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EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER USING TWISTED ALUMINIUM TAPE

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ABSTRACT

Heat exchanger has a wide industrial and engineering applications. Increasing the efficiency of heat exchanger will increase the overall performance of the unit. This paper is about increasing the heat transfer coefficient of heat exchanger by causing a turbulence in the liquid flow through the pipe. For causing the turbulence, liquid flow is subjected to a Twisted Aluminium Tape (TAT) which will increase the Reynolds number of flow. This will ensure heat transfer through the length of flow and thus there will be an increased heat transfer rate. The increased turbulence and higher shear caused by Twisted Aluminium Tape (TAT) will offer resistance to fouling also.

KEY WORDS: Twisted Aluminium Tape in path of liquid flow, Turbulent flow created, Over all heat transfer increased.

INTRODUCTION

Heat exchanger is a device in which heat is transferred form one medium to another across a solid surface. Efficiency of heat exchanger depends on the type of flow. If the flow is laminar, heat transfer in the boundary of liquid flow will be maximum and heat in the center of flow will not be transmitted efficiently. But due to the surface roughness factor of the pipes used for flow, the flow of all liquids will be a transitional flow. This factor increases the heat transfer coefficient to some extent. If the flow is fully turbulent the heat concentrated in the center of liquid flow will spread equally and the temperature of fluid will be even throughout the flow. This will ensure constant heat transfer throughout the length of flow.

In this paper we aimed to increase the efficiency of heat exchanger by causing a turbulence in the liquid flow. Twisted Aluminium Tape (TAP) when placed in the path of liquid flow, creates a high degree of turbulence i.e. Reynolds number of flow increases. This will increase the Heat transfer coefficient of the liquid and there will be a pressure drop in the liquid flow due to the resistance caused by Twisted Aluminium Tape (TAP). This factor will increase the load on pump which will increase the pump cost. To increase the pressure, a taper clip is placed at the outlet of heat exchanger. This taper clip will increase the pressure of outlet fluid. Fouling is one the major factor which will reduce the heat transfer coefficient of a heat exchanger. Fouling is a dirt layer that gradually build up on heat transfer surfaces, increases thermal resistance caused by the flow there will be a resistance to fouling also.

EXPERIMENTAL SETUP

For proving the above theory, we took a counter flow heat exchanger and inserted a Twisted Aluminium Tape in the inner pipe. The inner pipe is subjected to a hot water flow (60 to 70°C) and the outer pipe is subjected to flow of water in ambient temperature. Inlet and outlet temperatures of both the pipes are measured with the help of Resistance Temperature Detector (RTD). To handle the pressure drop in the flow, taper clips and provided at the outlet of inner pipe. The experimental setup is shown below.

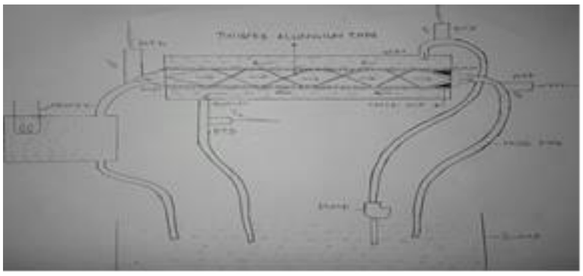


Figure.1.Experimental setup

Specifications:

Outer pipe material	= Mild steel	Inner pipe material	= Copper
Hose pipe	= vinyl	Taper clip	= stainless steel
Outer pipe outer diameter	= 62mm	Outer pipe inner diameter	= 60mm

Inner pipe outer diameter = 32mm Inner pipe inner diameter = 30mm
Heat transfer length = 1.5m Twist ratio of (TAT) = 1:3
Width of (TAT) = 20mm Water at room temperature (20 to 25°C) is allowed to flow through outer pipe and hot water at 60-70ºC temperature is flowed through inner pipe.

