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Performance Test of Heat Exchanger Using Stainless Steel Tube with Fin

A Thesis

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE

DEPARTMENT OF MECHANICAL ENGINEERING
SONARGAON UNIVERSITY (SU)

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APPROVAL

This is to certify that the project work entitle, “Performance Test of Heat Exchanger using stainless steel tube with Fin” has been carried out by Md. Milon Babu (ID: ME2101023449), Md. Zhorul Islam (ID: ME2101023343), Md. Bokul Sheikh (ID: ME2101023321), Md. Nahim (ID: ME2101023448), Md. Nazmul Hossain (ID:ME2101023351) thereby declared that the work presented here is original work done by me and has not been published or submitted elsewhere for the requirement of a degree of Bachelor of Science (B.Sc.) in Mechanical Engineering in the year of 2024 Program in the Department of Mechanical Engineering, Sonargaon University of Bangladesh (SU) has been carried out under by supervisor.

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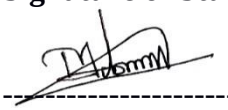
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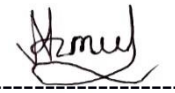
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ABSTARCT

Eventually, economics plays a key role in the design and selection of heat-exchange equipment, and the engineer should bear this in mind when embarking on any new heat transfer design problem. The weight and size of heat exchangers used in space or aeronautical applications are very important parameters, and in these cases cost considerations are frequently subordinated in so far as material and heat exchanger construction costs are concerned; however, the weight and size are important cost factors in the overall application in these fields and thus may still be considered as economic variables The primary modes of heat transfer are conduction and then convection. This is not to imply that radiation is not important in heat exchanger design.

Heat exchanger is equipment used to transfer heat from one fluid to another. It has extensive domestic and industrial applications. Extensive technical literature is available on heat exchanger design, operation and maintenance, but it is widely scattered throughout the industrial bulletins, industrial design codes and standard, technical journals, etc. The purpose of this book chapter is to consolidate into basic background and concepts design of heat exchangers, operation, cleaning and green technology maintenance on heat exchanger closely related to the industrial practices. A fin-and-tube heat exchanger model is presented in this paper. It uses empirical heat transfer and flow friction correlations identified in the literature. The model structure, its range of validity and accuracy are described in detail.

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CHAPTER - 1

INTRODUCTION

1.1 Introduction:

The mid-20th century has proven to be a time during which the world has had a rude awakening from its relaxed attitude towards the usage of our depleting natural resources. Proof of this is the waste heat recovery systems that have been in use in industries all over the world for the last 50 years. An example of this is the integration of various factory sections where the waste heat from one section is used in another. This is common practice in the food industry and not only saves money, but streamlines production and results in better efficiencies. Nonetheless, a large amount of energy is still being lost in the form of heat generated by everyday industrial and domestic equipment (Koorts 1998). The definition of waste heat includes the following: unburned but combustible fuel; sensible and latent enthalpy discharge from exhaust gas mixtures; and sensible heat discharge in liquid waste (Al Rabghi et al 1993). A quarter of the energy consumption in the western world is centered in the transportation sector.

Automobiles and trucks account for approximately 80% of all transportation energy expenditures. These thermal engines operate with a thermal efficiency between 30 and 40% (Koehler et al 1997). The typical energy balance for a turbocharged diesel engine, as tested by Stellenbosch Automotive Engineering (Wipplinger 2000), is as follows: oil cooling (2%), air cooling (5%), water cooling (25%), exhaust gasses (33%) and mechanical power (35%). It is clear that approximately one third of the total energy released by the combustion process is lost along with the exhaust gas, while one third is transferred to the cooling fluids and the rest is converted to actual mechanical power. The cooling fluids are necessary losses which prevent catastrophic failure of the engine due to overheating. But the energy lost along with the exhaust gas, can be ascribed to the inefficient utilisation of the available energy, which makes research into the recovery of waste energy and subsequent efficiency and fuel utilization improvement, a viable option.

While it is well known that sensible hydro-carbon combustion waste heat recovery is a common practice in large units found in marine applications, the present study forms part of ongoing investigations desiring to examine ways for exhaust gas waste heat recovery on

smaller units, e.g. trucks and locomotive engines. The final system design would ideally convert the recovered energy into electricity by implementing a turbine and generator combination. In a detailed study done by Wipplinger (2004), the following premises were accepted: The sensible heat must be recovered by means of a heat exchanger, which will impose a low back pressure on the exhaust system. Latent enthalpy recovery is not envisaged at present as the condensation of any vapours present in the exhaust gas mixture is considered unfavorable to the exhaust system. Without committing to a downstream Rankine steam cycle and its variations (e.g. a Stirling engine might serve as an alternative), high pressure capability on the water side would be required. For various reasons discussed by Wipplinger (2004), a finned tube cross-flow configuration was considered the most suitable. In order to correctly specify such a unit, knowledge of the behaviour of two-phase flow and its subsequent heat transfer coefficients, are required.

1.2 Objective:

We have some specific objectives for this project and they are pointed below:

- To study about **Performance Test of Heat Exchanger using stainless steel tube with Fin.**
- To test the performance of the system.
- To take necessary notes from the project for future improvements.
- To design & construct water cooling system
- To get difference between two water condition temperature.
- Recycling the water with appropriate usage.

1.3 Thesis Outline:

- **Chapter 1: Introduction.** This chapter is all about Introduction and objectives.
- **Chapter 2: Literature Review-** Here briefly describe about literature review.
- **Chapter 3: Hardware and Software -** This chapter is discussed about instrument and software. Hardware and Software details and its working procedure.
- **Chapter 4: Methodology –** Here briefly discuss about project methodology, Block Diagram, circuit diagram, required instrument cost analysis, working principle etc.

