PERFORMANCE EVALUATION AND CFD ANALYSIS OF INDUSTRIAL DOUBLE PIPE HEAT EXCHANGER

Research Paper

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ABSTRACT

Double pipe heat exchanger is one of simplest type of heat exchanger, generally used for the purpose of sensible heating or cooling. In present work Double pipe heat exchanger is practically investigated at industry and collected necessary data like mass flow rate, inlet-outlet temperatures, dimensions of double pipe heat exchanger. Heat exchanger running at industry is with fix mass flow rate and aim of present work to improve the performance of heat exchanger. So analysis with different mass flow rate is necessary. Practical results are validated with ANSYS 14 CFX software and it is in acceptable limits. Analysis with different mass flow rate is done through same software. Such heat exchanger is also analyzed by putting extended surfaces in the annulus space with same software. As per the Results it shows that heat transfer rate, pressure drop, pumping power is increases with the increase of mass flow rate and friction factor decreases. Heat transfer performance of heat exchanger with fins is higher than the simple heat exchanger but pressure drop, pumping power is also higher. When only heat transfer performance is considered no consideration of pumping power, pressure drop heat exchanger with fins is superior than the simple heat exchanger.

Key words- Double pipe Heat exchanger, extended surfaces (Fins)

INTRODUCTION

Double pipe heat exchangers are the simplest device in which heat is transferred from the hot fluid to the cold fluid through a separating cylindrical wall. It consists of concentric pipes separated by mechanical closures. Inexpensive, rugged and easily maintained, they are primarily adapted to high-temperature, high-pressure applications due to their relatively small diameters. Double pipe heat exchangers have a simple construction. They are fairly cheap, but the amount of space they occupy is generally high compared with the other types. The amount of heat transfer per section is small, that makes the double pipe heat exchangers a suitable heat transfer device in applications where a large heat transfer surface is not required.[1]many engineering techniques have been devised for enhancing the rate of convective heat transfer from the wall surface[2,3]. The use of tabulator elements is a typical example of this application to increase the heat transfer coefficient from the flow surface through an increase in turbulent motion. In general, enhancing the heat transfer can be divided into two groups. One is the passive method, without stimulation by the external power such as a surface coating, rough surfaces, extended surfaces, turbulent/swirl flow devices, the convoluted tube, and additives for liquid and gases.Method, which requires extra external power sources, for example, mechanical aids, surface-fluid vibration, injection and suction of the fluid, jet impingement, and use of electrostatic fields considered as an active method.Those methods are, for instance, the insertion of twisted stripes and tapethe insertion of coil wire and helical wire coil [4,5] and the mounting of turbulent decaying swirl flow devices [6–8] in several heat exchangers. Another concept in augmenting heat transfer rate by using small louvered strip inserts is developed and investigated experimentally. The strips are mounted on the brass wire or core rod, placed inside the inner hot water tube. The strips are expected to induce a rapid mixing and a high turbulent and longitudinal vortex flow like a delta wing, it resulting an excellent rate of heat transfer in the tube.

Results and Disscussion

In this case study Double pipe heat exchanger was used to analyze. Such Double pipe heat exchanger was installed at Industry and observed for working. Necessary data were collected. This heat exchanger works as counter flow condition. Temperature data of heat exchanger were validated with ANSYS 14 CFX software and was found to be in acceptable limits

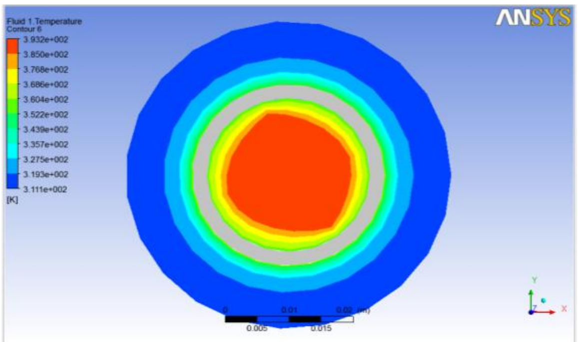


Fig.1 Inlet of hot fluid and outlet of cold fluid

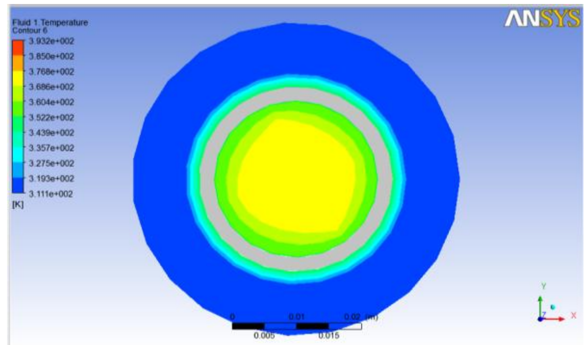


Fig.2 Inlet of cold fluid and outlet of hot fluid

Fig. 1 shows Inlet of hot fluid and outlet of cold fluid. Fig. 2 shows Inlet of cold fluid and outlet of hot fluid. It is a results obtain from ANSYS CFX 14 software.

