displacement in Zone V:

Table 4: Storey displacement in zone V (MM)

S.NO.	Storey displacement in Zone V	
	Conventional	TLD
10 STOREY	69.852	43.594
9 STOREY	63.471	38.927
8 STOREY	56.941	34.294
7 STOREY	50.305	29.725
6 STOREY	43.603	25.276
5 STOREY	36.87	20.967
4 STOREY	30.141	16.848
3 STOREY	23.445	12.98
2 STOREY	16.811	9.44
1 STOREY	10.285	6.393
GF	4.071	3.966
BASE	0	0

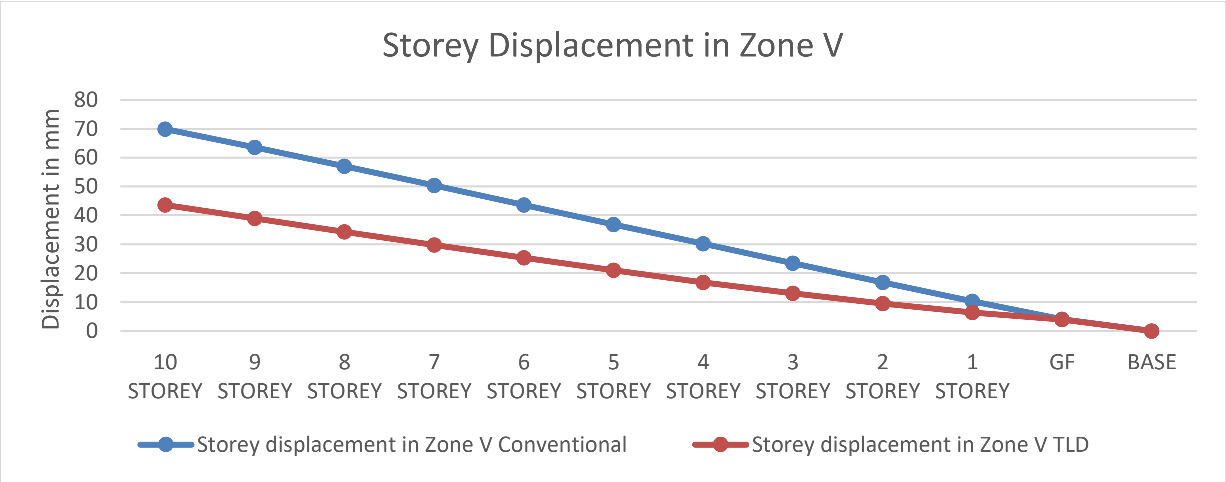

Fig 6: Storey Displacement in zone V

Inferences:

As shown in fig 5.4: It can be said that with the help of TLD one can resist the structure from lateral failure by 37.4 % which is necessary for the structure to be in its permissible limit.

4.6. Plate Stresses:

Table 5: TLD Structure

Plate	SQX N/mm2	SQY N/mm2	MX kNm/m	MY kNm/m	MXY kNm/m	SX N/mm2	SY N/mm2	SXY N/mm2
1	6.45	-4.56	-380.34	-1903	1290.46	0.054	0.98	1.23
2	6.2	-2.58	-290.58	-1045.6	1589.03	-0.76	0.43	0.87
3	5.95	-0.6	-200.82	-188.29	1887.6	-1.574	-0.12	0.51
4	5.7	1.38	-111.06	669.05	2186.17	-2.388	-0.67	0.15
5	5.45	3.36	-21.3	-103.98	2484.74	-3.202	-1.22	-0.21
6	5.2	5.34	68.46	7.6	2783.31	-4.016	-1.77	-0.57
7	4.95	7.32	158.22	119.18	3081.88	-4.83	-2.32	-0.93
8	4.7	9.3	247.98	230.76	3380.45	-5.644	-2.87	2
9	4.45	11.28	337.74	342.34	3.43	-6.458	-3.42	0.027

Table 6: General structure

Plate	SQX N/mm2	SQY N/mm2	MX kNm/m	MY kNm/m	MXY kNm/m	SX N/mm2	SY N/mm2	SXY N/mm2
1	7.66	-5.77	-381.55	-1904.2	1289.25	-1.156	-0.23	2.44
2	7.18	-3.56	-291.56	-1046.6	1588.05	-1.74	-0.55	1.85
3	6.7	-1.35	-201.57	-189.04	1886.85	-2.324	-0.87	1.26
4	6.22	0.86	-111.58	668.53	2185.65	-2.908	-1.19	0.67
5	5.77	3.04	-21.62	-104.3	2484.42	-3.522	-1.54	0.11
6	5.65	4.89	68.01	7.15	2782.86	-4.466	-2.22	-0.12
7	5.53	6.74	157.64	118.6	3081.3	-5.41	-2.9	-0.35
8	5.41	8.59	247.27	230.05	3379.74	-6.354	-3.58	2.71
9	4.45	11.28	337.74	342.34	3.43	-6.458	-3.42	0.027

4.7. Cost Analysis in zone III and V

Table 7: Cost Analysis

Case	**Quantity (Kg)**	**S.O.R. Rate/Kg**	**Total Cost (Rs)**
General Structure Zone III	142800.67	48	6854432.16
TLD Structure Zone III	134220.21	48	6442570.08
General Structure Zone V	157004.00	48	7536192.00
TLD Structure Zone V	146000.54	48	7008025.92

Inferences:

As shown in table 5.2.6 it can be said that TLD structure is cost effective than general structure in both the seismic zone (III & V) with cost reduction of 8%.

5. CONCLUSION

In an earthquake disaster hundreds and thousands of buildings may collapse at the same time. The weaknesses of the existing disaster management structure to provide emergency response in such a disaster are pointed out. Some measures are suggested to strengthen the post-disaster management system in the country for facing an earthquake disaster.

Other damage indicators from the damaging earthquake, such as peak story drift and peak residual drift, did not correlate strongly with the change in collapse risk. However, the full distribution of story drifts and residual drifts offer the potential to use the drift profiles to help identify damage and potentially inform the building safety assessment. This suggests opportunities to utilize post-earthquake analyses and/or dense (multi-floor) building instrumentation to enable more reliable assessments of building safety as related to decisions about building repairs, re-occupancy, and safety cordons.

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A study on the Effect of Cooling Capacity in Capillary Ceiling Radiant Cooling Panel by using different Shape Pipe Design & Parameters

Vikas Kumar Patle[1*]

[1]*Research scholar, Department of Mechanical Engineering, Truba Institute of Engineering and Information Technology, Bhopal*

Abstract

In order to obtain surface temperature distributions and cooling capabilities, a computational fluid dynamics (CFD) simulation was carried out on the heat transfer of chilled water flow in the capillary of the ceiling radiant cooling panel. Capillary radiant panel circumstances and heat transfer performance were complicated by six elements, including chilled water intake parameters, gypsum plaster conditions, and capillary matting structural characteristics. Temperature profiles on ceiling panels may be evaluated using an index of temperature non-uniformity coefficient. The results of the simulation were compared with temperature variation and hydraulic power is calculated in terms of pressure in all 4 cases which are defined in form of different shapes of pipes and variation in gap between each pipe. Pipe having spiral shape with 20 mm spacing between each spirals have the best heat absorptions rate and this design obtain lowest temperature in ceiling which is 17.593.

Keywords: Radiant cooling, Ceiling design, Heat transfer, Pipe arrangements, Ceiling material, CFD, ANSYS, floor heating/cooling, spiral tube.

1. INTRODUCTION

The Residential heating applications basically contains tubes or electrical elements which are embedded in surfaces or ceilings. Figure explains the classic construction of subfloor, the pipes which

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are embedded in concrete or gypsum. On the top of the rafters (beams) pipes are installed. By accumulating metal heat transfer plates, heat diffusion as well as surface temperature can be enhanced and regulated which extended the heat underneath the finishing material. [1]

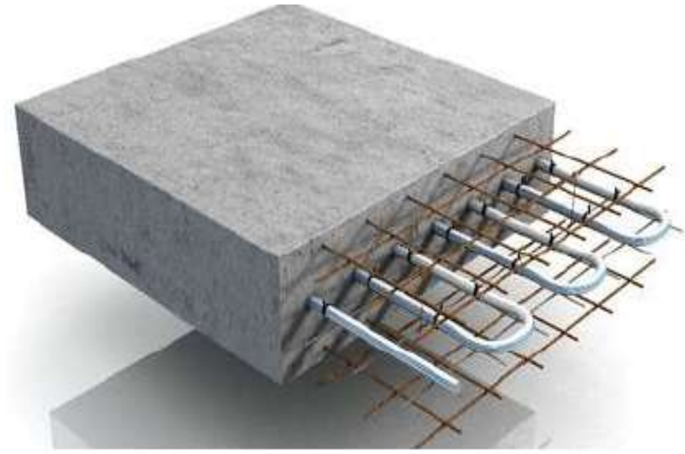

Figure 1: Embedded Pipes in concrete

To save the prospective energy as well as to improve thermal relief (constant cooling and heating supply) Radiant floor heating systems (RFH) is used, due to this RFH become popular. There are many benefits of Radiant floor heating systems (RFH). To increase the energy efficiency the hydronic panel systems might be arranged in a sequence. Radiant panels control the air temperature inside the building along with mean radiant temperature and reduce the air space inside it. Hence thermal comfort is more satisfying as compare to convectional air conditioning methods. Additionally the cost of radiant panel systems is low as compared to the convectional air conditioning system. [2]

1.1. Working Procedure of Radiant Cooling Panel Systems

In radiant cooling ceiling, the pipes are connected with the non – visible side of the panels containing chilled water, the chilled water is running throughout the pipes. The main use of ceiling panels is to exchange the heat between the air flow inside the room and the chilled water. By circulating cold water ceiling panels absorbed heat, which is coming from the heat sources in the room.[3] After absorb heat and circulating chilled water then this chilled water are driven to the chiller, cooled again and return to the ceiling. In radiant cooling ceiling system the heat flow is distinctive. The heat of people which is emitting inside the room is radiated towards the cool ceiling. To control the warmness of ceiling, chilled water is running in the ceiling.[4] The water carries the energy to the cooler [5]

1.2. Applications of Radiant Cooling Panel System

As they are very common and easy to operate these Radiant cooling panel systems are generally used in the common buildings. These public buildings containing hospitals together with nursing homes including schools, libraries plus museums, as well as offices and various other buildings.[6] Radiant cooling panels can be mounted where it require.

