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DESIGN OF DIFFERENT TYPES OF FIN FOR OPTIMUM HEAT TRANSFER USING CFD

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Abstract:- Convective heat transfer is more when fins are used suitably, since the contact surface area for heat transfer increases, recently fin design is considered for improving the heat transfer and many investigations have been done recently and types fins are used and different shapes and various materials are tried to know the effect of heat transfer and improve it for better shape and material for greater rate of heat transfer. By increasing the surface area we can increase the heat dissipation rate. This will help to determine better geometry and materials for fins to achieve better heat transfer coefficient. Fins are integral part of any heating or cooling system. Our prime objective is to obtain optimum heat transfer rate which will result in producing highly efficient fins. A fin is a surface that extends from an object to increase the rate of heat transfer to or from the environment by increasing convection. Pin fins are broadly utilized as a part of heat exchanging body which result in enhancing the heat exchange between the surface of the body and ambient fluid by doing thermal analysis on the fins, it is helpful to know the heat dissipation and rate of heat transfer in different types of fins.

Keywords: - *Heat transfer, thermal analysis, geometry, Fluid Flow, Heat Transfer Rate, Fin.*

I INTRODUCTION

Heat transfer in fins is the exchange of heat from higher to low temperature. Exchange of heat develops till body and the environment reach a similar temperature. As indicated by the second law of thermodynamics, where there is a temperature consist between object in max heat exchange between them can never be stopped, it must be backed off. Heat is the energy in travel between frame words which happen by ideal of their temperature variation when they communicate. We are used different three types of fins. Square fin, Spiral fin, Circular fin & the aluminum material used for square fin & copper material used for spiral fin & composite material is used in circular fins. When any fluid flows through rectangular duct with heated object placed inside it, a respective pattern of flow carries heat through convection and radiation. Different profiled objects may give different rate of heat transfer. Hence the objects like pin fin with enhanced surface areas (Perforated) placed inside the duct, the heat transfer rate will be maximum. Computational Fluid Dynamics (CFD) are heavily used to solve, design and model complex industrial applications. Rate of heat transfer, mass flow rate, inside velocity, pressure and other associated parameters are studied and explained. Three case studies were performed the temperature profile of different fin as a function of length for different material and the effect of thickness on the proper length of the fin and the heat transfer rate for copper and aluminum. Low thickness involved low temperature and resulting in low heat transfer rate.

II EXPERIMENTAL SETUP

Apparatus:

A fin of different cross sections is fitted across a long rectangular duct the other end of duct is connected to the suction side of blower and the air flow pass the fin perpendicular to the axis. One end of the fin projects outside the duct and is heated by the heater. Temperature at five points along the length of fins. The air flow rate is measured by an orifice meter fitted on the delivery side of blower.

Schematic diagram of setup is shown in figure.

Fig 1: Experimental Setup

III EXPERIMENTAL PROCEDURE

- **NATURAL CONVECTION:**

Start heating the fin by switching ON the heater element and adjust the voltage on dimmer-stat from 0 to 100 V.

See that this input remains constant throughout the experiment.

When steady state is reached, record the final readings (1) to (5) and also record the ambient temperature reading.

- **FORCED COVECTION*:***

Start heating the fin by switching ON the heater element and adjust the voltage on dimmer-stat from 0 to 100 V.

See that this input remains constant throughout the experiment.

Start the blower and adjust the difference of level in the manometer with the help of gate valve. When steady state is reached, record the final readings (1) to (5) and also record the ambient temperature reading.

IV . CONSTRUCTION OF FIN:

- **Square fin:**

For manufacturing of square fin from lathe and from aluminum bar of size 150mm*15mm is done by lathe machine operations, mainly facing and threading operation in which facing is up to 125mm and threads on 25mm so that it is fitted in equipment and outer holes for wire attachment by which calculations are done and then performance by natural and forced convection of heat transfer takes place.

Fig.2. Square Fin

a. Spiral Fin:

Spiral fin operations take place on machine from copper bar of size 150mm*20mm is done by lathe machine mainly facing and threading operations in which facing operation and threading is up to 25 mm, so that it is fitted in equipment and outer holes for wire attachments by which calculations are carried out for both natural as well as forced convection.

b. *Circular Fin:*

In circular fin manufacturing is done through lathe machine and composite bar of size 150mm*20mm*12mm is done by the lathe machine operations of bore, facing, threading so that it is fitted in equipment and outer holes for wire attachments by which calculations are carried out and performance for forced and natural convection takes place.

Fig.3. Circular Fin

V . CFD ANALYSIS

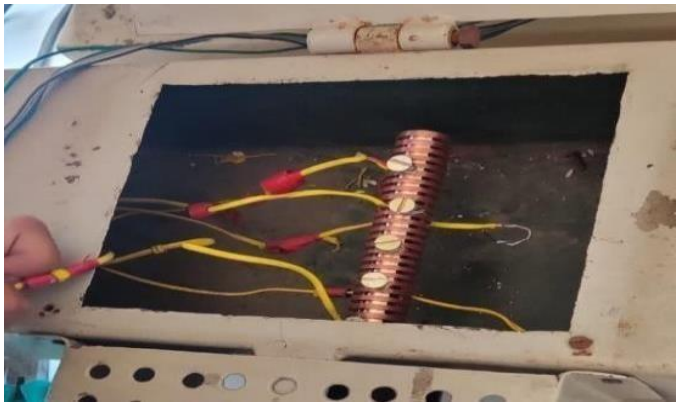
1) Modelling:

Design of fins were done in CATIA software and a fin different cross section fitted across a long rectangular duct and other end of duct is connected to suction side of blower & the air flow pass the fin perpendicular to the axis. Different materials are used along with variable geometries having their own thermophysical properties.