Formula used for calculation:

1.Overall heat transfer coefficient, U

Performance of heat exchanger is evaluated normally by the overall heat transfer coefficient "U" that is defined by the equation

Q = U×A×LMTD Where, Q = Heat exchanged, KW A= Heat transfer surface area, m²

LMTD= Log mean temperature difference in °C

1.U = Overall heat transfer coefficient, W/m²K

2.Heat transferred in hot fluid, $Q_h = WxC_{ph} \text{ x } (T_i - T_o)$ 3.Heat transferred in cold fluid $Q_c = W \text{ x } C_{pc} \text{ x } (t_o - t_i)$

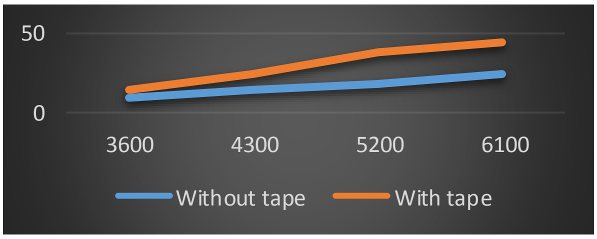
4.Heat transfer coefficient, $h_i = q/\Delta T (KW/(m^2K))$ 5. Heat flux (q) = Q/A (KW/m^2)

6.Temperature range of hot fluid $\Delta T = T_i - T_o$ (K) 7.Temperature range of cold fluid $\Delta t = t_i - t_o$ (K)

8. Effectivness, ϵ $= (t_o - t_i) / (T_i - T_o)$ 9.LMTD $= ((T_i - t_o) / (T_o - t_i)) / \ln((T_i - t_o) / (T_o - t_i))$

RESULT AND DISCUSSIONS

Reynolds Number vs Heat transfer coefficient: In this study, first we took the performance test of counterflow heat exchanger without twisted tape(TAT) and then with twisted tape(TAT). Both the results are compared and shown in the graph (fig4.1). The graph clearly shows that, when the flow is subjected to the twisted tape, the heat transfer coefficient (h_i) increases. This is because, the twisted tape will increase the reynolds number(Re) of flow, when the reynolds number(Re) increases, heat transfer coefficient also increases simultaneously.



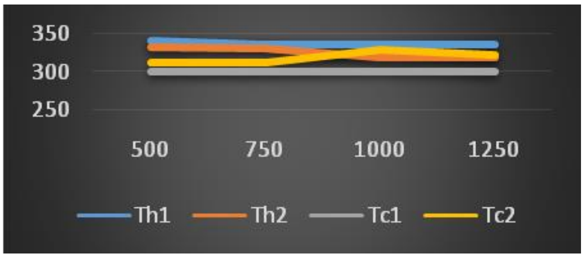


Figure.2.Reynolds Number(Re) vs hi (KW/m²K) **Figure.3.Heat transfer (Q), vs Temperature of fluids in (k)**

Heat transfer (Q) vs Temperature of fluids: The temperature of fluid at inlet and outlet of both the pipes are compared with the heat transfer rate and the results are shown in graphical form in fig.4.2

Length of pipe (L) vs Heat transfer rate (Q): As said before, If the heat transfer length increases it will simultaneously increase the performance of heat exchanger. As we know, the length of pipe is directly proportional to heat transfer (Q), when the length of fluid flow increases, heat transfer rate also increases. The fig 4.3. clearly shows the heat transfer rate for different length of pipes we calculated.

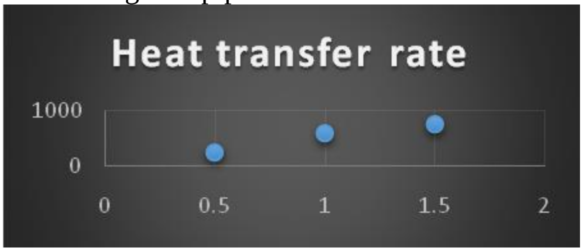


Figure.4.Length of pipe in (m) vs Heat transfer rate (Q)

FUTURE WORK

- In future, the next step is to rectify the pressure drop due to aluminium tape.
- We are also working on reducing the loss due to fouling factor
- We also try to reduce the workoutput to the agitator.

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