- **Chapter 5: Result & Discussion**: in this chapter we discuss about result analysis, advantages, application precaution etc.
- **Chapter 6: Conclusion** – This chapter is all about our project advantages, limitation, application and this project conclusion.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction:

This chapter is arranged on Literature Review. Here's a look at some of last year's literature, like our project. By reading them, we can overcome the mistakes of the previous project and make a more effective project.

2.2 Literature Review:

The research work under consideration represents a significant advancement in the field of thermal engineering as it presents the Tube Element Method (TEM) as a novel approach to the complex problem of uneven airflow in fin-and-tube heat exchangers. These heat exchangers are essential components in many different industrial applications, and airflow distribution across their fin surfaces has a big impact on how well they function. The study's authors are aware of the shortcomings of the current computation methods in handling with nonuniformity of airflow and proposed TEM as a potential remedy. Using tests using a three-row heat exchanger outfitted with seven flow circuits, they successfully validate TEM and demonstrate its ability to predict thermal performance in difficult fluid flow topologies. The investigation's main finding is that airflow nonuniformity has a negative impact on heat exchanger efficiency. The study highlights the nonuniformity of this efficiency loss and its dependence on multiple variables, including the quantity of heat transfer units (NTU), the heat capacity rate ratio (C*), and the particular fluid flow circuitry utilised in the heat exchanger. The TEM method presented in this study proves to be a very useful tool for thermal design and assessment, especially when dealing with the real-world challenges of fin-and-tube heat exchangers operating in nonuniform airflow settings. This approach could completely change the way that heat exchanger design and optimization panorama, guaranteeing their efficacy and efficiency even in the face of complex airflow conditions. It will therefore be advantageous to numerous companies that depend on these essential heat exchange systems.[1]

The reviewed study offers a thorough experimental investigation of the features of heat transfer and the thermal stresses that fin-and-tube heat exchangers experience. Its main goal is to assess how different fluid mass flow rates impact heat transfer efficiency. Apart from the actual study, the authors employ ANSYS software to perform an exhaustive examination of the thermal stresses that arise in the fins and tubes, specifically when adjusting the fins' width and the tubes' diameter. In order to get experimental data, fluid mass flow rates must be systematically adjusted while maintaining a given temperature. The results of these experiments are then contrasted with theoretical forecasts. The main conclusions of this study highlight a clear relationship between the thermal stresses that arise and the diameter of the tubes and the fin width. More specifically, the research shows that higher fin and tube diameters lead to higher thermal stresses in the fins and tubes. Moreover, it indicates that the valve controlling fluid flow is fully open when the maximum levels of thermal stresses appear. By clarifying how different operating conditions and geometric characteristics affect heat transfer and thermal stress, this research significantly advances the field of heat exchanger design and performance evaluation. The knowledge gained from this research can be extremely useful in directing the assessment and design of heat exchangers, enabling engineers to enhance their efficiency and reliability across a wide spectrum application.[2]

Domain of finned tube heat exchanger optimisation; these are often used parts in air conditioning systems. It's The main goal is to reduce pressure drop and increase these heat exchangers' heat transfer efficiency. The addition of more fins to the heat exchanger's design is the main focus of the optimisation procedure. In order to achieve this, the optimisation framework has a volume constraint that allows for the explicit addition of additional fins to increase the heat transfer area. Remarkably, the primary goal still stands to minimize pressure drop, ensuring that adding these additional fins won't negatively impact performance in general. The research methodology verifies the efficacy of the optimised fin structures through numerical methodologies and 3D conjugate heat transfer simulations. The study's results clearly demonstrate the potential of using topology optimization as a calculated tactic to increase thermofluidic equipment efficiency. As a result, this study provides priceless new information for the development of air conditioning systems and related applications.[3]

The development and assessment of fin and tube heat exchangers with air cooling that use R32 and R410A refrigerants. A significant portion of the study was devoted to emphasizing

the advantages of R32 over R410A, including lower refrigerant charge requirements and better performance. The testing results clearly showed that R32 had a higher heat transfer coefficient, especially in the vapour and two-phase stages, indicating that it could be a more effective refrigerant. While it is important to note that R32 did have a greater pressure drop, its significantly improved heat transfer qualities make it a viable option for a variety of applications. These findings are highly relevant to the optimisation of condenser designs in air conditioning systems, offering insightful information for improving the systems' efficacy and efficiency—a critical consideration in the energy-conscious world of today.[4]

Using ANSYS CFX-11, this comprehensive numerical study investigated the pressure drop and heat transfer behaviors of a four-row fin-and-tube heat exchanger with both plain and wavy fin structures. The study included tests in both laminar and turbulent flow scenarios, clarifying the various impacts of these different fin shapes on the heat exchanger's functionality. Additionally, the study carefully verified the accuracy and reliability of its numerical results by contrasting them with experimental data. The investigation's conclusions were very instructive. They demonstrated the better performance of wavy fins over plain fins, exhibiting advantageous pressure drop properties combined with enhanced heat transfer characteristics. Additionally, the study highlighted the benefits of an in-line tube layout, emphasizing its higher efficiency relative to the2379 Dnyaneshwari Wable, et al (/ Kuey, 30(5), 3296 staggered setups at particular Reynolds numbers. These findings are highly significant in the field of heat exchanger design. Providing essential information that can be applied to a wide range of businesses in order to design heat exchange systems that are more effective and efficient.[5].