2) DESING AND FABRICATION OF FINS

Square Threaded Pin Fin:

In his experiment Square threaded pin fin is used which is having three screw at the top face of the pin fin which is use for the connecting the thermocouple which is use for measuring the temperature at various point at pin fin. We made models of the fin by using CATIA software by using sketch command, pad, pocket commands etc. The fin having a dimension of side 20 mm length and height 125 outer diameter of copper rounded bar 13mm . On the outer surface of the aluminum rounded bar there is five screw are situated



for thermocouple to know the temperature at various point.

Fig 4: Square Threaded Pin Fin

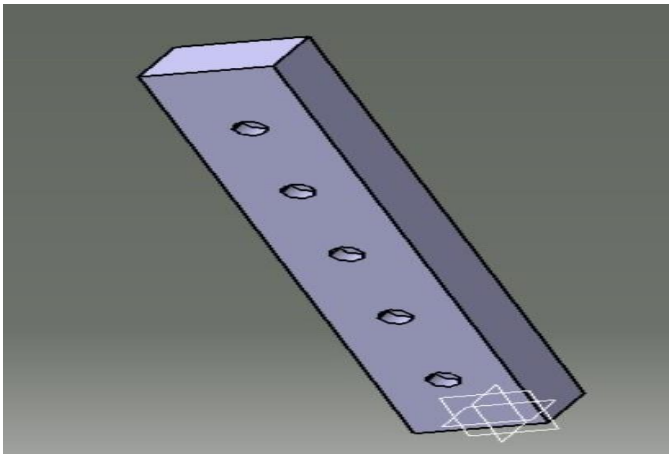


Fig.5. Square Threaded Pin Fin by Using CATIA Software.

Circular Threaded Pin Fin:

In this type of pin fin we consider circular which is having square threaded on outer surface of pin fin. This pin fin is made up of copper material.

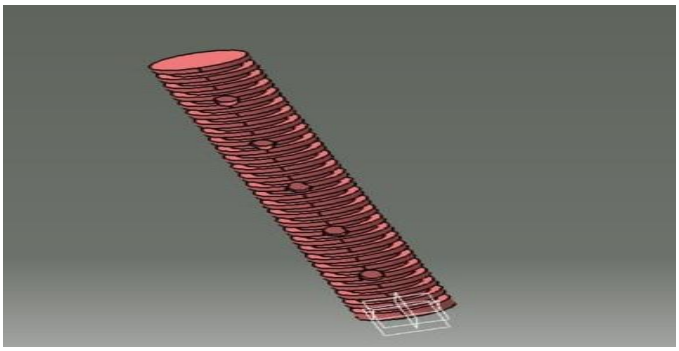


Fig.6.Circular Threaded Pin Fin by using CATIA software.

We make models of these fin with the CATIA software by using the various command in software like pad, pocket, mirror etc. these commands are use for making the models with software. The pin fin having diameter of 20 mm and height of 125 mm with square threaded on its circumference with height of 2.5 mm.

Circular Composite Pin Fin:

In this type of pin fin, we consider the two types of materials are copper and aluminum. This type of pin fin is manufactured by placing a copper rounded bar inside the aluminumrounded bar. On the outer periphery of rounded bar there is five holes are for the thermocouple which gives us temperature at various of point of fin. The dimension of the fin is having outer material is of aluminum having diameter 20mm and hollow diameter which is

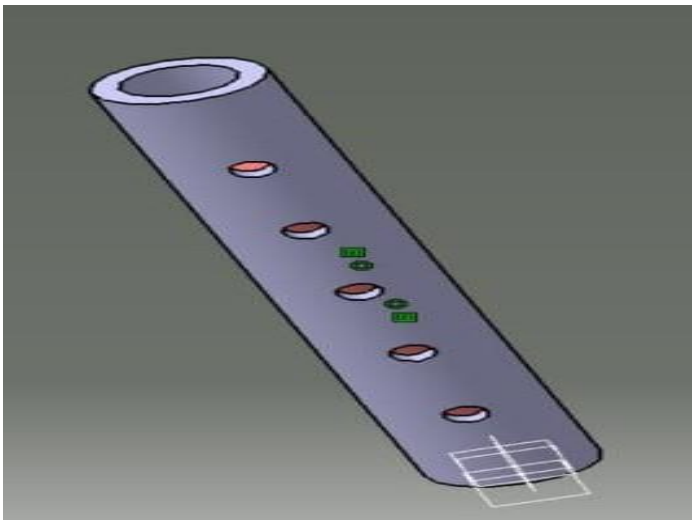


Fig.7. Circular Composite Pin Fin by using CATIA software.

VI CONCLUSION

It was designed an important graphical user interface to analyze and design fins for exchange of heat. Three case studies were performed, the temperature profile of different fins as a function of length for different materials, and the effect of thickness on the proper length of the fin and the heat transfer rate for copper and aluminum. The best working material was copper with the highest thermal conductivity (395W/moC). Low thickness involves low temperature in the extreme of the fin resulting in a low heat transfer in that zone. The higher the thickness, the higher the proper length. Between copper and aluminum, the best material for the same thickness is aluminum because it has the shortest proper

length. Though, it is necessary to see the amount of heat removed. Aluminum removes less heat than copper. The composite fin gives result in between two.

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