

Design and Experimental Analysis of Concentric Tube Heat Exchangers with Various Fins

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ABSTRACT: A Heat Exchanger is a device built for the efficient heat transfer from one fluid to another, whether the fluids are separated by a solid wall so that they never mix, or the fluids are directly in contact. Heat transfer by convection between a surface and the fluid surrounding can be increased by attaching to the surface called fins. Every year research in Heat exchanger technology is growing to develop efficient, compact and economical heat exchangers, all over the world. counter flow heat exchanger models were developed. and reading were taken, The results were compared between each model and between hexagonal and semi circular fins. The heat exchange dependencies of the heat transfer coefficient and the pressure drop are investigated through experimental . We have to increases the efficiency of the heat exchanger by changing various configuration of design. Overall heat transfer co efficient of the heat exchangers were calculate and compare the results of hexagonal and semicircle fin ,select suitable fin which could produce high heat transfer rate and efficiency than the other one.

KEYWORDS: heat transfer enhancement, counterflow, hexagonal fin, semicircle fin

I. INTRODUCTION

The heat exchanger is a device which transferred the heat from hot medium to cold medium without mixed both of medium since both mediums are separated with a solid wall generally. There are many types of heat exchanger that used based on the application. Heat exchangers are useful in many engineering process like those in power generation, chemical processing, electronics cooling, air-conditioning, refrigeration, and automotive, food processing applications. For example, double pipe heat exchanger is used in chemical process like condensing the vapor to the liquid. When to construct this type of heat exchanger, the size of material that want to uses must be considered since it affected the overall heat transfer coefficient. For this type of heat exchanger, the outlet temperature for both hot and cold fluids that produced is estimated by using the best design of this type of heat exchanger. Basically the heat exchanger has two type that are parallel flow heat exchanger, counter flow heat exchanger. Based on performance and heat transfer rate counter flow heat exchanger has high efficiency than the parallel flow heat exchanger. So that in for produce best heat transfer counter flow heat exchanger is used. After few years of research the fins has introduce in heat exchangers for Improve performance. After the presence of the fins ,the modification were implemented in heat exchanger for improve performance of the system. The heat conducting through solids, walls, or boundaries has to be continuously dissipated to the surroundings or environment to maintain the system in a steady state condition. In many engineering applications large quantities of heat needed to be dissipated from small areas. The fins increase the effective area of a surface thereby increasing the heat transfer by convection. Past few years lot of modification are implemented in fin design for increase heat transfer rate in the heat exchanger. The reason for implementation of fin is increase the pressure drop. while the pressure drop increases that affect mass flow rate and make it low ,due to low mass flow rate the amount of heat transfer is increased.

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II. PROBLEM STATEMENT

The heat exchanger is used in industry such as condenser for Chemical process and cooling fluid process. This is designed in a large size for large application in industry. Heat transfer is considered as transfer of thermal energy from physical body to another. Heat transfer is the most important parameter to be measured as the performance and efficiency of the concentric tube heat exchanger. In normal heat exchanger there various fins are used but, Due to the low pressure drop, low heat transfer rate is produced.

III. OBJECTIVES

Our main aim of the project is to increase the overall heat transfer coefficient of the heat exchanger. Based on this concept the semi circle and hexagonal shape fins are placed over the inside copper tube so the cold fluid are passed over the fins in that time pressure drop of the fluid are increased so the heat transfer rate from hot fluid to cold fluid are increase.

IV. COUNTER FLOW

In this flow arrangements the fluids (hot & cold) enter in the unit from opposite ends, travel in opposite directions and subsequently leaves from opposite ends. Obviously the flow of fluids is opposite in direction to each other. For a given surface the counter flow arrangement gives the maximum heat transfer rate & is naturally preferred for the heating & cooling of fluids.

