Comparative analysis of heat exchanger with different inserts

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***Abstract*—A heat exchanger is a device which is used to transfer heat between two or more fluids. Heat exchangers are normally used for both cooling and heating processes. The fluids can be separated by a solid wall so the fluid does not mix with each other. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. There are various type of heat exchanger like shell and tube heat exchanger, plate heat exchanger, plate and shell heat exchanger, helical coil heat exchanger etc. In the industry the shell and tube heat exchanger is very popular because of it's heat dissipation rate. In shell and tube heat exchanger normally straight tube is used but the size of shell and tube is very large due to this it is not economical in small scale industry.**

In this paper we are going to do experimental study of different inserts so heat dissipation rate increases and we can decrease the shell size and it becomes more efficient and economical. We are going to compare three various shape of inserts. The rectangle, triangle & circular shapes compare to find which type of inserts have good heat dissipation rate.

I. INTRODUCTION

In this research, the heat transfer performance of fin is analyzed by design of fin with various sections such as square shape, triangular shape and circular shape. The cross-sectional area of all three sections will be same. The heat transfer performance of fin with different geometry having same area is compared. In the study of heat transfer, fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Sometimes it is not feasible or economical to change the first two options. Thus, adding a fin to an object increases the surface area and can sometimes be an economical solution to heat transfer problems.

II. EXPERIMENTAL DETAILS AND MEASUREMENT

The specimen used for the experiment fabricated with one meter ½" (10S) pipe. The ID and OD of pipe specimen are 17.08 mm and 21.30 mm. Wall thickness of the selected tube is of 2.11 X 2 mm. As mentioned earlier in this experiment area of fin parameter is kept constant. Hence calculations to maintain the area of the fins of all three types constant are as below:-

1. Circular Fins
   Tube ID:-17.08 mm
   Tube OD:-21.30 mm
   Tube Wall thickness X 2:-4.22 mm
   Circular Fin height:-40 mm
   Total OD of Fin:- 101.3
   Surface Area of fin =
   Total area – Area of tube cross section

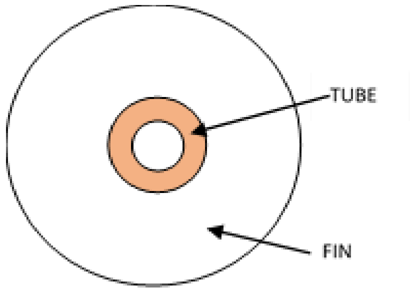

Fig.1 Cross Section of Circular Fin

Tube Area= πr^2= 356.4707 mm^2
Area of one side face of fin= πr^2=7706.2857 mm^2
Fin thickness area= πDL = 477.5571 mm^2 (L is fin thickness)

Now let us take total fin surface area =(2 X Single surface area) + Fin thickness area=15890.12857mm^2

2. Square Fins
Tube ID:-17.08 mm
Tube OD:-21.30 mm
Tube Wall thickness X 2:- 4.22 mm
As surface area is to be kept constant in all the cases i.e. 15890.12857 mm^2

Area= (2 X Area of square fin) + Fin thickness area
15890.12857 mm^2 = (2 X Area of square fin) + (4 X 1.5 X Length of one side of square)
Solving this we get, Square side length as 89.6251 mm

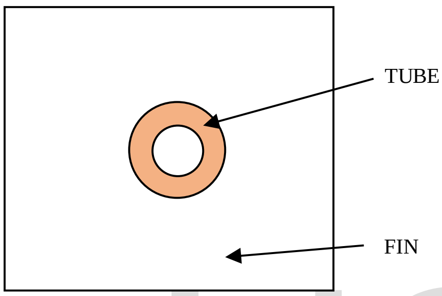

Fig.2 Cross Section of Square Fin

3. **Triangular fin:**
Tube ID:-17.08 mmTriangular Fins
Tube OD:-21.30 mm
Tube Wall thickness X 2:- 4.22 mm
As surface area is to be kept constant in all the cases i.e. 15890.12857 mm^2
Area= (2 X Area of triangular fin) + Fin thickness area
15890.12857 mm^2 = (2 X Area of triangular fin) + (3 X 1.5 X Length of one side of triangle) solving this we get, triangle side length as 132.8829 mm

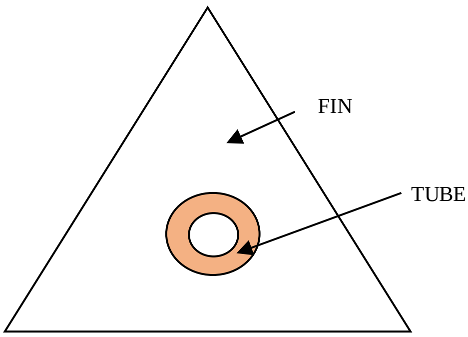

Fig.3 Cross Section of Triangular Fin

III. METHODOLOGY

In this paper comparative analysis of different types of inserts (triagular, square & circular) is done by the method of ansys&experimentation.Different cross-sectional inserts of same surface area of standard size(table -experiment setup) is taken into consideration.Now the nature of heat dissipation in these inserts is studied by the help of ansys by providing the necessary input data's.Now after getting the result , the best insert is chosen for experimentation purpose.Now a physical model (of shell & tube type heat exchanger) is used for experimental study of standard size. Now connection of pipes is done according to the type of heat exchanger with inserts placed inside the shell.Now cold water is pumped into the shell via pump until the entire shell is filled with it & the exit valve closed. Now after the shell being filled with cold water, hot water via another pipe consisting of inserts on the outer periphery is passed through it.Hot water is heated by the means of a heating coil in an outside tank & then pumped inside the shell & tube heat exchanger.Now as the hot water passes through the pipe enclosed in a hot surrounding, now due to temperature difference heat gets transferred from hot region to cold region.Now transfer rates is enhanced due to presence of fins with high conductivity value.Now temperature at four points (2 at inlet & 2 at outlet of cold pipe & hot pipe respectively) is measured by means of sensors and is noted.Now different values for different inserts & different hot water condition is experimented and is noted.Now the above noted values are substituted in formula and effectiveness is calculated for various measured values.After the calculation, the insert with high effectiveness value is chosen as the most efficient insert for economical use.

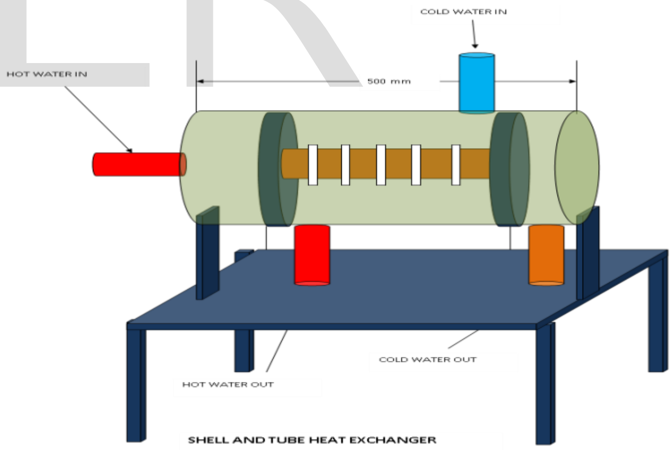

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Fig. 3 Cross Section of Squ