2. LITERATURE REVIEW

(Jin et sl., "*Sustain. Cities Soc.",* 2020) [7] Surface condensation limits the use of radiant ceiling cooling panels. Supply water flow management and surface temperature variation are intimately linked, and this is a major element in condensation issues. In order to regulate the supply water flow, this article investigates the dynamic change in surface temperature. When the chilled water supply is shut off, condensation may be successfully avoided on the radiant ceiling panel surface. The average temperatures of the non-cooling surface, the interior air temperature, as well as the internal surface temperature of the outer windows are the three key elements influencing the surface temperature for fixed supply water flow. There is a 47.6%, 39.2%, and 10.1% contribution from each of these variables. The dynamic variations in surface temperature of radiant ceilings for closed water supply are modelled and confirmed on the basis of this study, and the findings match with the experimental results.

(Lim, Kang and Jeong, "*J. Build. Eng.",* 2020) [8] Phase change material (PCM) integrated thermoelectric radiant cooling panel (PCM-TERCP) design was the goal of this research. Thermal performance of the PCM-TERCP was studied numerically and experimentally. TEM, heat sinks, insulation, and a PCM layer sandwiched between two aluminium panels are the components of the PCM-TERCP design. As a thermal energy storage, the PCM layer freezes at peak demand periods to offer passive cooling without requiring TERCP to be operational at all times. Computer simulations were used to establish an ideal PCM layer structure for the proposed cooling panel. So, the panel's temperature could be maintained over the operating time without activating the TEMs. Measurement and data from the PCM-TERCP mock-up were used to verify the numerical model. Within the 10% error margin, the anticipated results were in agreement with the measured data. PCM-cooling TERCP's performance was studied using a parametric research to identify the most important design factors.

(Jobli et al., "*Appl. Therm. Eng.",* 2019) [9] With the goal of improving the interior thermal climate and reducing energy consumption, this research investigates a new system of Capillary Tubes embedded in a Phase Change Material (CT-PCM). Buildings' radiant heating and cooling systems and phase change materials may be used to optimise low-grade energy utilisation potential, according to the CT-PCM system. Experiments on thermal response are carried out on a CT-PCM component constructed in a laboratory to determine its thermal properties. In addition, a simplified model is built to evaluate the CT-PCM system's long-term thermal performance for use in a strategically designed system.

(Li and Chen, "*Appl. Therm. Eng.",* 2019) [10] Thermal environment and heat consumption of a room with varied radiation end laying types are studied in this work in order to investigate how cross-household heat transfer affects excellent indoor thermal environment and building energy efficiency. The surface temperature and overall heat consumption of the inner wall are directly affected by the temperature of the surrounding room. A 2.3–3.7 percent reduction in heating surface temperature, a 15.3–16.3 percent increase in heat flux density for floor and ceiling heating, and a 22 percent reduction in heating surface temperature due to the substantial heat transfer to neighbouring rooms via internal walls were observed.

(Plytaria *et al.*, "*Energy Convers. Manag.",* 2019) [11]This work was investigated for the energy and financial purpose, in which the estimation of energy saving capacity and the total capital invested over the construction of building which include solar cooling system along with radiant walls which comprises Phase Change Materials (PCMs). The building which is used to studies the installation of solar cooling radiation system containing the area of 100 m^2 is situated in Athens in Greece. To produce cold water which intend for the radiant walls of building, to join the single effect absorption chiller tied along with evacuated tube collectors to solar cooling system.

(Zhou *et al.*, "*Energy Build.",* 2019) [12] Radiant heating and cooling system displayed a disproportionate radiant symmetry, even though many scholars explore this topic to examine the effects of thermal comfort along with the uneven symmetrical effect of radiant environments. The exposure duration particularly in floor heating plus cooling scenarios has not been highlighted. This study concluded that the test series conducted in a climatic chamber along with the floor cooling radiant asymmetries to study the effect of thermal comfort from short-term (2h) and long-term (8h) exposure views. A test conducted on 2 h exposure specifies the more complaints of discomfort in floor cooling system than other radiant systems it has strong cooling effects to cool the floor rapidly.

3. METHODOLOGY

3.1. Steps of Methodology

The experiment has been carried out through the numerical simulation of the radiant cooling system. The complete methodology includes model design and CFD analysis of the same. While the modeling was done using the CATIA V5 software, for the numerical analysis ANSYS has been employed. The steps involved in the complete numerical simulation of the radiant cooling are as follows:

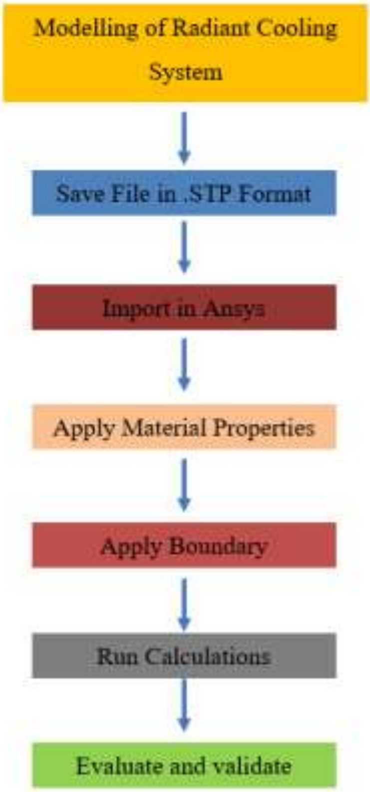

Figure 2: Working Methodology

3.2. Material property

A gypsum plaster solid was used to fill in the spaces left by the capillary tubes, which were assumed to be fluid in the physical model.

The property of Water, Aluminium and Gypsum is determined with respect to their thermal conductivity, density and specific heat and their separate values are listed in table below:

Table 1: Properties of water liquid

Properties	**Value**
Thermal conductivity$(Wm^{-1}K^{-1})$	0.75
Density (Kg/m^3)	998.2
Specific heat(J/KgK)	4182

Table 2: Properties of gypsum plaster

Properties	**Value**
Thermal conductivity$(Wm^{-1}K^{-1})$	0.50
Density (Kg/m^3)	836.4
Specific heat(J/KgK)	950

Table 3: Properties of aluminium

Properties	Value
Thermal conductivity($Wm^{-1}K^{-1}$)	900
Density (Kg/m^3)	2719
Specific heat(J/KgK)	871

3.3. Model design

- (Length)L= 2000 mm
- Width = 120 mm
- (Tube spacing)W= 20 mm
- (Tube diameter)a= 4 mm
- (gypsum plaster)δ= 10 mm

4. RESULTS AND DISCUSSION

4.1. Case-1 Validation design

Design is validated with the base paper which is selected for study, variation of maximum (19℃) and minimum (16℃) temperature is same in both results.

