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Mesh In Tube Technique for the Tube in Tube Heat Exchanger Performance

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ABSTRACT

The tube-in-tube heat exchanger is designed in order to study the process of heat transfer between two fluids through a solid partition. It will be designed for a parallel flow as well as counter-flow arrangement and the logarithmic mean temperature difference (LMTD) method of analysis is adopted. Water will be used as a working fluid for the experiment. The temperatures of the hot and cold water supplied to the equipment. The method consider whether the exchanger is performing correctly to begin with, excess pressure drop capacity in existing exchangers, and their effect on exchanger calculations, and the use of augmented surfaces and enhanced heat transfer. The examples will be provided to show how commercial process simulation programs and tube-and-tube exchanger rating programs may be used to evaluate these exchanger performance issues. The parameter required to find out the effectiveness of the heat exchanger will be arranged in this setup such as the inlet and outlet temperature of the hot and cold fluid, flow rate of the fluid power consumption etc. The modified tube in tube will be replaced for the ordinary tube in tube so the surface area is increased so maximum heat will exchange from hot side to the cold side. This will be proved by calculation of the LMTD, Heat transfer coefficient and temperature difference. Arrangement will be made such that in one set we can achieve the both parallel and counter flow by simply opening and closing of the valve shown in the process of this whole setup. Inner tube used in this set up is made of the copper so the maximum heat is transfer to the outer fluid and outer pipe is made of the MS which is the insulated by the insulation to reduce the heat losses. This set up will be used for Increasing the Logarithmic mean temperature difference, Increasing heat transfer coefficient, Increasing the effectiveness, Compare the temperature difference in graphical view for the modified heat exchanger by the parallel flow and counter flow & compare with the ordinary HE.

***Keywords*— a Heat transfer, LMTD, Parallel flow, Counter flow, Effectiveness, Heat transfer coefficient**

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I. INTRODUCTION

This A heat exchanger is a device that transfers thermal energy from a high-temperature fluid to a low-temperature fluid with both fluids moving through the device. Examples in practice in which flowing fluids exchange heat are air intercoolers and pre-heaters, condensers and boilers in steam plant, condensers and evaporators in refrigerator units, and many other industrial processes in which a liquid or gas is required to be either cooled or heated.

There are three main types of heat exchangers:

1) The Recuperative type in which the flowing fluids exchanging heat are on either side of a dividing wall.
2) The Regenerative type in which the hot and cold fluids pass alternately through a space containing a matrix of material that provides alternately a sink and a source for heat flow.
3) The Evaporative type in which a liquid is cooled evaporatively and continuously in the same space as the coolant.

Recuperative type of heat exchanger, which can further be classified, based on the relative directions of the flow of the hot and cold fluids, into three types:

1) Parallel flow, when both the fluids move in parallel in the same direction.
2) Counter flow, when the fluids move in parallel but in opposite directions.
3) Cross flow, when the directions of flow are mutually perpendicular (Lienhard 2005).

Heat exchanger is a special equipment type because when heat exchanger is directly fired by a combustion process, it becomes furnace, boiler, heater, tube-still heater and engine. Vice versa, when heat exchanger make a change in phase in one of flowing fluid such as condensation of steam to water, it becomes a chiller, evaporator, sublimator, distillation-coloumn reboiler, still, condenser or cooler-condenser. Heat exchanger may be designed for chemical reactions or energy-generation processes which become an integral part of reaction system such as a nuclear reactor, catalytic reactor or polymer. Normally, heat exchanger is used only for the transfer and useful elimination or recovery of heat without changed in phase. The fluids on either side of the barrier usually liquids but they can be gasses such as steam, air and hydrocarbon vapour or can be liquid metals such as sodium or mercury. In some application, heat exchanger fluids may use fused salts.

Increasing heat exchanger performance usually means transferring more duty or operating the exchanger at a closer temperature approach. This can be accomplished without a dramatic increase in surface area. This constraint directly translates to increasing the overall heat transfer coefficient,

A. *Objective*

1. To design and construct a Mesh in concentric- tube heat exchanger in which two tubes are concentrically arranged and either of the fluids (hot or cold) flows through the tube and the other through the annulus.