A wide range of researches are already done to study the flow characteristics and heat transfer in helical heat exchangers. The enhancement of the heat transfers in the helically coiled tubes is due to the centrifugal forces. A secondary flow field is produced due to the curvature of the tube with a circulatory motion, which causes the fluid particles to move towards the core region of the tube. The secondary flow enhances heat transfer rates by reducing the temperature gradient across the cross-section of the tube. Thus, there is an additional convective heat transfer mechanism occurs, perpendicular to the main flow, which does not exist in straight tube heat exchangers. [6] K.S. Bharuka, D.Y. Kasture studied the characteristics of heat transfer in a double pipe helical heat exchanger and found

that the overall heat transfer coefficients increase with increasing inner Dean number. However, this increase is a function of the ratio of the mass flow rates.

[7] Vimal Kumar, Burhanuddin Faizee, Monisha Mridha and K.D.P. Nigam conducted an experiment on tube-in-tube heat exchanger and observed that with the increase in operating pressure in the inner tube, the overall heat transfer coefficient increases and the friction factor value in the inner-coiled tube was in agreement with the literature data.

[8] N. Ghorbani, H. Taherian, M. Gorji, H. Mirgolbabaei conducted a practical experiment on a vertical helically coiled heat exchanger and found that the coil surface area was the most influential geometrical parameter on the heat transfer coefficient and effect of tube diameter is almost negligible on overall heat transfer coefficient.

[9] Rahul Kharat, Nitin Bhardwaj, R.S. Jha experimented on the effect of various geometric parameters on a concentric helical coil heat exchanger. They plotted the graph between heat 13transfer coefficient versus tube diameter and coil gap and found that two most important design parameters are coil gap and tube diameter.

[10] J. S. Jayakumar conducted an experiment on helically coiled heat exchangers using CFD and found that the use of constant values for the heat transfer and thermal properties of the fluid resulted in inaccurate heat transfer coefficients. Based on the analysis results he developed a correlation in order to evaluate the heat transfer coefficient of the coil. In this study, analysis was done for both the constant wall temperature and constant wall heat flux boundary conditions. The Nusselt numbers that were obtained were found to be highest on the outer coil and lowest in the inner side. The coil parameters like the diameters of the pipes, the Pitch Circle Diameters have significant effect on the heat transfer and the effect of the pitch is negligible.

[11] Timothy J. Rennie studied the heat transfer characteristics for a double pipe helical heat exchanger for both counter and parallel flow with both the boundary conditions of constant heat flux and constant wall temperature. The results from the simulations were within the range of the pre-obtained results. The overall heat transfer coefficients were determined for dean numbers ranging from 38 to 350. He observed that the overall heat transfer coefficients varied directly with the inner dean number but the fluid flow conditions in the outer pipe had a major contribution on the overall heat transfer coefficient. So, he concluded that during

the design of a double pipe helical heat exchanger, the design of the outer pipe should be given the highest priority in order to get a better overall heat transfer coefficient.

[12] J. S. Jayakumar, S. M. Mahajani, J. C. Mandal, Rohidas Bhoi studied the constant thermal and transport properties of the heat transfer medium and their effect on the prediction of heat transfer coefficients. Arbitrary boundary conditions were not applicable for the determination of heat transfer for a fluid-to-fluid heat exchanger. An experimental setup was made for studying the heat transfer and also CFD was used for the simulation of the heat transfer. The CFD simulation results were reasonably well within the range of the experimental results. Based on both the experimental and simulation results a correlation was established for the inner heat transfer coefficient.

Two fluids of different starting temperatures, flow through the heat exchanger. One flows through the tubes (the tube side) and the other flows outside the tubes but inside the shell (the shell side). Heat is transferred from one fluid to the other through the tube walls, either from tube side to shell side or vice versa. The fluids can be either liquids or gases on either the shell or the tube side. In order to transfer heat efficiently, a large heat transfer area should be used, leading to the use of many tubes. In this way, waste heat can be put to use. This is an efficient way to conserve energy.

Heat exchangers with only one phase (liquid or gas) on each side can be called one-phase or single-phase heat exchangers. Two-phase heat exchangers can be used to heat a liquid to boil it into a gas (vapor), sometimes called boilers, or cool a vapor to condense it into a liquid (called condensers), with the phase change usually occurring on the shell side. Boilers in steam engine locomotives are typically large, usually cylindrically-shaped shell-and-tube heat exchangers. In large power plants with steam-driven turbines, shell-and-tube surface condensers are used to condense the exhaust steam exiting the turbine into condensate water which is recycled back to be turned into steam in the steam generator.

2.3 Summary:

We try to do this project by reading the above literature, and we have been able to make our project successful by reducing the mistakes of last year's project.

CHAPTER 3

HARDWARE & SOFTWARE ANALYSIS

3.1 Introduction:

In this chapter we are going to describe our all components. How the components work and why we choose that. In this section, we will discuss elaborately about our hardware design of "**Performance Test of Heat Exchanger using stainless steel tube with Fin**" and the component description, features, working procedure and description of our all equipment.

3.2 Requirement of Main Instrument:

Hardware

- SMPS
- Fin Tube
- Stainless Steel Tube
- Pump Motor
- Cooling Fan
- Heater
- Reservoir Tank
- Temperature Sensor

Software

- Proteus Software

3.3 Switch Mode Power Supply (SMPS):

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power

conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.

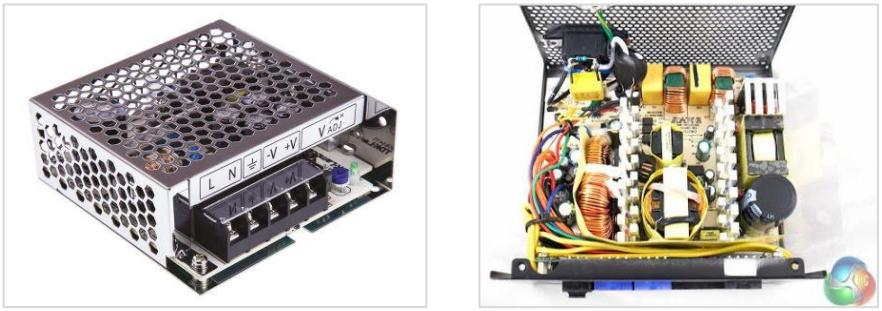


Figure 3.1: SMPS

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

12V 5A Industrial SMPS Power Supply – 60W – DC Metal Power Supply – Good Quality Non-Waterproof with Aluminum casing.

