EXPERIMENTAL ANALYSIS OF FIN TUBE AND BARE TUBE TYPE TUBE-IN-TUBE HEAT EXCHANGER

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ABSTRACT

Heat exchangers are the devices that facilitate the exchange of heat between the two fluids that are at different temperatures while keeping them from mixing with each other. In bare tube heat exchanger, the heat transfer rate is minimum so in order to increase the heat transfer rate different types of fins are used. The rate of heat transfer depends on the surface area of the fin. Rectangular and circular type fins are popular choices for transferring the heat from the primary surface of heat exchanger. In this paper, heat transfer rate and fin effectiveness for rectangular and circular fins were analysed for parallel flow and counter flow arrangement and comparison is done with bare tube (tube without fin) heat exchanger. Performance of rectangular fin is efficient than the circular fin.

KEYWORDS

Heat exchanger, types of fins, material used, LMTD, heat transfer rate, and fin effectiveness.

INTRODUCTION

Heat exchanger is a device which is used in most of the engineering applications. In conventional heat transfer equipments the heat is transfer between the two fluids which are separated by the surface. Typical examples of these equipments are refrigeration, vehicle engine, chemical processing plant, nuclear fuel storage tanks etc. In general, the heat transfer is takes place from inner tubes carrying the stream of hot fluid to stream of cold fluid by attaching the fins on the outer periphery of inner tube [1].

The rate of heat transfer depends on the surface area of the fin. The selection of any particular type of fin mainly depends on the geometry of the primary surface. Circular fins are mostly used for primary surface of cylindrical geometry for enhancing the rate of heat transfer. It is well known that the rate of heat transfer from the fin reduces as the length of the fin increases, therefore there is no utilisation of heat transfer surface to transfer the heat from the hot fluid to cold fluid. For this reason, the researcher has to work continuously for determining the optimum fin shape that will give the maximum heat transfer rate for specified fin volume or minimize the fin volume for a given heat transfer rate.

N. Nagarani [2] did the experimental analysis on annular circular and elliptical fins heat exchanger and concluded that rate of heat transfer is from elliptic fin is more than that of the circular fin. It has been shown that the fin efficiency is higher for elliptic fin than the circular fin.

Sikindar Baba.Md, Nagakishore.S,Prof.M.Bhagvanth [3] has done the work on two- stage air compressor and concluded that the heat transfer rate of heat exchanger using fins is more than that of bare tube heat exchanger. Also M.R. Jafari Nasr and A.T. Zoghi [1] had concluded that the by using Low finned tube rather plain tubes, not only can the performance of the heat exchanger be improved but also the number of shells required for a given can be reduced.

Vekariyamukesh V., G. R. Selokar and Amitesh Paul [5]reported that the aluminium material used for the fin reduces the cost of raw material and also improves the product performance.

However from the forgoing literature review shows that no combined work is attempted so far. So in this paper, aluminium material is used for the rectangular and circular fin. The objective of to find out heat transfer rate and fin efficiency of rectangular and circular fin and comparison is made with heat exchanger without fin.

EXPERIMENTAL ANALYSIS

Figure 1 shows the pictorial view of experimental setup used in the present study for the estimation of heat transfer on the rectangular fin attached in first tube and circular fin attached in second tube. The last one is bare tube heat exchanger. The rectangular and circular fin made of aluminium having thermal conductivity 203 W/mK. In this experimental setup the outer tube is made of stainless steel and inner tube is made of aluminium material. The primary as well as secondary fluid is water. There is one heater to heat up the water. The hot water is passing through the inner tube and the cold water is passing through the outer tube. There is flow arrangement provided in such a way that we can operate heat exchanger for parallel flow as well as counter flow. The fin dimensions for rectangular fin is 25mm*25mm*750mm and the diameter of circular fin is 28mmso that cross-sectional area is approximately same for both the fins. The readings are taken for different inlet temperatures of hot fluid like 75˚C, 70˚C and 65˚C and inlet temperature of cold fluid is kept atmospheric and readings are tabulated for both fins and tube without fins also for parallel flow and counter flow.