2. To carry out test on the Mesh in concentric- tube heat exchanger and obtain values which will be compared to theoretically determined ones.

3. Increasing the Logarithmic mean temperature difference for the modified heat exchanger by the parallel flow and counter flow & compare with the ordinary HE.

4. Increasing heat transfer coefficient for the modified heat exchanger by the parallel flow and counter flow& compare with the ordinary HE.

5. Increasing the effectiveness for the modified heat exchanger by the parallel flow and counter flow& compare with the ordinary HE.

6. Compare the temperature difference in graphical view for both modified and ordinary HE.

II. LITERATURE REVIEW

Folaranmi Joshua Department of Mechanical Engineering, Federal University of Technology Minna, Niger State, Nigeria, in his paper, he published the design and construction of a concentric tube heat exchanger. The concentric tube heat exchanger was designed in order to study the process of heat transfer between two fluids through a solid partition. It was designed for a counter-flow arrangement and the logarithmic mean temperature difference (LMTD) method of analysis was adopted. Water was used as fluid for the experiment. The temperatures of the hot and cold water supplied to the equipment were 87o and 27oC, respectively and the outlet temperature of the water after the experiment was 73oC for hot and 37oC for cold water. The results of the experiment were tabulated and a graph of the mean temperatures was drawn. The heat exchanger was 73.4% efficient and has an overall coefficient of heat transfer of 711W/m2K and 48oC Log Mean Temperature Difference. The research takes into account different types of heat exchangers.

In the paper of V.NATARAJAN* Research Scholar, Sathyabama University, Chennai, Tamil Nadu, India DR.P.SENTHIL KUMAR Professor & Head, K.S.R. College of Engineering, Thiruchencode, Tamil Nadu, India. They focused on the investigational cram of the recital characteristics of tube-in-tube compact heat exchangers. Experiments are conducted in the compact heat exchangers with R-134a and liquefied petroleum gas. The effectiveness of the heat exchangers was calculated using the experiment data and it was found that the effectiveness of heat exchanger-1 is above 75 and heat exchanger-2 is above 84% for R-134a.The effectiveness of heat exchanger-1 is about 60% and heat exchanger-2 is about 81% for liquefied petroleum gas. In this paper, details about the new tube-in-tube type compact heat exchanger, experimental setup, results and conclusions are discussed**.**

III.METHODOLOGY

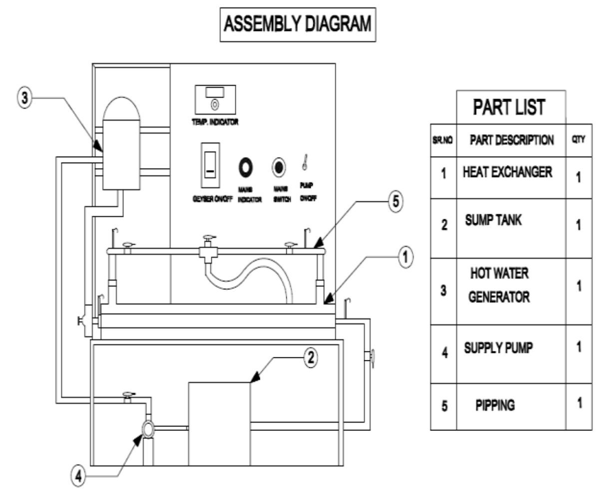

Fig. 1 General Setup for Modified Tube Heat Exchanger

A. Required components

Base stand, Heat exchanger, Sump tank, Geyser, Multipoint Temperature Indicator, K-type pencil thermocouples, Centrifugal pump, Pipes & valves.

B. Concentric Tube type heat exchanger:

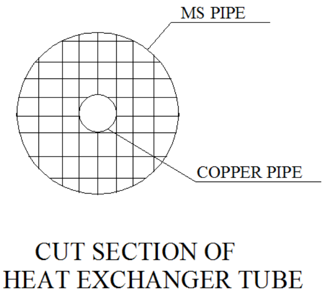

Fig. 2 Mesh for Tube

As this test rig is only for demonstrative purpose so that it is consist of concentric tube type heat exchanger having inner tube length 1600 mm & OD 12.7 mm& ID 10 mm. This tube is housed in shell of OD 47.8 mm& ID 40 mm. Heat exchanger is a device in which the exchange of energy between two fluids at different temperatures takes place.

