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Design & Fabrication of Double Pipe Heat Exchanger with Increased Effectiveness using Fins

Abhishek Pandey[1], Abhishek Sharma[2], Aman Khare[3], Anurag Patel[4]
[1, 2, 3, 4]*Mechanical Engineering Department, Under Graduate Student, Pranveer Singh Institute of Technology, Kanpur*

***Abstract:** This work introduces a novel method that enhances the thermal performance of a heat exchanger. These performances can be in terms of effectiveness, efficiency, rate of work produced and optimization in energy consumption. As Heat transfer is one of the most important processes in industrial and consumer products, therefore by reduction in heat loss or by increasing the rate of heat exchange we can be increasing the efficiency of a medium scale industry by approximately 4-5%. In our process, we have replaced the conventional heat exchanger with a finned tube so as to increase the area of contact and in turn the heat flow rate. Here, we should a have to perform experiments so as to analyze the effectiveness of the fin that can be helpful in increasing the efficiency of the industry (if rate of flow of heat increases). In this work we have initialized by making a finned tube model of a heat exchanger along with the conventional one. After successful fabrication, we also need to perform practical experiment so as to do the further analysis. Through the analysis, it is expected that the heat flow rate via finned tube heat exchanger should be greater than that of the conventional one. Thus, with increased effectiveness it has various application in the industrial plants or factories where hot fluid is to be transferred through a proper medium. Radiators are also a finned tube heat exchanger that has important application in vehicles.*

***Keywords:** Effectiveness, Efficiency, Fins, Radiators.*

I. INTRODUCTION

In this era the effective utilization of resources, minimum wastage of energy and increased efficiency is the need of every industry. Heat exchanger has been playing a vital role in meeting these demands, by effective transfer of energy from a hot fluid to a cold with maximum rate and minimum investment and running costs. It helps in effective utilization of waste heat in industries and also various machineries, in order to prevent overheating of the same. Heat transfer enhancement is the process of improving the performance of a heat transfer system to increasing the heat transfer coefficient. An increase in the heat transfer coefficient generally leads to another advantage of reducing the temperature driving force, which increases the efficiency of the industry. This increased coefficient can be attained by the techniques that are used to augment heat transfer. The most effective way to enhance the heat transfer on the air-side of a heat exchanger is to modify the fin pattern and geometry by interrupting it periodically along the stream wise direction.

Heat transfer enhancement techniques are classified as the - Passive Methods, Active Methods, and Compound Methods.

These methods are commonly used in areas such as process industries, heating and cooling in evaporators, thermal power plants, air-conditioning equipment, refrigerators, radiators for space vehicles, automobiles, etc.

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A. Different Methods of Heat Transfer Enhancement

Heat transfer enhancement, augmentation deals with the improvement of thermos hydraulic performance of heat exchangers. Different enhancements techniques have been broadly classified as passive, active and compound techniques.

1) *Inserts:* These are inserted inside tubes of heat exchangers which increase turbulence inside the tubes by guiding flow leading to forced convection and thus increasing rate of heat transfer.
2) *Fins:* In order to enhance heat transfer or quantity of heat transfer with the required temperature drop, extended surfaces or fins are used. This basically enhances the total contact surface area and thus heat enhancing transfer rate.

II. EXTENDED SURFACES

The heat conducted through solids, walls or boundaries has to be continuously dissipated to the surroundings or environment to maintain the system in steady state conduction. In many engineering applications large quantities of heat have to be dissipated from small areas. Heat transfer by convection between a surface and the fluid surroundings it can be increased by attaching to the surface thin strips of metals called fins. The fins increase the effective area of the surface thereby increasing the heat transfer by convection. The fins are also referred as “extended surfaces”. Extended surfaces (fins) are one of the heat exchanging devices that are employed extensively to increase heat transfer rates. The rate of heat transfer depends on the surface area of the fin. It increases the contact surface area, for example a heat sink with fins.

The heat transferred through the fins provides the problem of determination of heat flow through a fin requires the knowledge of temperature distribution through it. This can be obtained by regarding the fin as a metallic plate
connected at its base to a heated wall and transferring heat to a fluid by convection. The heat flow through the fin is by conduction. Thus the temperature distribution in a fin will depend upon the properties of both the fin material and the surrounding fluid.

Now-a-days the fin inserts are also incorporated to increase turbulence inside the tubes leading to forced convection and thus increasing rate of heat transfer.

A. Selection of Material

Aluminium has high thermal conductivity, scaling, oxidation & corrosion is not so effective in the performance of heat exchanger, and most importantly economical in cost as compared to copper and competes with it in a better way.

B. Geometry of Fin

A circular fin is easier to install and also the no. of fins that can be attached also increases as compared to when using longitudinal fins, which in turn increases effective contact surface area and hence heat transfer.

C. Base Area of Fin

The increase in number of fins and decreasing the thickness to very small, as infinite small thickness is not possible so it is chosen in such a way that it doesn’t affects the required strength of fin as well, this enhances the total surface in contact and thus increases effective heat transfer and hence effectiveness.