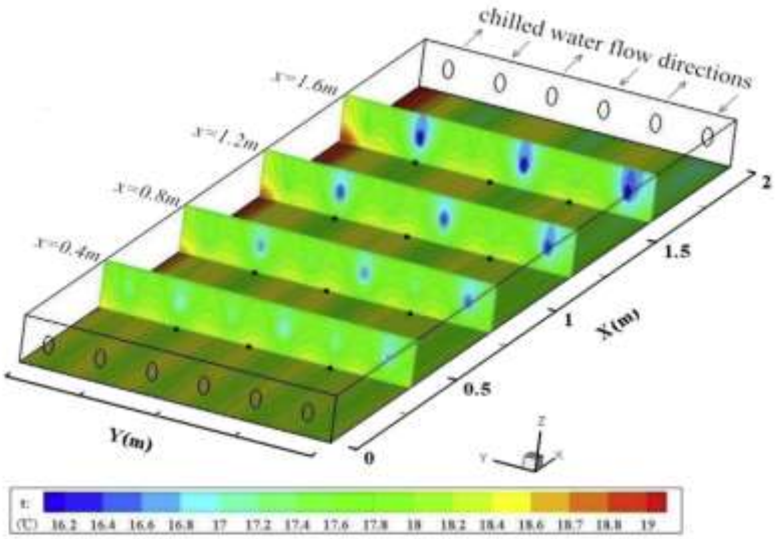

Figure 3: Result of paper

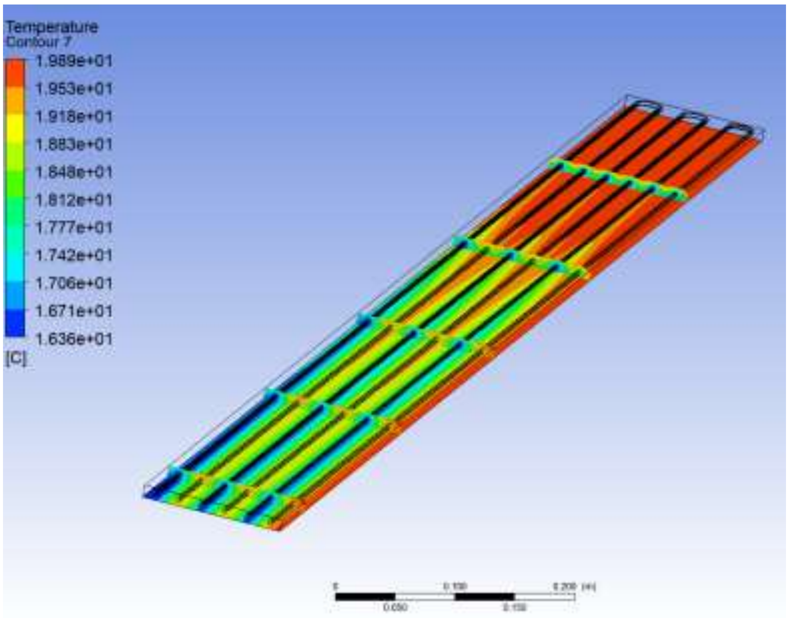

Figure 4: Temperature variation in different planes

4.2. Case-2 Linear pipe with 10 mm spacing

Below figure shows variation in temperature of linear pipe which were placed inside of gypsum plaster. Maximum and minimum temperature is observed as 19.75℃ and 16℃ respectively.

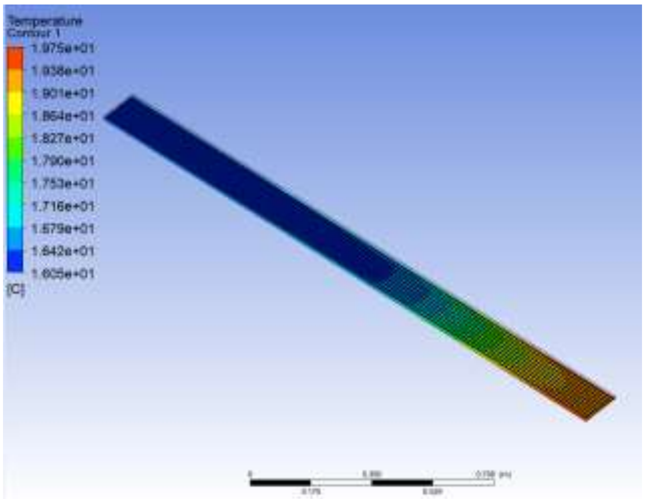

Figure 5: Temperature variation in linear pipe

4.3. Case-3 U tube pipes with 40 mm spacing

Below figure shows variation in temperature of U tube pipes with having 40 mm spacing in between pipes, which were placed inside of gypsum plaster. Maximum and minimum temperature is observed as 22.2℃ and 16℃ respectively. Here blue colour shows low temperature and red colour shows higher temperature, higher temperature can be observed at all outlet area of spiral pipes.

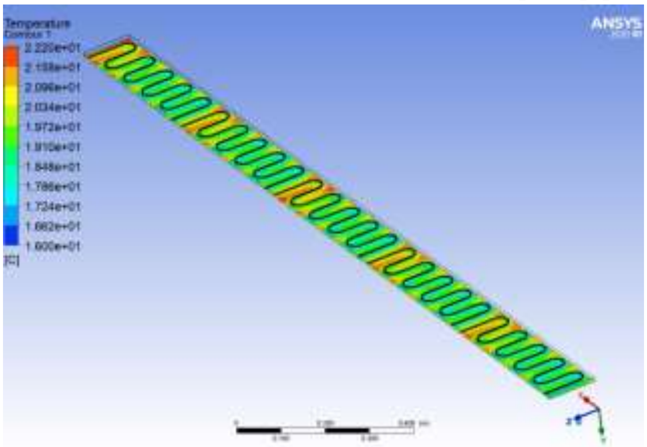

Figure 6: Temperature variation in spiral pipe with 40 mm spacing

4.4. Case-4 U tube pipes with 20 mm spacing

By analysing above U tube pipes case result, it was seen that spacing of pipe have wide impact on managing temperature because less spacing means it will cover more gypsum plaster area. So for this case spacing of pipes was reduced to 20 mm and results are defining in below figure:

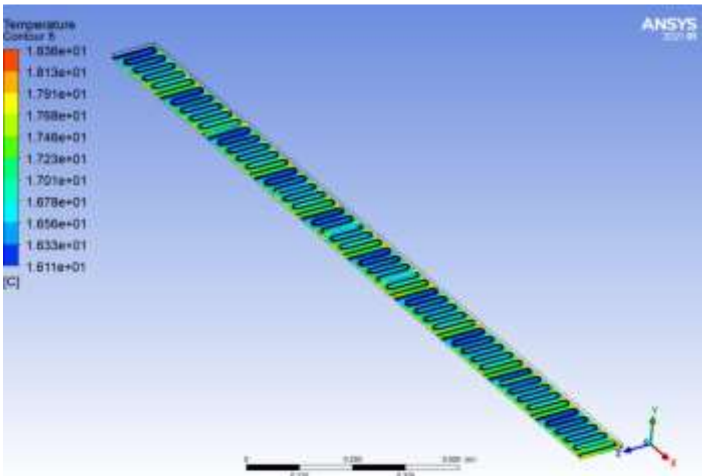

Figure 7: Temperature variation in spiral pipe with 20 mm spacing

Below mentioned graph is representing outlet temperature obtained by fluid inside pipes in all cases. And it shows that case 4 which is having spiral tubes with 20 mm spacing between pipes shows the best result because it got heated less from all others. Case 1, case 2, case 3 have 19.229℃, 19.196℃, and 19.33℃ respectively. Which are almost same for all 3 cases whereas case 4 has 17.593℃. it is defining that spacing of pipes shows important role in keeping the gypsum plaster and fluid temperature cool.

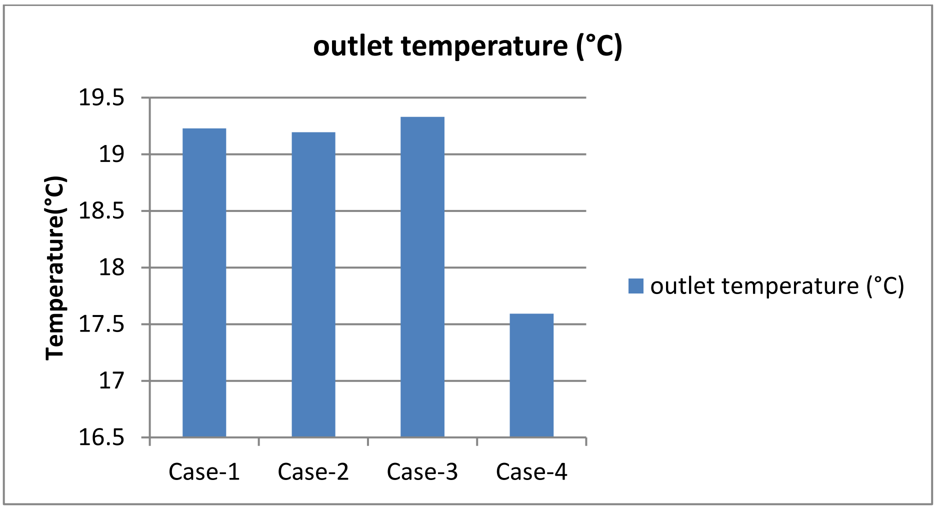

Figure 8: Temperature comparison in all cases

4.5. Power calculation

Pressure variation in all cases

Table 4: Value of pressure at inlet and outlet in all cases

Case	Inlet pressure(P1)	Outlet pressure(P2)
Validate	920.96	0
Linear	486.68	0
U tubes- 40	313.23	0
U tubes-20	290.82	0

Validation case

$$P_1 = 920.96\ Pa$$
$$P_2 = 0\ Pa$$

Inlet pipe diameter (d) = 4 mm

Velocity (v) = 0.1 m/sec

Discharge (Q) for each pipe

Q = $A \times V = \frac{\pi}{4} \times d^2 \times V$

$=\frac{\pi}{4} \times (0.004)^2 \times 0.1 = 12.56 \times 10^{-7} m^3/sec$

Number of inlet pipes in validation case = 3

Total discharge = $Q_T = \sum_{n=1}^{3} Q_n = 3 \times 12.56 \times 10^{-7}$

$$= 37.68 \times 10^{-7} m^3/sec$$

Hydraulic power (P)= $Q \times P$

$$= 37.68 \times 10^{-7} \times 920.96$$

$$3.47 \times 10^{-3} watt$$

Table 5: Hydraulic power in all cases

Case	Hydraulic power (watt)
Validate	3.47×10^{-3}
Linear	6.72×10^{-3}
U tubes- 40	1.96×10^{-3}
U tubes- 20	3.65×10^{-3}

Above mentioned table is defining hydraulic power which is calculated by formula. And it is a multiplication of discharge (Q) and pressure difference (P).