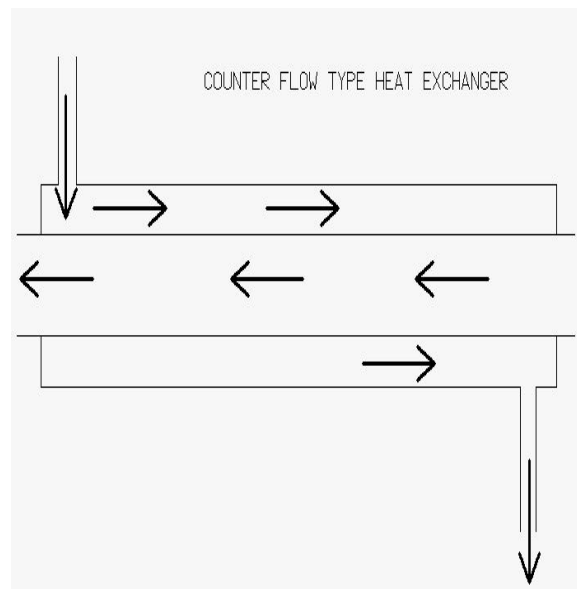


Figure [1]

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V. MATERIEL PROPERTIES

FIN MATERIAL

Aluminium alloy (GRADE 6063)

S.NO	DESCRIPTION	PROPERTIES
1.	Thermal Conductivity	200 W/M.K
2.	Yield strength	290 Mpa
3.	Elastic modulus	50 Gpa
4.	Melting point	660 ⁰ c
5.	Boiling point	2519 ⁰ c

6. FIN DESIGN: Thickness of fins =5mm

Hexagonal fin

Semi-circle fi

Copper



Figure [2]

TUBE MATERIAL

Side = 5mm

Diameter =10mm

S.NO	DESCRIPTION	PROPERTIES
1.	Thermal conductivity	400 W/M.K
2.	Yield strength	140 Mpa
3.	Elastic modulus	110-140 Gpa
4.	Melting point	1083 ⁰ c
5.	Boiling point	2562 ⁰ c

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VII. TUBE WITH FINS

The fins are fix on the copper tube and the copper tube length is 1250 mm. but the fins are fix 1000mm



Figure[3]

VIII. EXPERIMENTAL SETUP AND CALCULATION

8.1. EXPERIMENTAL SETUP

The test procedures are used to evaluate the fabricated heat exchangers. The experimental measurement of the heat exchanger effectiveness over a range of mass flow rates. In this test, an external cooler and a heater are used to control large temperature differences across the heat exchanger while minimizing the pressure drop. Pressure regulator is used to control the inlet pressure and the digital indicator is used to find the inlet temperature and also outlet temperature.



Figure[4]

flow type	fin	hot water temperature in k		cold water temperature in k	
		t_{hi}	t_{ho}	t_{ci}	t_{co}
counter flow	without fin	333	329	301	316
	Hexagonal fin	333	325	301	318
	Semi circle	333	327	301	317

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8.3. CALCULATION FOR EFFICIENCY AND HEAT FLOW RATE :

Logarithmic mean temperature difference

$$\frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}}$$

$$\Delta T_{lm} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}}$$

ΔT_i =inlet temperature difference in k ,

ΔT_o =outlet temperature difference in k

$$\Delta T_i = T_{hi} - T_{co} , \Delta T_o = T_{ho} - T_{ci}$$

Mass Flow Rate of Hot and Cold Water;

8.2. EXPERIMENTAL PROCEDURE

Experiments were conducted under steady state conditions with hot water (copper pipe) and tap water (aluminium pipe) as the working fluids. The flow rate in the copper tube was varied over a range of 0.025 kg/sec for a constant flow rate. Temperature data was recorded at every second by digital thermometer. Accuracy of the digital thermometer is $\pm 1^\circ\text{C}$. The copper tube flow Rate was kept constant at 0.025 kg/sec. At the inlet of the copper tube of the heat exchanger the cooling water temperature was 26–28 °C, and it rises by 10–15 °C at the outlet of the outer tube. During the experiments the ambient temperature was 27–28°C, therefore, there was not much heat loss from the outer wall of the heat exchanger The cold water from the tap flow into the aluminum tube. The hot water from the tank flow into the copper pipe in counter flow direction to the cold fluid . Here the heat exchange took place from the hot fluid into cold fluid. We have used 1 liter beaker and stop watch to find the mass flow rate of cold fluid. We know that the temperature between hold and cold fluids in the heat exchanger varies from point to point so, in order to find temperature, four thermometers are fitted in the aluminum pipe , copper pipe.