Figure 1. Pictorial view of experimental setup

RESULT AND DISCUSSION

Readings are taken on the experimental setup with different temperature conditions for parallel flow and counter flow and heat transfer rate and fin effectiveness is calculated for the rectangular and circular fin for the same flow arrangement.

Table 1. Result table for counter flow

Sr. No.	Types of fin	Temperatures				LMTD (°C)	Heat transfer rate(KW)	Fin effectiveness
		T_1	T_2	t_1	t_2			
1.	Rectangular	75	60	34	45	27.95	2.6866	1.3762
		70	58	34	43	26.50	2.1978	1.2857
		65	55	34	41	22.47	1.7094	1.1666
2.	Circular	75	59	34	44	27.89	2.442	1.25
		70	57	34	42	25.42	1.9536	1.1428
		65	55	34	41	22.47	1.7094	1.666
3.	Without Fin	75	62	34	42	30.43	1.9536	-
		70	61	34	41	27.99	1.7094	-
		65	57	34	40	23.99	1.4652	-

Table 2. Result table for parallel flow

Sr. No.	Types of fin	Temperatures				LMTD (°C)	Heat transfer rate(KW)	Fin effectiveness
		T_1	T_2	t_1	t_2			
1.	Rectangular	75	60	34	43	27.26	2.1978	1.2857
		70	59	34	42	25.32	1.9536	1.3315
		65	58	34	40	23.91	1.4652	1.5
2.	Circular	75	64	34	42	30.52	1.9536	1.1428
		70	61	34	41	27.22	1.7094	1.1650
		65	54	34	39	22.04	1.221	1.25
3.	Without Fin	75	65	34	41	31.74	1.7094	-
		70	61	34	40	27.83	1.4672	-
		65	55	34	38	23.30	0.9768	-

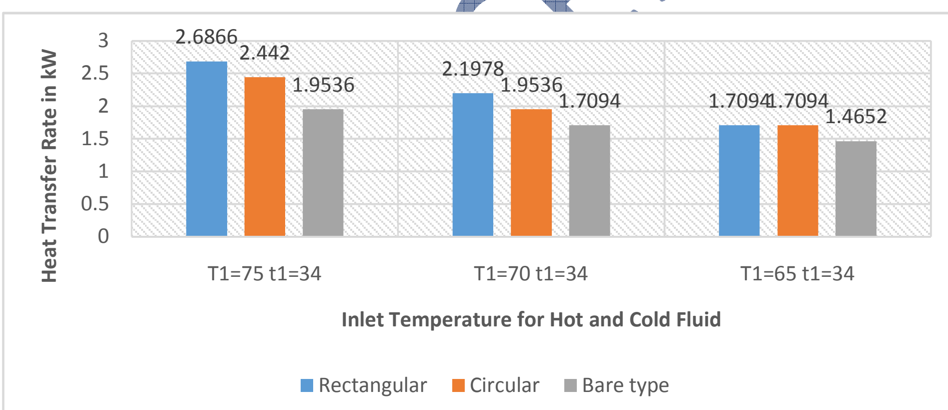

Figure 2. Graph of Heat Transfer Rate for counter flow

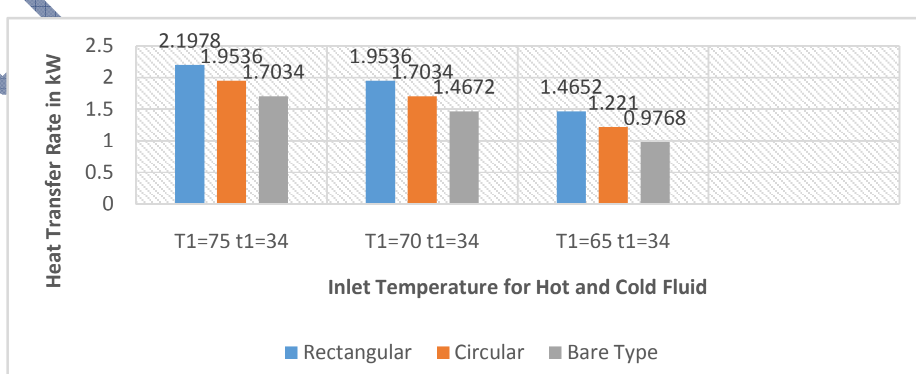

Figure 3. Graph of Heat Transfer Rate for Parallel Flow

As shown in figure 2and figure 3 the heat transfer rate is taken on the Y-axis and the inlet temperature conditions of hot and cold fluid is taken on the X-axis.