5. CONCLUSION

As the radiant cooling system has a good potential for energy saving as compared to conventional cooling system, this study is based on the design and performance improvement of ceiling radiant cooling system which can be used for any house, or building without installation of conventional HVAC. Out of the 4 different designs of the radiant cooling system that has been compared in this thesis, the U tube cooling system with 20mm spacing between the tubes has given the best results and the lowest outlet temperature of 17.593℃. The inlet pressure is also minimum in this case, i.e., 290.82 Pi and the hydraulic power is 3.65 x 10^{-3} watts.

As an alternative to completely air-conditioned office buildings, thermally active building components – or simply thermo active components – are a viable option. There must be a careful evaluation of the system's performance and improvement in order to execute them effectively. Rooms are cooled evenly and without any draughts or noises, making them more comfortable. As a result, additional research and evaluation is necessary for the betterment of the globe.

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TO STUDY THE EFFECT OF NANO PARTICLES WITH PCM MATERIAL IN SPIRAL TUBES HEAT EXCHANGER

Shivendra Singh[1*]

[1]*Assistant Professor, Department of Mechanical Engineering, Corporate Institute of Science and Technology, Bhopal*

Abstract

Demands for energy are growing as the economy grows at an accelerating pace. Due to the fast depletion of non-renewable resources, conservation of energy has been a major focus for scholars. To save fossil fuels, thermal energy storage is one of the most efficient ways of storing waste heat energy from the large field of heat exchangers. With its large latent heat capacity at low temperatures, phase transition material may effectively and efficiently store thermal energy. An energy storage medium called PCM is being tested in this study to see how it impacts the heat transfer rate of a spiral tube heat exchanger. Spiral wired tube heat exchanger performance is improved in this work by including nanoparticles such as Al2O3 into the PCM. Analytical research was conducted utilising simulation tools and software in order to get the final findings.

Keywords: PCM, Nano Particles, Heat Exchanger, CFD, Heat Transfer Rate, Melting, Mass Flow Rate

1. INTRODUCTION

A heat exchanger is a device that may be used to heat and cool an object. Heated fluids may be exchanged across systems. Anyone who uses a device for cooling, heating, condensation, boiling, or evaporation will understand the importance. Before the technique, the fluids may be heated or cooled, and they may also be subjected to physical alteration. Heat exchangers are called in accordance with

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their intended use. Heat exchangers that are used to condense are referred to as condensers, whereas those that are used to boil are called boilers. Heat transfer efficiency and pressure drop are used to evaluate the effectiveness and efficiency of heat exchangers. By calculating all heat transfer constants, a greater presentation of its efficacy may be achieved. The pressure drop and the amount of space required to transport a certain amount of heat provide an idea of a device's capital costs and power requirements (called the "Running cost"). It's common for there to be a plethora of literature and thoughts on how to design a gadget that meets the needs.

1.1. Phase change Material

PCMs (phase change materials) are widely employed in the storage and transport of thermal energy. Heat energy may be stored in PCM material, and it changes phase without changing its temperature. It heats up the surrounding air by altering its phase. It is this capacity to change phase and absorb or release heat at a steady temperature that gives PCM materials their unique advantages over other types of materials. Due to the poor thermal conductivity (less than 0.5 W/mK) of PCM material, heat exchanger system performance would suffer. As a result, new approaches to dealing with phase transition material's poor heat conductivity are required.

1.2. Classification of PCM Material

Organic and inorganic phase change materials (PCMs) may be subdivided into two primary categories.

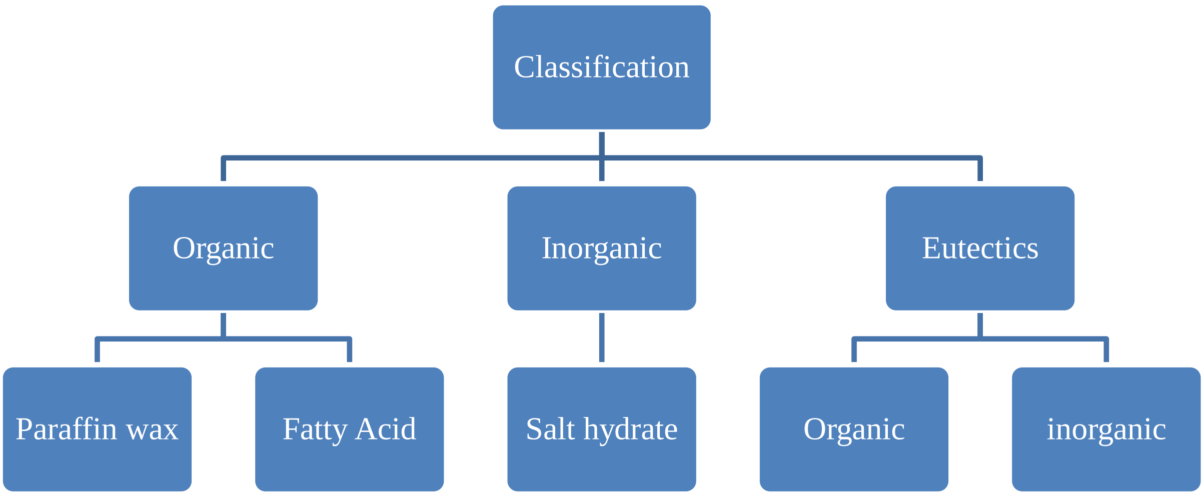


Figure 1 Classification of PCM Material

1.3. Nano particles

Using nanofluids, which are fluids containing nanoparticles (smaller than 100 nm in size), traditional fluids may have their heat transfer capacity increased in an entirely new way. Nano particle physics and thermal engineering converge in this technique. Conventional fluid is replaced with nanofluids, which have a high thermal heat transfer capacity and are employed instead. The thermal performance of nanoparticles is always superior to that of their basic fluids. Thermal conductivity is projected to be improved by this combination of base fluid and nanoparticle. As a result, further research into nanoparticles and nanofluids is needed to take use of their unique features. In addition to eliminating heat, nanofluids may also transmit heat.

1.4. Objectives of the study

The objectives of the following work are:

- To study the effect of A16 PCM Material in spiral tube heat exchanger.
- To study the performance of Nano particles mixed with PCM material.
- To calculate mass fraction of PCM materials using aluminium oxide (Al_2O_3) as nanoparticle in different percentage.
- To calculate Heat transfer rate of PCM materials using aluminum oxide (Al_2O_3) as nanoparticle in different percentage.
- To evaluate the results and performance using different percent of nano particles in PCM material for obtaining optimum percent of nano particles required for improving the performance of spiral tube heat exchanger.
- To compare the results with base paper.

2. LITERATURE REVIEW

(Youssef, Ge and Tassou, 2018) [1] In present study, PCM Material is used for the heat exchanger pipes with different design of and cross section of pipes. By using different pipe design, it is expected that the heat transfer and heat storage performance will increase. To verify this work and understand the process, a detailed 3D design is modeled and by using CFD it is developed for the PCM heat exchanger and with the dimensions, is validated. When charging and discharging the PCM, the temperature changes in PCM are simulated and shown. The effects of different water heat transfer fluid flow rates and temperature on the PCM melting/solidification time are also shown in this research.

(Mahdi *et al.*, 2019) [2] The “Triplex-tube heat exchanger (TTHX)” has been shown to be a particularly efficient thermal energy storage device when using Phase change material. Extendable fins, metals, and other materials have previously been studied. However, there has to be a lot more effort on improving thermal energy storage technologies. Heat may be stored and recovered or charged at the same time in a practical system. Adding an unique fin SCD condition to TTHX increased its performance in this trial. The performance of various fin shapes is studied numerically.

(Aldoss and Rahman, 2018) [3] In comparison to intelligent thermal storage systems, "latent thermal storage systems" are more cost effective and more compact. "Heat transfer fluid (HTF)" temperatures on the bed vary according on the technique of charging and discharging, with a greater intake temperature and a lower output temperature. Researchers recently proposed using numerous PCM's rather of a single PCM in the bed to match the "HTF temperature profile", therefore increasing the heat transfer rate by matching the temperature variance. It is known as "cascaded PCM distribution" when referring to this new approach. The next logical issue is how many steps should be in the cascade. This research addresses the cascading limit situation, which is the continuous linear cascade.