D. Use of Inserts

The use of inserts in heat exchanger tubes increases the turbulence of water flowing and thus causing forced convection and hence enhances the rate of heat transfer between the two fluids.

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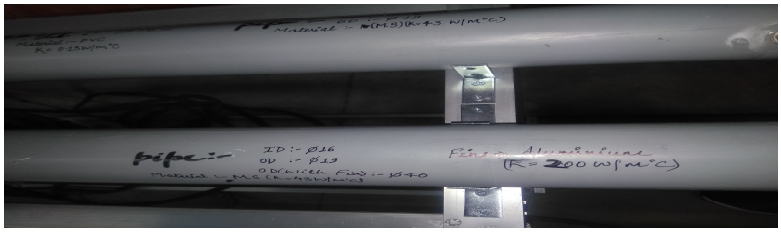
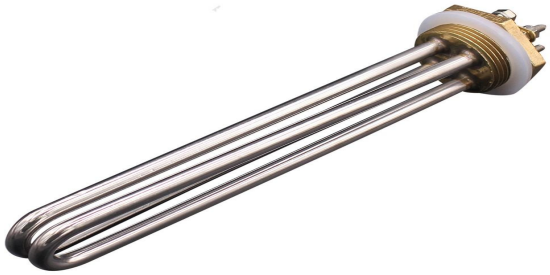
III. COMPONENTS USED

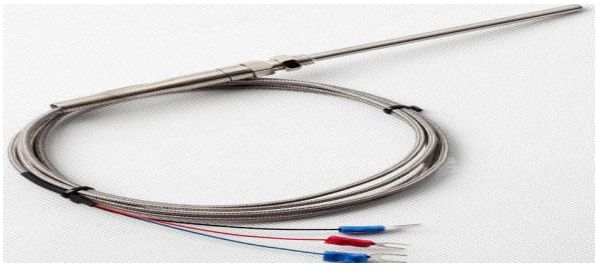
1) *PVC Pipe:* Polyvinylchloride (PVC) has high hardness Traditional product PVC has a maximum operating temperature around 140°F (60°C) when heat distortion begins to occur. As a thermoplastic, PVC has an inherent insulation that aids in reducing condensation formation and resisting internal temperature changes for hot and cold liquids. Thermal conductivity of PVC is 0.15 W/(m·K) .



2) *Heating Element:* A heating element converts electrical energy into heat through the process of Joule heating. Electric current through the element encounters resistance, resulting in heating of the element.



3) *Temperature Sensing Element:* A temperature sensor is a device, typically, a thermocouple or RTD, that provides for temperature measurement through an electrical signal. A thermocouple is made from two dissimilar metal wires. The wires are are joined together at one end to form a measuring (hot) junction. The other end, known as the reference (cold) junction, is connected across an electronic measurement device (controller or digital indicator).



4) *Valves:* Brass Ball Valves for use in residential and light commercial applications. Typical services include; Multi-purpose shut-off valve for use in domestic hot and cold water systems, natural or bottled gas and compressed air systems. Valve pressure rating 250 psi/17.2 bar non-shock cold working pressure, Maximum service temperature 250°F.

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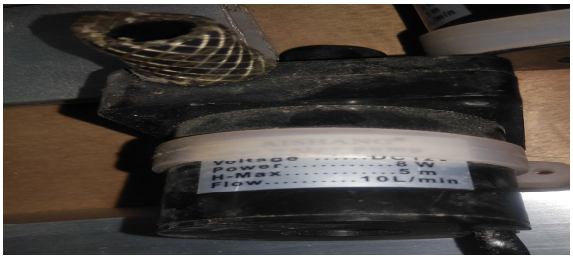
5) *Supporting Structure:* It helps supporting to support the components i.e., finned and un-finned pipes.
6) *Finned Pipe and Un-finned Pipe:* A fin tube is a tube that has small fins around the outside surface. These fins act as a filter and a mechanism to transfer heat from the material inside the tube to the outside space or vice versa. A fin tube exchanger can be used as an industrial heat exchanger also.

7) *Flow Sensor:* Flow sensors are devices which are used to measure a flow rate of Fluid. Liquid flow sensors are used for gauging mass flow, flow velocity, or a volumetric flow rate of a liquid. It can be calculated by determining the speed of a liquid over a particular area, or as forces created by a flowing stream overpowers a defined compression.

8) *Hose Pipes: For causing flow of fluid.*
9) *Pump:* A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action.



IV. HEAT EXCHANGER SPECIFICATIONS

S. No.	Title	Value
1	Fin Material	Aluminum
2	Tube Material	M.S
3	Tube Internal Diameter	0.016 m
4	Tube Outer Diameter	0.01 m
5	Fin Outer Diameter	0.0400 m
6	Fin Thickness	0.001 m
7	Fin Space	0.03933 m
8	No. of Fins	900
9	Total Length of Tube	1.75 m

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V. CONCLUSIONS

Aluminum already being good conductor of heat it accelerates heat transfer. Aluminium also has many qualities like rustproof, antifouling, corrosion free, cheap and easily available makes it very useful for heat exchanger. Inserts are used in copper tubes. Inserts are twisted helically, such that water flowing through tubes moves in helically rotation and inserts push them towards the wall of Aluminum tubes which helps in heat transfer. Also inserts increase turbulence of water inside the tubes. With increase in external circular fins made of Aluminium tubes, it increases contact surface (surface area) for convection heat transfer. Fins also make cold water turbulent while flowing from tubes surface.