The figure 2 is for the counter flow and figure 3 is for the parallel flow. The heat transfer rate is greater in the rectangular fin which is 2.6866 kW in counter flow and 2.1978 kW in parallel flow. The heat transfer rate is increased by 22.24 %.

The inlet temperature of hot fluid is changed as 75^{0}C, 70^{0}C, 65^{0}C and heat transfer is plotted on chart.

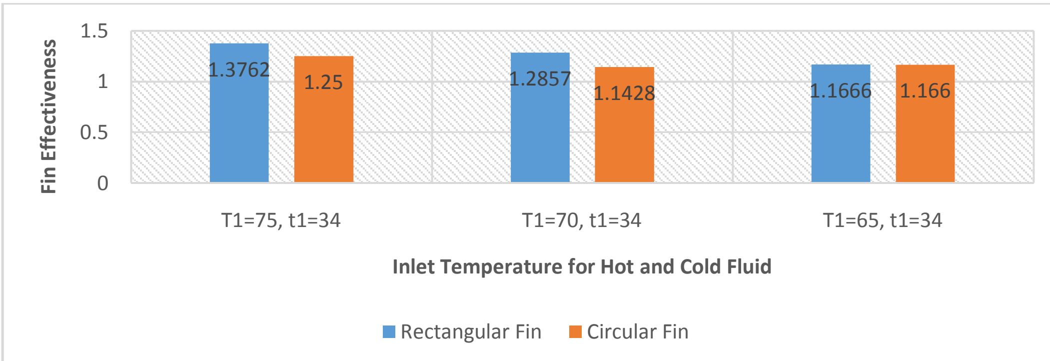

Figure 4. Graph of Fin Effectiveness in counter flow

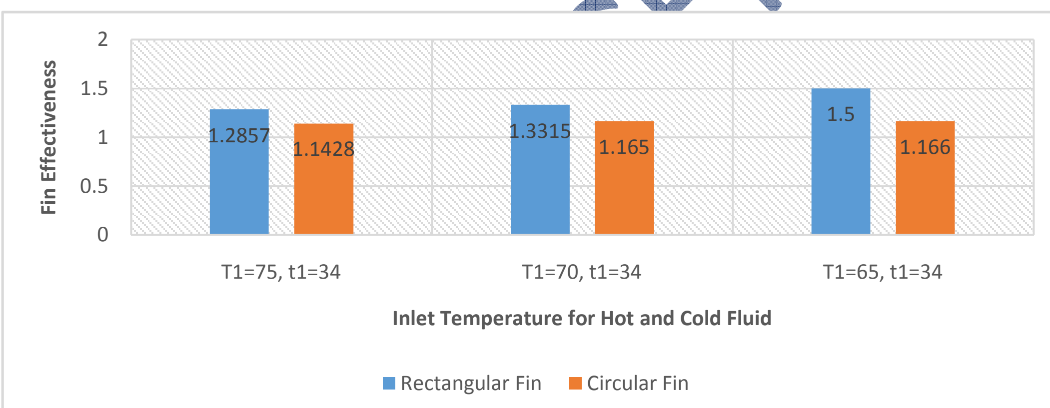

Figure 5. Graph of Fin Effectiveness in parallel flow

Figure 4 and figure 5 shows the comparison of fin effectiveness in counter flow and parallel flow respectively. From the analysis the fin effectiveness is more for rectangular fin than the circular fin at different temperature conditions.

CONCLUSION

It is observed that the heat transfer rate is higher in counter flow than that of the parallel flow as can be seen from the figure 2 and figure 3 that the driving force for heat transfer is constant in counter flow unlike parallel flow in which the driving force constantly decreases along with the length.

It is observed that fin effectiveness of the rectangular fin is greater than the circular type of fin.

The Log Mean Temperature Difference of tube without using fin is greater than the others but effect of reduced surface area dominates thereby nullifying the effect of increased log mean temperature difference resulting in lower heat transfer rate than the others.

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