- Input Voltage: AC 100 – 264V 50 / 60Hz.
- Output Voltage: 12V DC, 0-5A.
- Output voltage: Adjustment Range: ±20%.
- Protections: Overload / Over Voltage / Short Circuit.
- Auto-Recovery After Protection.
- Universal AC input / Full range.
- 100% Full Load Burn-in Test.
- Cooling by Free Air Convection.
- High Quality and High Performance.
- LED power supply with a metal body for hidden installation for LED lighting.
- Design with Built-in EMI Filter, improve signal precision.
- Certifications: CE & RoHs.
- No Minimum Load.
- Compact Size Light Weight.

High Efficiency, Reliability & low energy consumption. Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are:

- AC to DC.
- DC to DC.
- DC to AC.
- AC to AC.

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter.
- Inverter consisting of switching devices such as MOSFETS.
- Transformer.
- Output rectifier and filter.
- Feedback and control circuit.

The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC output is rectified and smoothed to produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level.

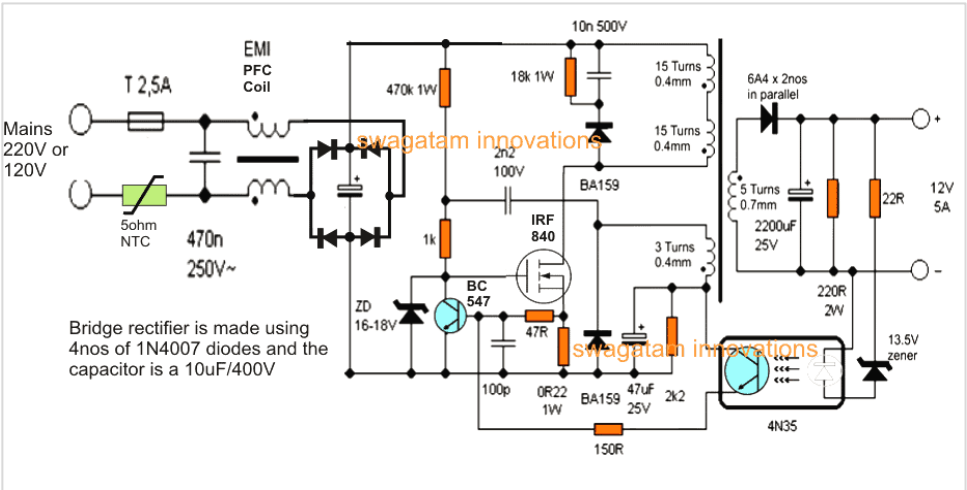


Fig 3.2: SMPS Circuit Design

Basic working concept of an SMPS:

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

Design basics:

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electro technical Commission (IEC) style input connector. As for output connectors and pin outs, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up to the manufacturer.

There are different circuit configurations known as topologies, each having unique characteristics, advantages and modes of operation, which determines how the input power is transferred to the output. Most of the commonly used topologies such as fly back, push-pull, half bridge and full bridge, consist of a transformer to provide isolation, voltage scaling, and multiple output voltages. The non-isolated configurations do not have a transformer and the power conversion is provided by the inductive energy transfer.

Advantages of switched-mode power supplies:

- Higher efficiency of 68% to 90%.
- Regulated and reliable outputs regardless of variations in input supply voltage.
- Small size and lighter.
- Flexible technology.
- High power density.

Disadvantages:

- Generates electromagnetic interference.
- Complex circuit design.
- Expensive compared to linear supplies.

Switched-mode power supplies are used to power a wide variety of equipment such as computers, sensitive electronics, battery-operated devices and other equipment requiring high efficiency.

Switch Mode Power Supply:

Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output. Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such a zener diode and a resistor, or transistors and even op-amps.

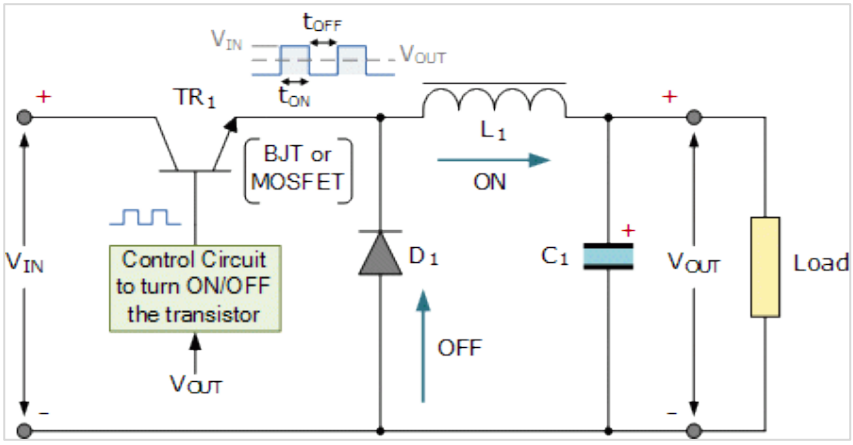


Fig 3.3: Power Supply Connection

The most popular linear and fixed output voltage regulator types are by far the 78… positive output voltage series, and the 79… negative output voltage series. These two types of complementary voltage regulators produce a precise and stable voltage output ranging from about 5 volts up to about 24 volts for use in many electronic circuits.