(Esteves *et al.*, 2018a) [4] Two phase transition materials, salt and paraffin, were tested in a laboratory setting to see how they behaved during fusion and solidification cycles. Because the heat transfer medium was thermal oil, the state change material was evaluated during a fusion and hardening cycle, which necessitated the use of thermal oil. To aid in the fusion process, the heat transfer oil provided energy to the phase change material, as well as absorbed energy lost during this process. The effect of the heat transfer fluid's mass rate on the phase change material's reaction, but not its temperature, was investigated.

(Solano *et al.*, 2018) [5] The heat transmission between a fluid, a tube, and a PCM material is being examined in the current research. The heat transfer fluid intake and outflow boundary conditions are coupled with the solar collector, which delivers the thermal energy to the fluid. Using this method, the model can quantify the effect of a particular solar radiation curve on the thermal energy storage capacity. With the employment of rectangular finned tube, the decreased latent heat storage detected under winter settings (peak irradiance of 500 W/m2 and nine hours of sun light) may be overcome. When the heat transfer surface to PCM volume ratio is increased by 5.7 times, thermal energy storage capacity is increased by 2.2 times.

(Al Siyabi *et al.*, 2018) [6] The high latent heat capacity of PCM-based conductors on a small scale will allow them to manage the temperature of electrical equipment. PCM combination, PCM arrangement, PCM thickness, melting temperature, and intensity of heat supply are evaluated in three distinct heat sinks to see how these factors affect the thermal behaviour of the heat sink. The melting profile of PCM may be determined by analysing the heat sink's temperature distribution.

3. RESEARCH METHODOLOGY

3.1. Step of working [7]

- Inquiring into the PCM material-based heat exchanger's data and information.
- The mixing ratio of PCM material and nanofluid is calculated manually.
- It is designed in CATIA V5 in accordance with the base paper's recommendation.

- CATIA V5 file is then converted to step format and loaded into fluent work bench following the conversion.
- The various sections of the system are given further names.
- The 3D model is used for meshing.
- It is applied to the model in accordance with the chosen base paper.
- This is done by assigning properties to materials.
- Results are computed and compared to other instances.

3.2. Governing Equations used in CFD [8]

Continuity Equation

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \underset{V}{\rightarrow}) = 0$$

Momentum Equation in x direction

$$\frac{\partial (\rho u)}{\partial t} + \nabla.\ (\rho u \underset{V}{\rightarrow}) = -\frac{\partial p}{\partial x} + \frac{\partial \tau xx}{\partial x} + \frac{\partial \tau yx}{\partial y} + \frac{\partial \tau zx}{\partial z} + \rho f x$$

Momentum Equation in y direction

$$\frac{\partial (\rho v)}{\partial t} + \nabla.\ (\rho v \underset{V}{\rightarrow}) = -\frac{\partial p}{\partial y} + \frac{\partial \tau xy}{\partial x} + \frac{\partial \tau yy}{\partial y} + \frac{\partial \tau zy}{\partial z} + \rho f y$$

Momentum Equation in z direction

$$\frac{\partial (\rho w)}{\partial t} + \nabla.\ (\rho w \underset{V}{\rightarrow}) = -\frac{\partial p}{\partial z} + \frac{\partial \tau xz}{\partial x} + \frac{\partial \tau yz}{\partial y} + \frac{\partial \tau zz}{\partial z} + \rho f z$$

Energy Equation

$$\frac{\partial}{\partial t}\left[\rho\left(e + \frac{v2}{2}\right)\right] + \nabla.\ \left[\rho\left(e + \frac{v2}{2}\ \underset{V}{\rightarrow}\right)\right] = \rho \dot{q} + \frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right) + \frac{\partial}{\partial y}\left(k\frac{\partial T}{\partial y}\right) + \frac{\partial}{\partial z}\left(k\frac{\partial T}{\partial z}\right) - \frac{\partial (uP)}{\partial x} - \frac{\partial (vP)}{\partial y} - \frac{\partial (wP)}{\partial z} + \frac{\partial (u\tau xx)}{\partial x} + \frac{\partial (u\tau yx)}{\partial y} + \frac{\partial (u\tau zx)}{\partial z} + \frac{\partial (v\tau xy)}{\partial x} + \frac{\partial (v\tau yy)}{\partial y} + \frac{\partial (v\tau zy)}{\partial z} + \frac{\partial (w\tau xz)}{\partial x} + \frac{\partial (w\tau yz)}{\partial y} + \frac{\partial (w\tau zz)}{\partial z} + \rho f \cdot \underset{V}{\rightarrow}$$

3.3. Boundary Condition

When charging, the PCM and HTF temperatures should be adjusted to 10 and 40 degrees Fahrenheit correspondingly, and the PCM should be solid. The "Velocity-intake" boundary condition for the HTF at the PCM HX inlet is utilised in the CFD model's boundary conditions. It is governed by the input volumetric flow rate and the diameter of the inlet inner pipe. [9] [10]

Table 1: Applied boundary conditions

Inlet Condition	**Parameter**
Inlet Fluid Temperature	40 ^{0}C
Inlet water velocity	0.33 m/s
PCM Initial temperature	10 ^{0}C
Operating environment temperature	27 ^{0}C

4. RESULTS AND DISCUSSION

4.1. Mass Fraction of Different Material

There is a mass fraction between 0 and 1. Solid materials have a range of 0; liquid materials have a range of 1. The red colour indicates that the substance is in a liquid condition, while the blue colour shows that the material is in a solid state. Tables, snaps, and a Bar Chart are used to display the results.

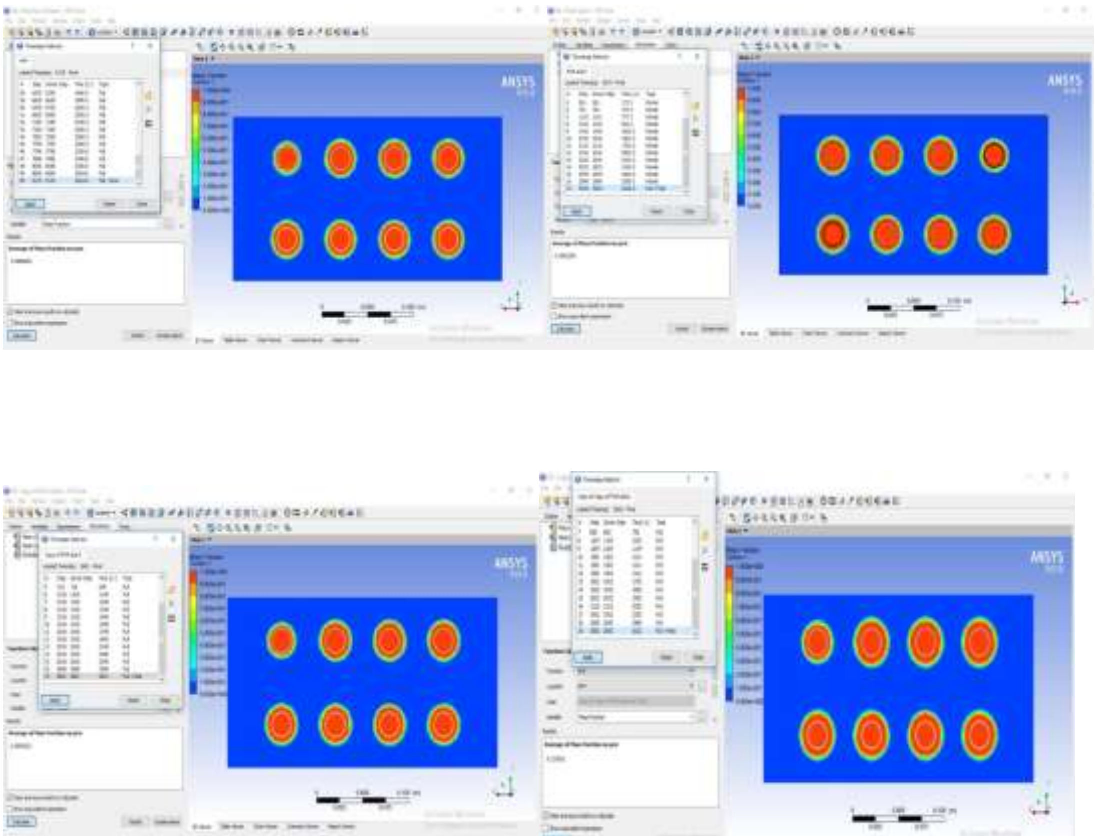


Figure 2: Mass Fraction Contour (a) Only PCM; (b) PCM + 0.5%Al_2O_3 (c) PCM + 1%Al_2O_3 (d) PCM + 2%Al_2O_3