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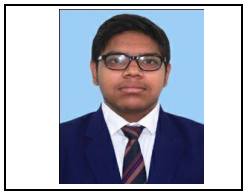
AUTHORS

Abhishek Pandey was born in Basti, India on 1998. He completed his Schooling from Central Academy, Lucknow, India.

Abhishek Sharma was born in Kanpur, India on 1998. He completed his Schooling from Dr. Virendra Swarup 21st Century School Kanpur, India.



Aman Khare was born in Kanpur, India on 1998. He completed his Schooling from Kendriya Vidyalaya IIT Kanpur, India.

Anurag Patel was born in Etawah, India on 1999. He completed his Schooling from Theosophical Inter College, Etawah, India.

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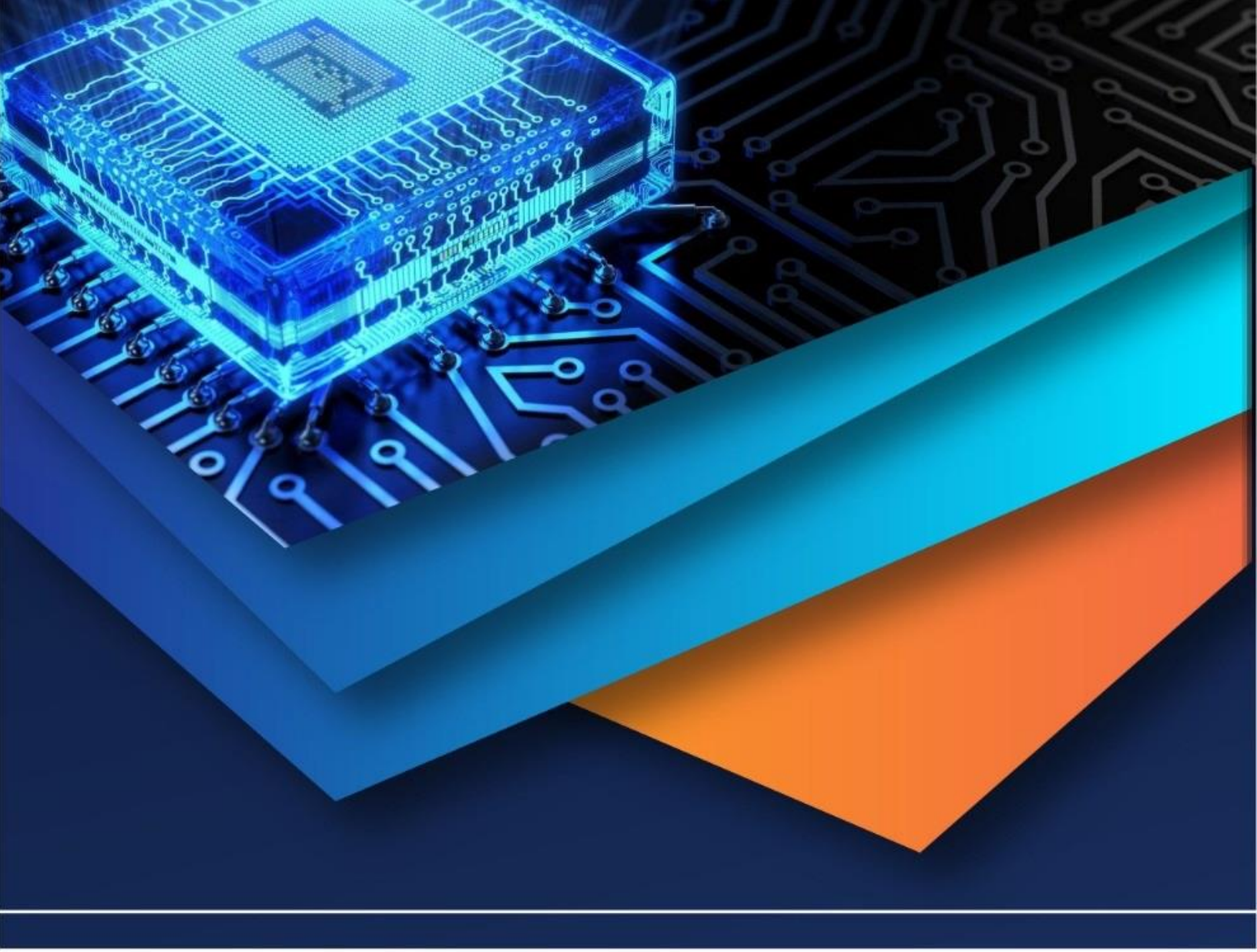

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