There is a wide range of these three-terminal fixed voltage regulators available each with its own built-in voltage regulation and current limiting circuits. This allows us to create a whole host of different power supply rails and outputs, either single or dual supply, suitable for most electronic circuits and applications. There are even variable voltage linear regulators available as well providing an output voltage which is continually variable from just above zero to a few volts below its maximum voltage output.

Most D.C. power supplies comprise of a large and heavy step-down mains transformer, diode rectification, either full-wave or half-wave, a filter circuit to remove any ripple content from the rectified D.C. producing a suitably smooth D.C. voltage, and some form of voltage regulator or stabilizer circuit, either linear or switching to ensure the correct regulation of the power supplies output voltage under varying load conditions. Then a typical D.C. power supply would look something like this:

Typical DC Power Supply:

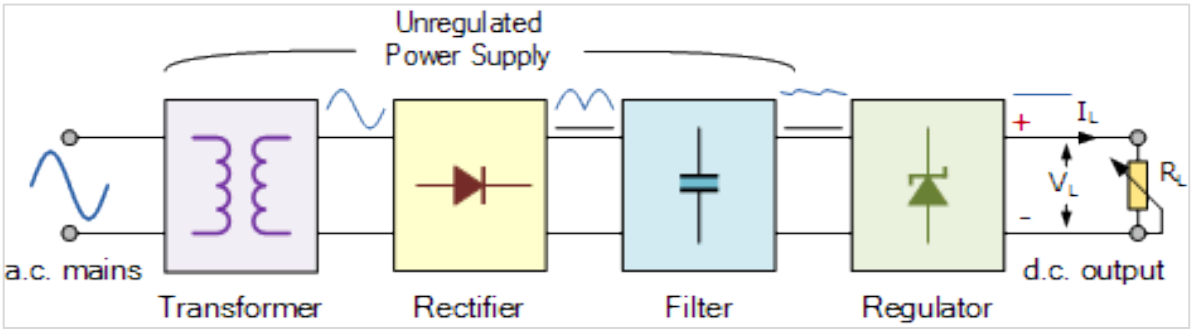


Fig 3.4: DC Power Supply Step

These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a dissipative series regulator circuit. The regulator circuit could consist of a single Zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

3.4 Fin Tube:

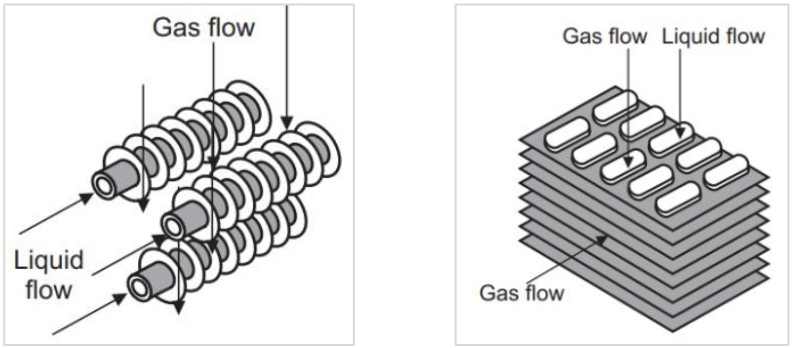
Fin tubes are a type of heat exchanger tube where fins (thin, extended metal surfaces) are attached to the tube's outer surface. These fins increase the surface area available for heat transfer, thereby improving the efficiency of the heat exchanger.



Fig: 3.5 Fin Tube

Function:

- **Enhanced Heat Transfer:** The primary purpose of fins is to increase the surface area through which heat can be transferred from one fluid to another. By adding fins, the overall heat exchange surface area is significantly enlarged.
- ·**Improved Efficiency:** In applications where fluids flow over the fins (such as air in air-cooled heat exchangers), the increased surface area allows for more effective heat dissipation or absorption.
- **Compact Design:** Fin tubes help in designing more compact and efficient heat exchangers, as they allow for the same amount of heat transfer in a smaller footprint compared to a plain tube.



(a) Horizontal (b) Vertical

Figure 3.6: Horizontal and vertical Fin Tube

Application:

- **HVAC Systems:** Fin tubes are often used in air conditioning and heating systems to exchange heat between air and refrigerant or water.
- **Industrial Processes:** They are used in various industrial applications for cooling or heating processes, including power generation, petrochemical, and manufacturing industries.
- **Automotive:** In vehicle radiators and intercoolers, fin tubes help to cool engine fluids or boost air intake temperatures.

3.5 Stainless Steel Tube:

Stainless steel tubes are hollow cylindrical products made from stainless steel. Stainless steel is an alloy of iron that contains a minimum of 10.5% chromium, which gives it its resistance to rust and corrosion. These tubes come in various sizes, shapes, and grades, making them suitable for a wide range of applications.



Figure 3.7: Stainless Steel Tube

Applications:

1. **Chemical and Pharmaceutical Industries:** For transporting chemicals and pharmaceuticals due to their resistance to corrosive substances.
2. **Oil and Gas Industry:** Utilized in pipelines, structural components, and equipment due to their strength and resistance to harsh environments.
3. **Food and Beverage Industry:** Ideal for processing and transporting food and beverages because of their hygiene and ease of cleaning.
4. **Construction and Architecture:** Used in handrails, supports, and decorative elements due to their aesthetic appeal and durability.
5. **Medical Devices:** Employed in medical instruments and equipment for their hygienic properties and structural integrity.

3.6 Pump Motor:

A **pump** is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into hydraulic energy. Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers and other components of heating, ventilation and air conditioning systems. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis.



Figure. 3.8: Centrifugal water Pump.

