Effect of Friction Factor on Triple Tube Heat Exchanger within Dimple Tubing

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Abstract— Heat exchanger refers to a device which exchanges heat from hot fluid to cold fluid with maximum rate and minimum running cost. These are having applications in many industries such as material processing, automobiles, food industries, power plants, space research etc. triple concentric tube heat exchanger in a tubular type of heat exchanger which consists of three tubes which provides more heat transfer rate per unit length of heat exchanger. Experiments were performed to increase the effectiveness of triple tube heat exchanger by dimple tubing. So we considered the parameters of friction factor are compared with result of turbulent flow in triple tube by dimple tubing. Statistical correlations for the Nusselt number and friction factor have been developed in terms of geometrical parameters of the roughness elements and the flow Reynolds number.

Key words: Triple Tube Heat Exchanger, Effectiveness, Dimple

I. INTRODUCTION

Heat exchanger may be defined as equipment which transfers the energy from a hot fluid to a cold fluid, with maximum rate and minimum investment and running cost. Heat exchangers are mostly used devices in many areas of the industries such as material processing, food preparation refrigerators, radiators for space vehicles, automobiles and air conditioning etc. Heat exchangers have several industrial and engineering applications. Triple pipe heat exchanger consists of three pipes of three different diameters fitted concentrically in each other. Thus the heat exchanger consists of three sections which are inner tube, inner annulus and outer annulus. The main advantage of using triple tube heat exchanger is that they provide greater heat transfer rate per unit length of heat exchanger. In this heat exchanger hot fluid passes through the inner annulus and cold fluid passes through inner tube and outer annulus. The application of artificial roughness in the form of dimples of different shapes has been recommended to enhance the heat transfer coefficient by several investigators. Dimple tubes have been used to improve the heat transfer coefficient by creating turbulence in the flow.

For pipe flow, as long as entrance effects, roughness, and temperature variation are small dimensional analysis indicates that the friction factor is only a function of the Reynolds number Re by small dimensional analysis.

The Darcy-Weisbatch equation is an equation, which is relates the head loss, or pressure loss, due to friction along a given length of pipe to the average velocity of the fluid flow for an incompressible fluid. In a cylindrical pipe of uniform diameter D, the pressure loss due to viscous effects is proportional to length L and can be characterized by the Darcy Weisbach equation.

$$Fd= 4fLv^2/2gD$$

The Darcy friction factor 'Fd' depends on such things as the characteristics of the pipe (diameter D) and the characteristics of the fluid and the velocity of the fluid flow v. it has been measured to high accuracy within certain flow and may be evaluated by the use of various empirical relations, or it may be read from published charts.

II. EXPERIMENTAL SETUP

Fig. shows of experiment set up of triple tube heat exchanger with dimples that have been used in this experiment. This experiment consist of three tube which is made up of copper, aluminium and mild steel. The setup includes three rotameter for the measurement of flow rate of fluid, six thermocouple to the measure inlet and outlet temperature of three tube. It also includes hot tank and cold tank of capacity 40litre.We are using geyser to heat the water which is passing through aluminium tube. We are also using two pump of half hp to lift the water. In this experiment, cold fluid is passing through first tube and third tube i.e. copper and mild steel tube and hot fluid is passing through aluminium tube. Hence we called it as triple tube heat tube heat exchanger.

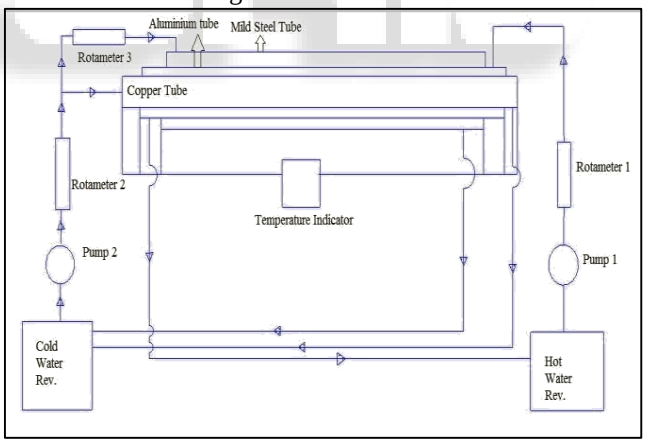

Fig. 1: Line diagram of setup

Fig. 2: Pictorial view of setup.

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III. EXPERIMENTAL PROCEDURE

1) Refer the fig.1 and make all the connection carefully.
2) Switch on hot water pump and also on water heater and wait until the temperature reaches optimum temperature.
3) Switch on temperature display.
4) Start the cold water pump.
5) So water flow becomes in counter flow manner.
6) We kept the hot water flow rate constant at particular limit and vary the flow rate of cold water, then take the reading of temperature at all the inlet and outlet of triple tube pipe.
7) Then calculate friction factor of heat exchanger and similarly, kept flow rate of cold water constant and vary the hot water flow rate further calculate friction factor of heat exchanger.
8) Then plot the graph of friction against Reynolds number.

IV. RESULT AND DISCUSSION

Fig-3 shows the relation between friction factors against Reynolds number in triple tube heat exchanger with dimple tubing, for turbulent flow condition. This proves that experimental rig validated. By the chart we can explain that as the Reynolds number increases friction factor in triple tube becomes decreases.

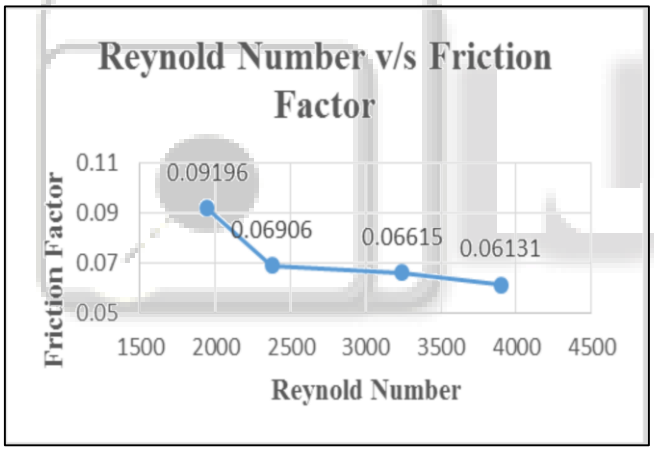

Fig. 3: Reynold Number v/s Friction Factor

Reynold number becomes varies from range 1500 to 4000, so that friction factor becomes reduces. This proves that experimental rig is validated.

V. CONCLUSIONS

By the experiment calculation of heat transfer and friction factor of triple tube heat exchanger we get valid effectiveness of heat exchanger. Also by calculation drawn the graph of friction factor against Reynolds number. The result obtained were considerable enhancement of heat transfer. It is concluded that heat transfer rate increases by friction factor increases so with less pumping power more heat transfer can achieved.

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