IV.EXPERIMENTAL PROCEDURE

It consists of a concentric tube type of heat exchanger. This heat exchanger consist of a tube is housed in shell. A pipe & valve arrangement is provided to select the direction of cold water. A water heater is provided to supply hot water at specified temperature continuously. K-type thermocouples are fitted at the inlets & outlets of both fluids to measure the temperature.
Arrangement is made such that in one set we can achieve the both parallel and counter flow by simply opening and closing of the valve shown in the process and information diagram of this whole setup

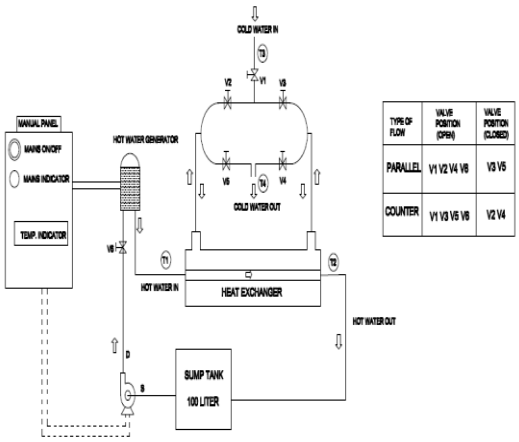

Fig. 3 Parallel & Counter Flow for Modified Heat Exchanger

Temperatures in system:

Parallel system:

T1= Temperature Of Hot Water At Inlet
T2= Temperature Of Hot Water At Oulet
T3= Temperature Of Cold Water At Inlet
T4= Temperature Of Cold Water At Outlet

Counter system:

T1= Temperature Of Hot Water At Inlet
T2= Temperature Of Hot Water At Oulet
T3= Temperature Of Cold Water At Outlet
T4= Temperature Of Cold Water At Inlet

V.CALCULATION PROCEDURE

A. *LMTD (θ_m)*

$$(\theta_m)_{Parallel\ flow} = \frac{(T_1 - T_3) - (T_2 - T_4)}{\ln\left\{\frac{(T_1 - T_3)}{(T_2 - T_4)}\right\}}$$

Where,

T_1 - Hot Water In.
T_2 - Hot Water Out.
T_3 - Cold Water In.
T_4 - Cold Water Out.

$$(\theta_m)_{Counter\ flow} = \frac{(T_1 - T_4) - (T_2 - T_3)}{\ln\left\{\frac{(T_1 - T_4)}{(T_2 - T_3)}\right\}}$$

Where,

T_1 - Hot Water In.
T_2 - Hot Water Out.
T_3 - Cold Water Out.
T_4 - Cold Water In.

B. *Heat Transfer Coefficients*

$Q_{\text{Parallel flow}} = (m\ C_p)_{hot}\ (T_1\text{-}T_2) = (m\ C_p)_{cold}\ (T_4\ \text{-}T_3)$
$Q_{\text{Counter flow}} = (m\ C_p)_{hot}\ (T_1\text{-}T_2) = (m\ C_p)_{cold}\ (T_3 - T_4)$

Where,

m - Mass of hot water
C_p - specific heat of hot water (2000 J/Kg K)
C_p - specific heat of cold water (4178 J/Kg K)

$Q = U\ A\ \theta_m$

Where,

Q = total heat required.
U = Heat transfer coefficient.
θ_m = log mean temperature difference.
A = Heat transfer area = ΠDL

$$U = \frac{Q}{\theta_m A}$$

C. *Heat Exchanger Effectiveness*

$$\text{Effectiveness} = \frac{(mC_p\Delta T)_{\text{hot or cold}}}{(mC_p)_{\text{small}}\,(T_1 - T_4)}$$

VI.CONCLUSION

By this experimental work, effectiveness of the modified heat exchanger is increased. Also Increasing the Logarithmic mean temperature difference (LMTD), heat transfer coefficient. It gives the comparatively results for the ordinary and modified heat exchanger.

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