Specification:

- Material: ABS (Acrylonitrile Butadiene Styrene) + Stainless Steel
- Overall Size: Approx. 80 x 48 x 63mm/3.15 x 1.89 x 2.48"
- Pump Inlet Diameter: 16mm (Outer), 12mm (Inner)
- Pump Outlet Diameter: 12mm (Outer), 6.9mm (Inner)
- Inlet/Outlet: 1/2" male thread
- Voltage: 6-12V DC
- Maximum Rated Current: 1.2A
- Power: 16.8W
- Max Flow Rate: 700 L/H
- Max Water Head: 5M
- Max Circulating Water Temperature: 60°C

3.7 Water Heater:

A water heater is a device that used to heat water or fluid. In this experiment water heater is used to heat up the water of hot cycle. **Water heating** is a heat transfer process that uses an energy source to heat water above its initial temperature. Typical domestic uses of hot water include cooking, cleaning, bathing, and space heating. In industry, hot water and water heated to steam have many uses.

Domestically, water is traditionally heated in vessels known as water heaters, kettles, cauldrons, pots, or coppers. These metal vessels that heat a batch of water do not produce a continual supply of heated water at a preset temperature. Rarely, hot water occurs naturally, usually from natural hot springs. The temperature varies with the consumption rate, becoming cooler as flow increases.



Figure. 3.9: Water heater

3.8 Fan:

A **DC 12V 2-Pin Cooling Fan** is a compact and efficient cooling solution designed for various electronic and mechanical applications. Operating on a 12-volt direct current (DC) power supply, this fan features a straightforward 2-pin connector, which simplifies installation and integration into different systems. The two pins are typically designated for power and ground connections, making it easy to connect to standard power sources.

These cooling fans are commonly used in computer systems, electronic enclosures, and small machinery to dissipate heat and maintain optimal operating temperatures. They are valued for their reliable performance, low noise levels, and energy efficiency. The 12V 2-pin cooling fan is a practical choice for enhancing airflow and preventing overheating in devices with limited space. Its robust design and ease of use make it an essential component in maintaining the reliability and longevity of electronic equipment.



Figure 3.10: Cooling Fan

Specification:

- Connector: 2Pin-2510.
- Dimensions: 80mm×80mm×15mm.
- Rated Voltage: DC 12V.
- Rated Current: 0.18±10% Amp.
- Rated Speed: 2700±10%rpm.
- Air flow: 19.35CFM.
- Bearing Type: Sleeve.
- Cable Length: 23cm.

3.9 EASY EDA:

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share-publicly and privately-and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

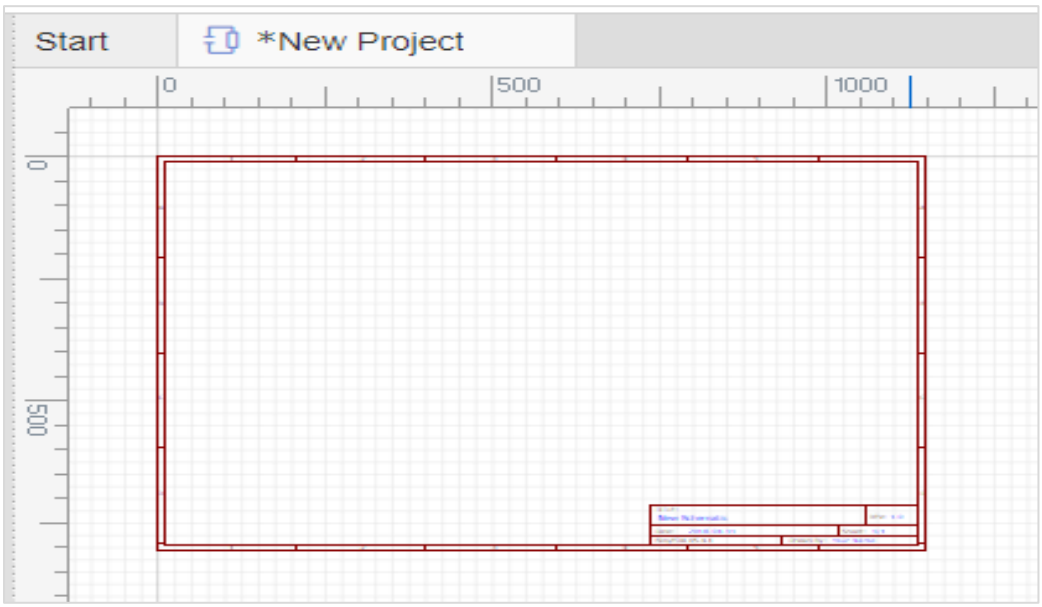


Figure 3.11: Easy EDA Software Interface

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription. Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

CHAPTER 4

METHODOLOGY

4.1 Methodology:

Our methodologies for the project:

- **Performance Test of Heat Exchanger using stainless steel tube with Fin** and designing a block diagram & circuit diagram to know which components need to construct it.
- Setting all components in a PCB board & soldering. Then assembling the whole block in a board and finally run the system & checking.
- To take necessary notes from the project for future improvements.

4.2 Block Diagram:

The SMPS simply converts the 220V AC to a pure DC of 12V 20Amp. We will use this 12V DC output from the SMPS to run our controller, motor and other units.

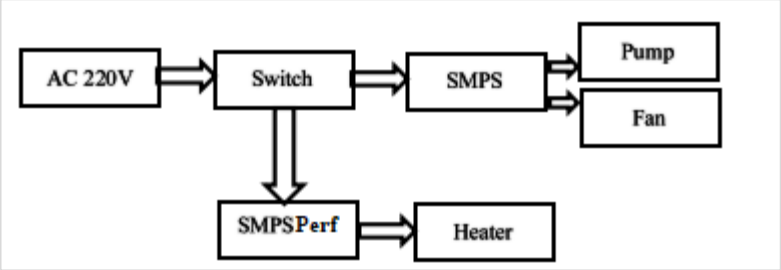


Figure 4.1: Block Diagram of Our Performance Test of heat Exchanger using Stainless Steel Tube with Fin

4.3 Cost Analysis:

Table 01: Cost Analysis

Sl.no	Instrument	Qty.	Unit Price (Taka)	Total Price (Taka)
1	SMPS	1	500	500
2	Fin Tube	1	2500	2500
3	Stainless Steel Tube	1	600	600
4	Fan	2	150	300
5	Motor	1	300	300
6	Heater	1	450	450
7	Others		1500	1500
				Total= 6250/

4.4 Schematic Diagram:

The schematic diagram here is representing the electrical circuit and the components of the project. Here we have used standardized symbols and lines.