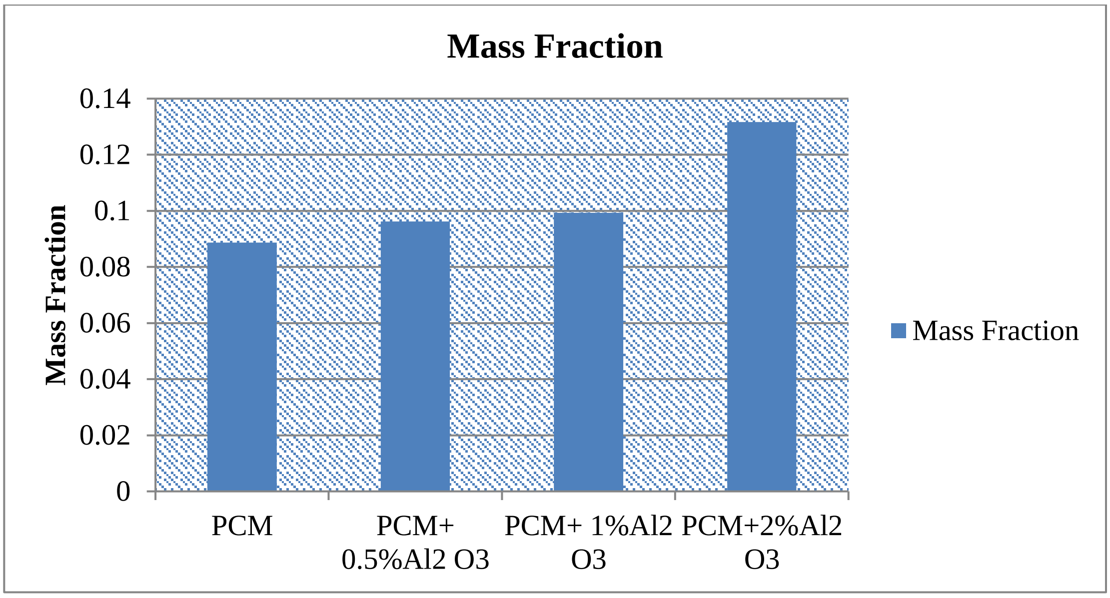
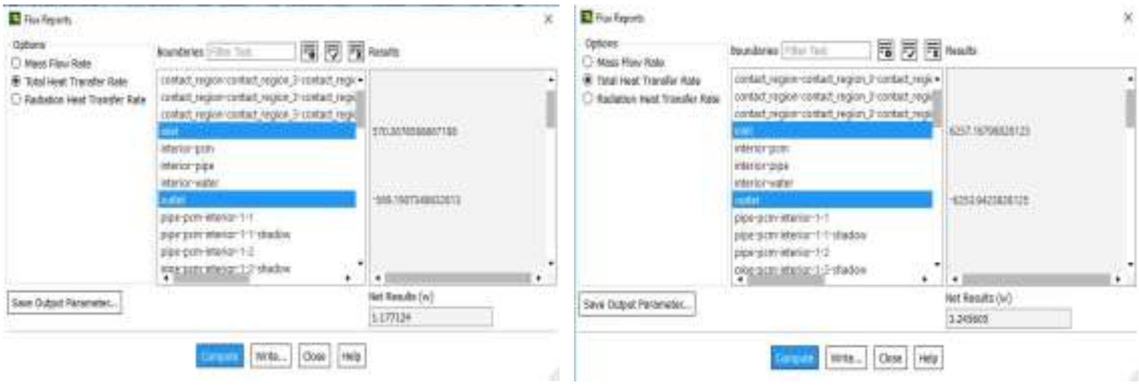


Figure 3: Average of mass fraction Graph

4.2. Total heat transfer rate of Different Material

The total heat transfer rate in calculate by using ANSYS Flux reports interface and select total heat transfer rate in between inlet and outlet of HTF (Heat Transfer Fluid). The positive sign indicate that the heat in inter is system and negative sign indicate that the heat is rejected by the system. All the heat transfer value and graph of PCM material and different percentage of nano fluid is shown in figure.



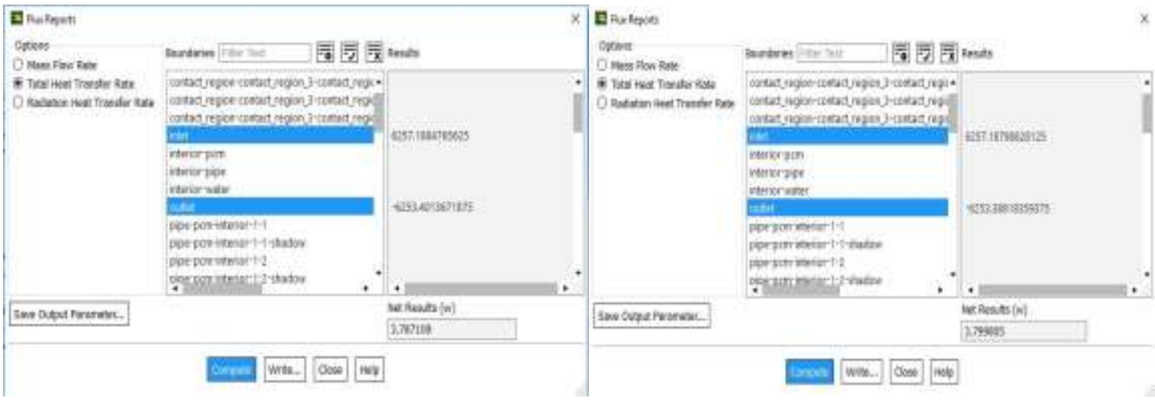


Figure 4: Total heat transfer (a) PCM material; (b) PCM+0.5% Al_2O_3 material; (c) PCM+1% Al2O3 material; (d) PCM+2% Al_2O_3 material

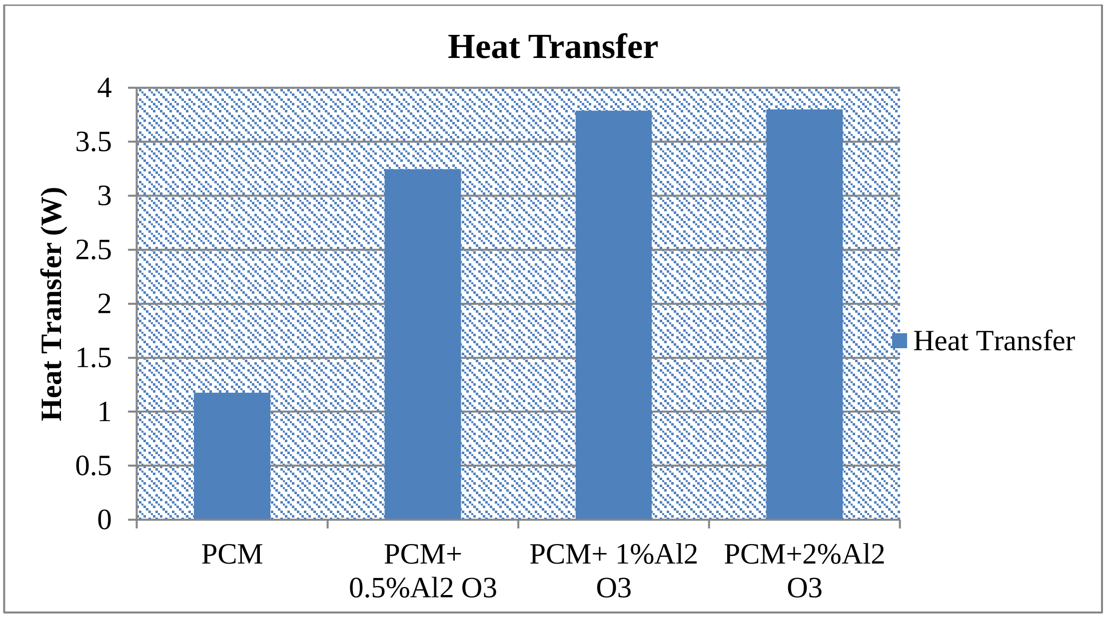


Figure 5: Total heat transfer rate in different percentage of Nano Particle

4.3. Temperature Distribution of Material

There is a 313K inlet temperature and a 0.33m/s velocity in the HTF system. The graphic depicts the temperature distribution after the completion of the study in 2560s. The greatest temperature, displayed in red, is 313 degrees Kelvin, while the lowest temperature, represented in blue, is 284.8 degrees Kelvin.