$$M_h = M_c = 1.5 / 60$$

$$M_h = M_c = 0.025 \text{ Kg/sec}$$

Overall heat transfer co-efficient,

$$U = \frac{Q}{A \cdot (\Delta T_{lm})}$$

A= surface area in m^2

$$Q = U \cdot A \cdot \Delta T_{lm}$$

2

$$\Delta T_{lm} = \frac{T_{hi} - T_{ho}}{\ln \frac{T_{hi} - T_{co}}{T_{ho} - T_{ci}}}$$

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$$Q_c = U_c * A_c (T_{h1} - T_{c1})$$

Effectiveness of heat transfer;

$$\epsilon = \frac{T_{h1} - T_{h2}}{T_{h1} - T_{c1}}$$

Efficiency of heat exchanger;

$$\eta = \epsilon * 100$$

FOR HEXAGONAL FINS

LMTD = 19.148 k

Heat transfer rate $Q = 1.308 \text{ W}$

Overall heat transfer coefficient $U = 1.553 \text{ kW m}^2/\text{k}$

Effectiveness $\epsilon = 0.5312$

Efficiency of heat exchanger $\eta = 53.12\%$

FOR SEMI CIRCLE FINS

LMTD = 20.5 k

Heat transfer rate $Q = 1.151 \text{ W}$

Overall heat transfer coefficient $U = 0.684 \text{ kW m}^2/\text{k}$

Effectiveness $\epsilon = 0.50$

Efficiency of heat exchanger $\eta = 50\%$

Heat exchanger efficiency:

without fin = 47%

with hexagonal fin = 53%

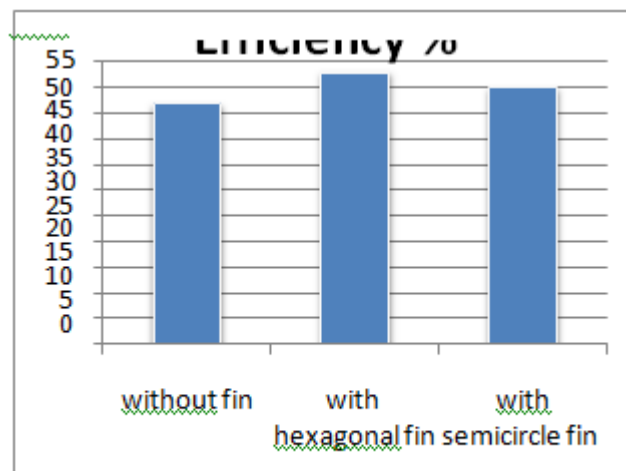
with semicircle fin = 50%

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IX. CONCLUSION

The present work carried out for predicting and comparing the performance of shell and finned tube heat exchanger using hexagonal and semi circular fins. The small shell and tube heat exchanger is modeled with sufficient details to resolve the flow and temperature fields. In experimental analysis result was completed and the effect on temperature reduction and the pressure drop in the finned tube and shell side was observed. In existing model the heat transfer rate and efficiency is low by using finned tube. Compare both existing and new model type heat exchanger over all heat transfer rate is increased and also the efficiency of the heat exchanger for semi circle fins is increased by 3% , and for hexagonal fins is increased by 6% of finned tube heat exchanger. So the hexagonal fin is more efficient than the semi circle fin.

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- [8] D.Bhanuchandrarao , M.Ashok chakravarthy , Performance of parallel flow, counter flow in concentric tube heat exchanger,IJERT Vol- 2,issue 11, (2013) without fin with hexagonal fin semicircle fin