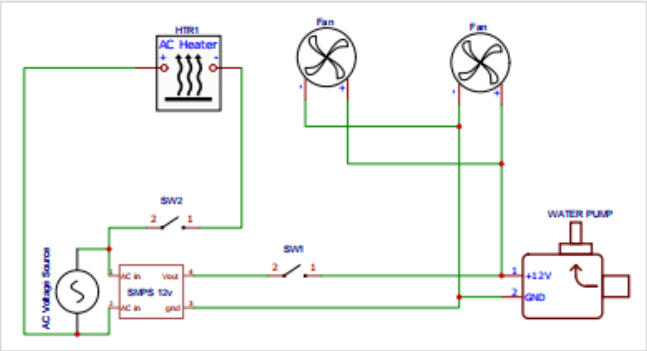


Figure 4.2: Schematic Circuit Diagram of the Project

4.5 Working Principle:

The main power source of our system is a powerful 12 v 2 A SMPS. Once the system is switched on and connected to the SMPS, the system is ready to work. A performance heat exchanger using stainless steel tubes with fins operates by enhancing heat transfer between two fluids. The stainless-steel tubes serve as the primary conduit for fluid flow, while the attached fins increase the surface area available for heat exchange. As one fluid flows through the tubes, heat is transferred through the tube walls to the fins, which then dissipate this heat to the surrounding fluid or environment. The fins, being extended surfaces, improve the efficiency of heat transfer by maximizing contact with the secondary fluid or air. This design boosts overall heat exchanger performance by improving thermal conductivity and fluid flow dynamics.

4.6 Our Final System view:



Figure 4.3: Our Final System Overview

CHAPTER 5

RESULT & DISCUSSION

5.1 Discussion:

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

5.2 Advantage:

There are many advantages of our project because of its accuracy. Some of the advantages are pointed out below:

- **Enhanced Heat Transfer Efficiency**: Fins significantly increase the surface area available for heat exchange, improving the overall heat transfer rate between the fluids.
- **Corrosion Resistance**: Stainless steel's inherent resistance to corrosion ensures durability and longevity, even in harsh or corrosive environments.
- **High Temperature Tolerance**: Stainless steel maintains its structural integrity and performance at elevated temperatures, making it suitable for high-temperature applications.
- **Compact Design**: The use of fins allows for a more compact heat exchanger design, reducing the space required while maintaining high performance.
- **Improved Durability**: Stainless steel's strength and resistance to mechanical wear contribute to the heat exchanger's robustness and long-term reliability.
- **Energy Efficiency**: Enhanced heat transfer efficiency leads to better thermal management and reduced energy consumption, resulting in cost savings and improved operational efficiency.

5.3 Disadvantage:

- **Corrosion Resistance Limits:** While stainless steel generally has good corrosion resistance, in certain environments (e.g., high chloride levels), it can still suffer from pitting and crevice corrosion, which can lead to reduced heat exchanger efficiency and lifespan.
- **Cost Implications:** Stainless steel, particularly when finned, can be more expensive than other materials. This increases the overall cost of the heat exchanger, making it less appealing for budget-sensitive projects or applications.
- **Heat Transfer Efficiency:** Although fins enhance heat transfer, they can also create additional pressure drops. If the design isn't optimized, this can lead to lower overall efficiency in fluid flow, potentially negating the benefits of enhanced surface area.

5.4 Application:

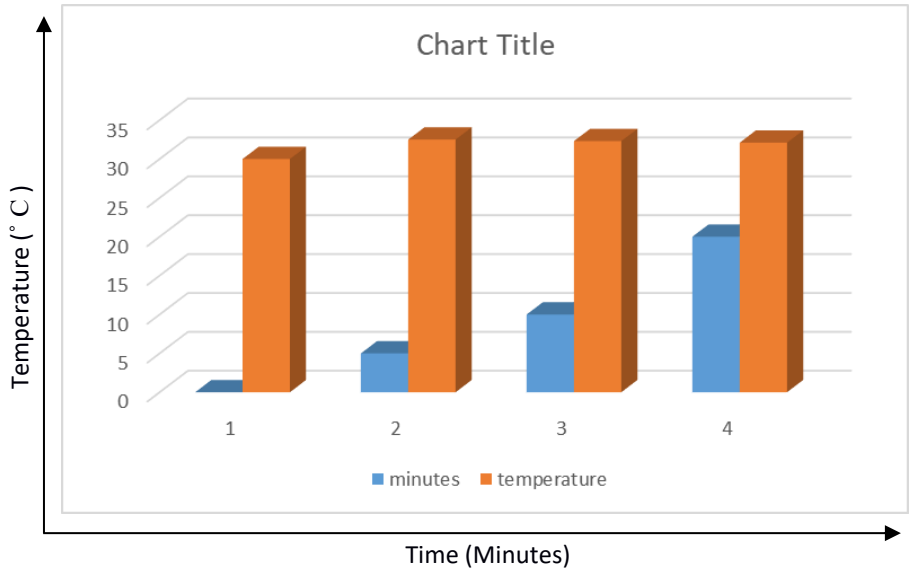
Some of the application areas of the project have been pointed out below:

- Ensuring quality control in mass production.
- By some modification it can be used to control the water cooling.
- By some modification it can be used to measure the weight of the water.
- By increasing its pipe capacity, it can be used in industry's.
- It is also very useful in laboratories and workshops.
- It's can be widely used any productive industry.