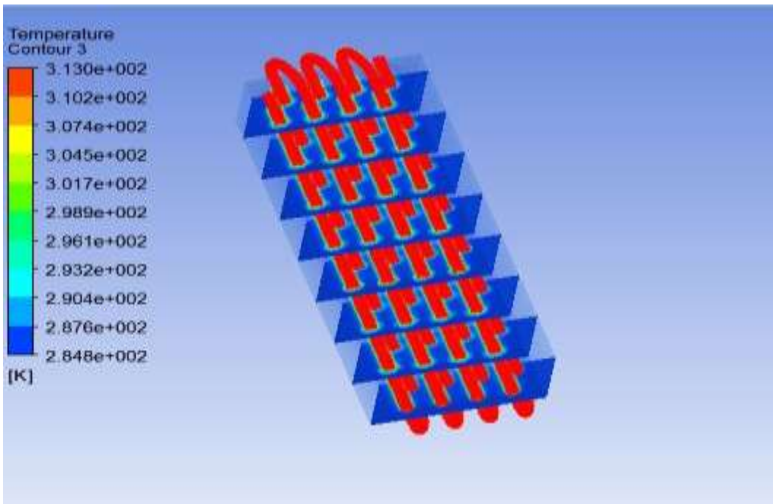


Figure 6: Temperature distribution PCM materials

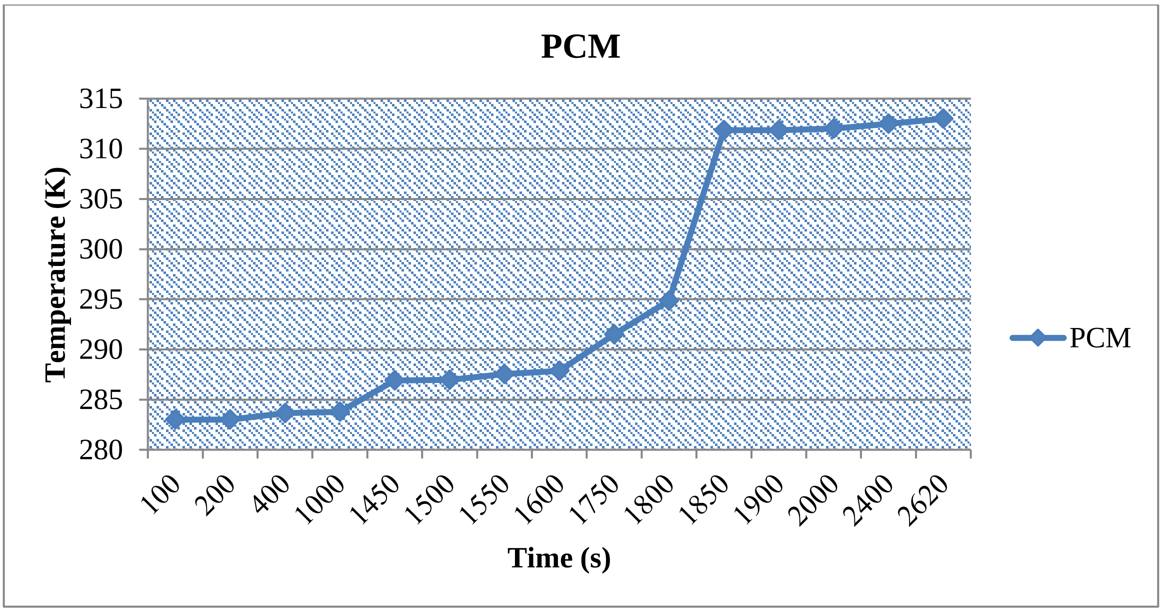


Figure 7: Graph showing steadiness in temperature rise on PCM material

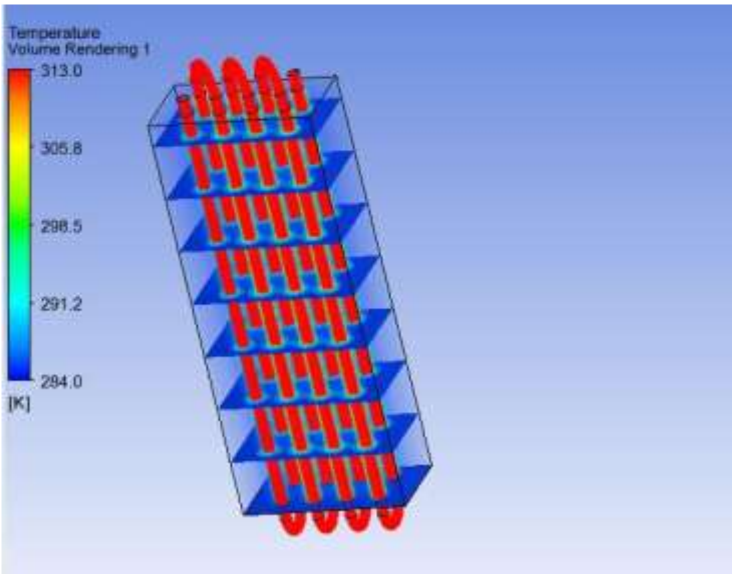


Figure 8: Temperature distribution PCM+0.5% Al_2O_3 materials

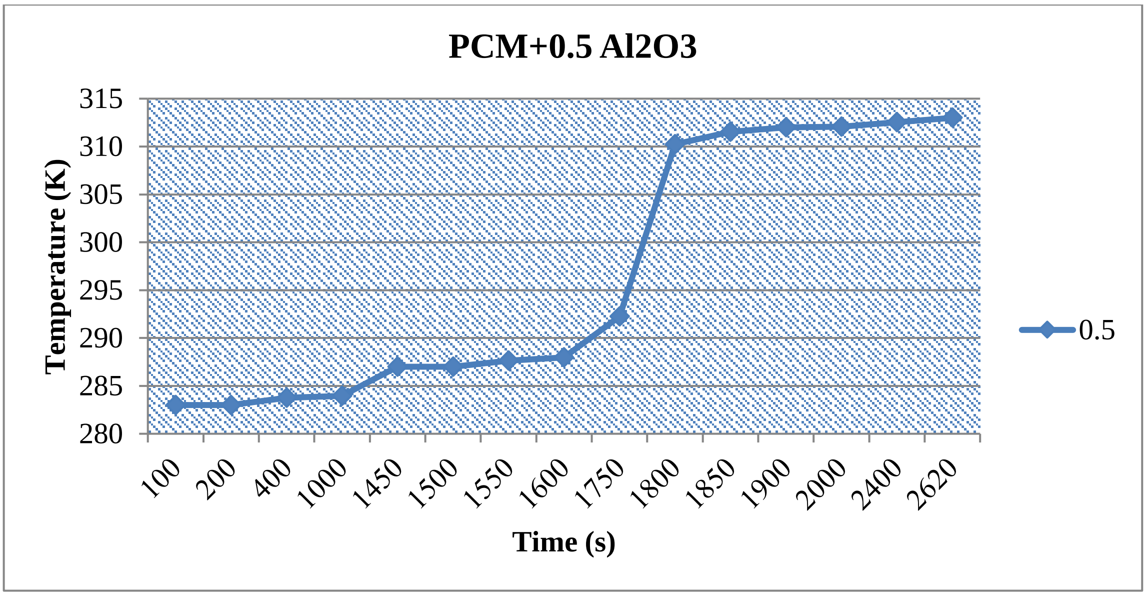


Figure 9: Graph showing steadiness in temperature rise on PCM+2% Al_2O_3 material