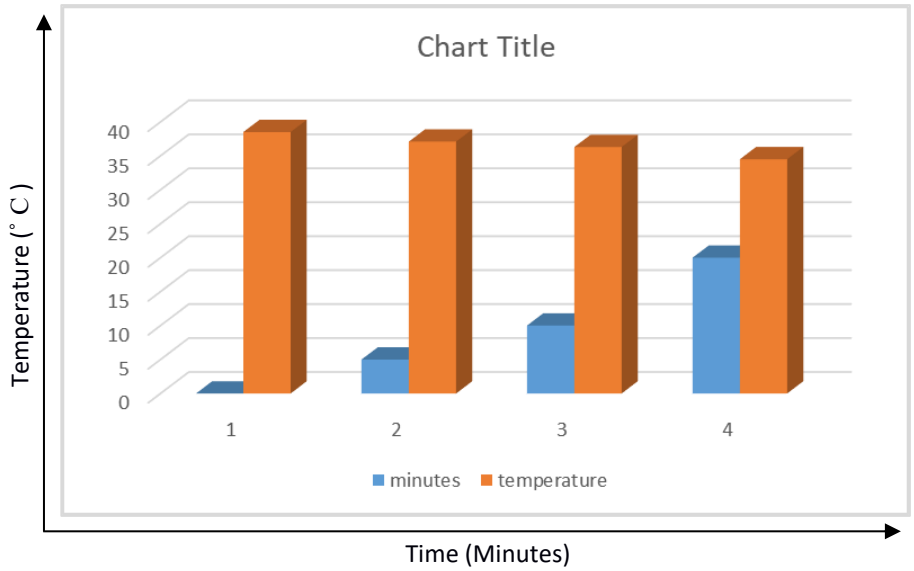
5.5 Result Analysis:

Objectives	Normal Water Temperature	After 5 mint water temperature	After 10 mint water temperature	After 20 mint Water temperature
Stainless steel pipe	30˚ C	32.5˚ C	32.3˚ C	32.1˚ C
Heating water	38.5˚ C	37.1˚ C	36.3˚ C	34.5˚ C
Fin pipe	30˚ C	31.7˚ C	31.5˚ C	31˚ C

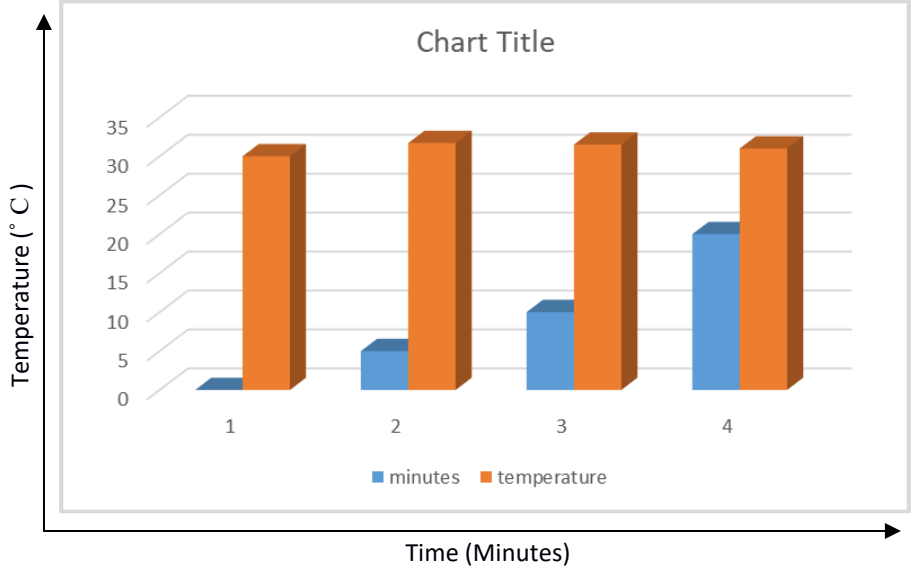
❖ **Stainless Steel Tube Pipe Temperature Graph Chart**



❖ **Heating water temperature Graph Chart**



❖ **Fin Tube Pipe Temperature Graph Chart**



CHAPTER 6

CONCLUSION

6.1 Conclusion:

In conclusion, the use of stainless-steel tubes with fins in heat exchangers significantly enhances performance by optimizing heat transfer efficiency. Stainless steel's excellent thermal conductivity, corrosion resistance, and durability make it an ideal choice for handling diverse and harsh operating conditions. The fins, strategically attached to the tubes, expand the heat exchange surface area, facilitating more effective thermal transfer between fluids. This design not only improves heat dissipation but also boosts the overall thermal performance of the system. By increasing surface area and improving fluid dynamics, finned heat exchangers achieve higher heat transfer rates and energy efficiency. This results in better thermal management and cost savings in various industrial and commercial applications. Therefore, integrating stainless steel tubes with fins in heat exchangers represents a robust solution for achieving superior heat transfer performance and reliability.

6.2 Future Scope:

We are thinking about adding many features to our project in the future to get more desirable outcomes. Some of the steps that we are thinking about taking are given below:

1. In By using the same set of tabulators, heat transfer augmentation for various fluids can be studied.

2. Instead of using steam as isothermal source to maintain constant wall temperature hot water can be used as isothermal source.

3. These variant tabulators can be used for heat transfer augmentation studies also in refrigeration system.

4. For the same set of tabulators, heat transfer and friction characteristics can be studied for laminar flow condition.

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