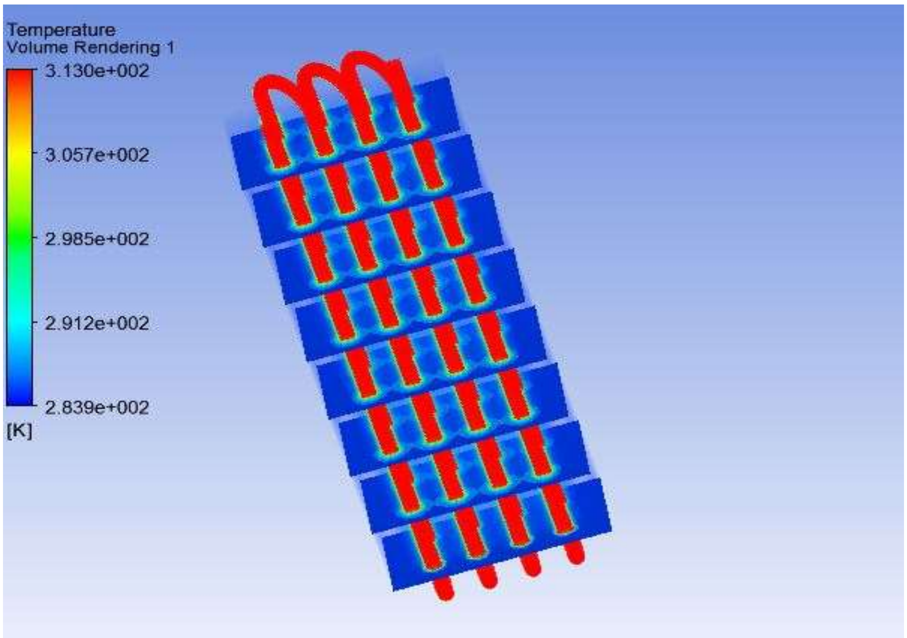


Figure 10: Temperature distribution PCM+1% Al_2O_3 materials

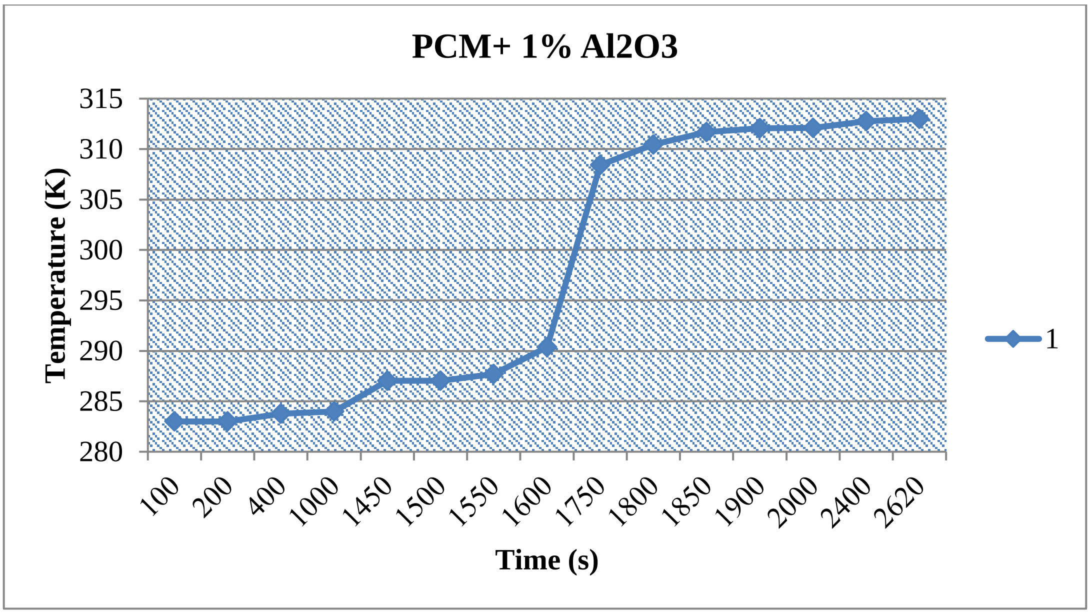


Figure 11: Graph showing steadiness in temperature rise on PCM+1% Al_2O_3 material

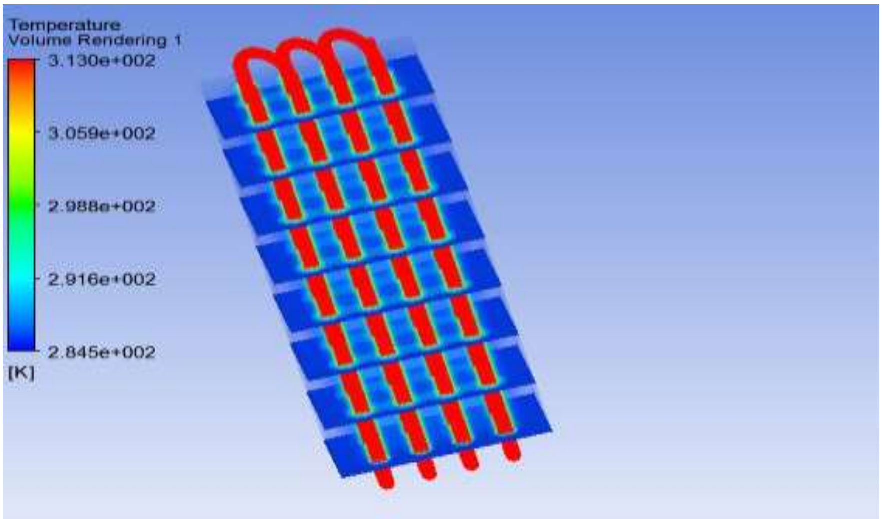


Figure 12: Temperature distribution PCM+2% Al_2O_3 materials

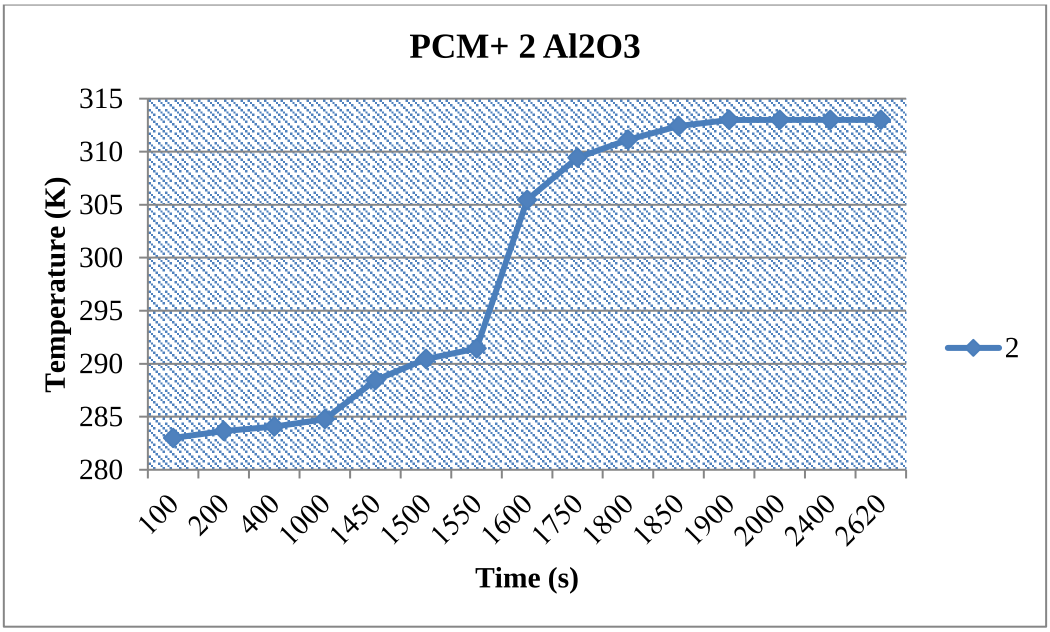


Figure 13: Graph showing steadiness in temperature rise on PCM+2% Al_2O_3 material

4.4. Discussion

- PCM material containing Nano particles has been discovered to improve the heat exchanger's performance.
- When a little number of Nano particles was added to the phase change material, the PCM's heat absorption capacity rose.

- In order to make comparisons between various percent values, the findings demonstrate how the whole system behaves when different percent of Nano particles mixed with PCM material are used.
- Using the data, we can figure out what Nano particle percentage should be used in the PCM material combination for best outcomes.
- It is possible to compare the heat exchangers with basic PCM and PCM with nanoparticles.

5. CONCLUSION

The complete CFD test was carried out satisfactorily and the desired result was reached. As a consequence of the findings, we can say the following:

- For each example, the PCM material was combined with varying percentages of the Nano particle Al_2O_3, such as 0.5, 1, or 2 percentages.
- It has been shown that the mass fraction increases as the proportion of PCM material increases.
- It has also been shown that the total heat transmission from intake to exit rises when Nano particles are added in varying percentages.
- The mass fraction of PCM material is 0.08868, whereas the mass fraction of AL_2O_3 nanoparticle mix with PCM in 0.5, 1, and 2 percentages is 0.09623, 0.09925, and 0.13165, respectively.
- Total heat transmission of PCM is 1.17W, whereas the total heat transfer of AL_2O_3 nanoparticle mix with PCM in 0.5, 1, and 2 percentages is 3.24, 3.78, and 3.8 W correspondingly.
- Temperature increases in PCM heat exchangers when AL_2O_3 nanoparticles are mixed with it in 0.5, 1, or 2 percent solutions take place in the 1800s, 1750s, and 1600s (roughly) before they reach their maximum output temperature.
- The blend of 2% PCM material yielded the highest mass fraction value. How does one choose the ideal combination of ingredients to use in the whole setup?
- It was also discovered that the temperature increase was much quicker when no Nano particle was supplied. The temperature rose steadily when Nano particles were put to PCM material.

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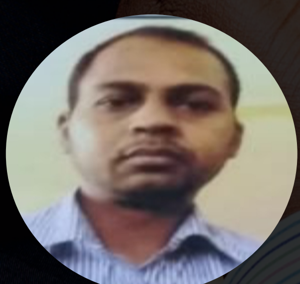
Dr. E. Vijay Kumar, HOD Department of Electrical and Electronics Engineering, RKDF Institute of Science & Technology, SRK University ,Bhopal, M.P, India. Had awarded Ph.D. in Electrical & Electronics Engineering from Rabindranath Tagore University (RNTU), Bhopal, and his Doctorate in the area “Investigations on control strategies of multilevel inverters for Improved power Quality”. M.Tech from Jawaharlal Nehru Technological University, Hyderabad, A.P, B.Tech from Kakatiya University, (KITS) Warangal, Telangana State. And Diploma from SRRS Govt. Polytechnic College, Sricilla, Karimnagar Dist., A.P.

Prof. Krishna Gopal currently associated with Samrat Ashok Technological Institute, (grant in aid autonomous engineering college under the Gov.t of M.P.) Vidisha since 2005. He has completed his masters from M.A.N.I.T. Bhopal and currently pursuing his Doctoral from R.G.P.V. Bhopal. He has published his research papers in repute journals. His research areas are Signal & Image processing, Machine Learning application in health analytics and Embedded systems.



Prof. Priyank Gour has been in the Profession of teaching since 20 years with more than 10 years of research experience. He has published more than 40 International journals and conferences, and 15 Elsevier & Scopus papers are published along with One PATENT titled “Invention is system and method to recognize human emotions with multi scale features from video sequences” App. No. 202021027187 Date.26.06.2020. He has Supervised 06 Ph.D. Scholars and more than 25 students in M.Tech. His research area is Control Strategies of Multilevel Inverters Technology, Power Quality Improving Techniques, Renewable energy systems, Power electronics, Electrical drives and Electrical Machines design.

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