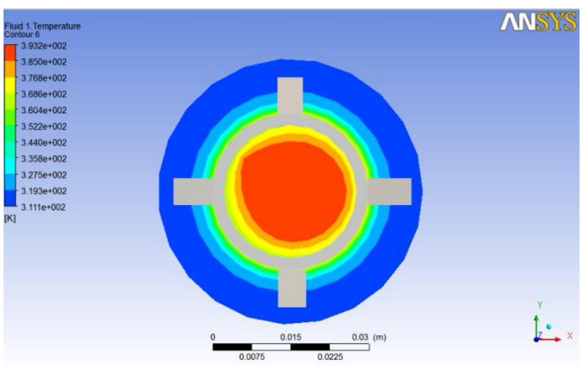


Fig. 3 Inlet of hot fluid and outlet of cold fluid (Heat exchanger with Fins)

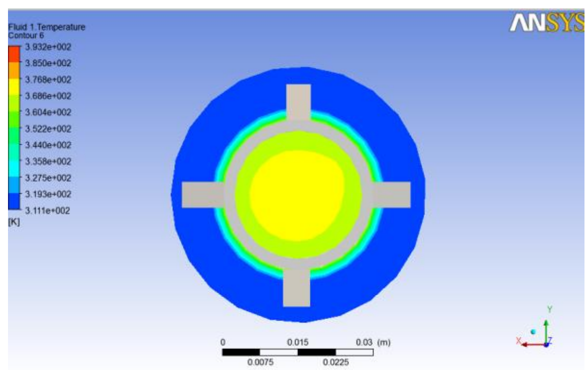
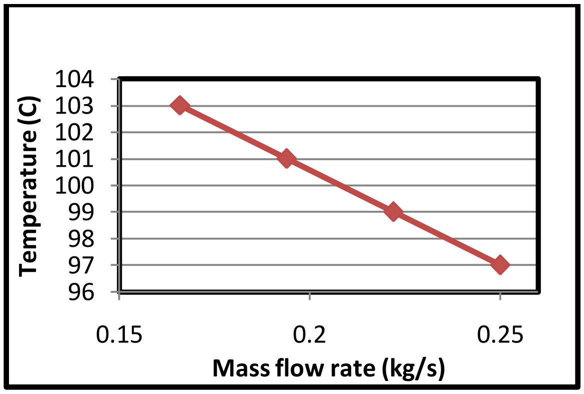


Fig. 4 Inlet of cold fluid and outlet hot fluid (Heat exchanger with Fins)

Fig.3 shows Inlet of hot fluid and outlet of cold fluid. Fig.4 shows Inlet of cold fluid and outlet of hot fluid. It is a results of double pipe heat exchanger modified with extended surfaces (Fins).

Experimental readings for Double pipe heat exchanger were carried out from industry like inlet-outlet temperatures, mass flow rate, geometry of heat exchanger etc. Hot fluid is flow through the inner tube and cooling water flow through the annulus. Temperature readings of double pipe heat exchanger with fixed mass flow rate. Analysis of double pipe heat exchanger with different mass flow rate done through Ansys 14 CFX software. Readings of inlet temperature, outlet temperature for hot and cold fluid were taken by varying mass flow rate of cold fluid inlet. Using these readings along with other properties and known parameters like thermal conductivity, specific heat capacity, viscosity, density, inside diameter of pipe, outside diameter of pipe, other parameters like heat transfer, Prandtl number, fluid velocity, Reynolds number, friction factor, Nusselt number, heat transfer coefficient, pressure drop, Log Mean Temp Difference (LMTD), overall Heat Transfer were calculated analytically.

Mass flow rate v/s hot water outlet temperature for heat exchanger without and with fins are shown in fig 5 & 6 respectively. It is clear seen from figures 5 & 6 that hot water outlet temperature decreases with the increase of mass flow rate. Heat exchanger with fins has shown good result as compared to heat exchanger without fin



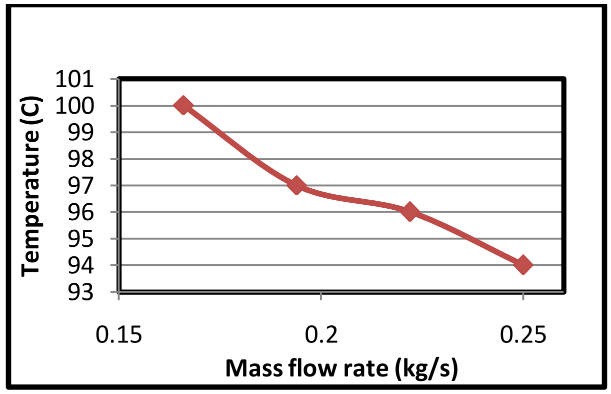


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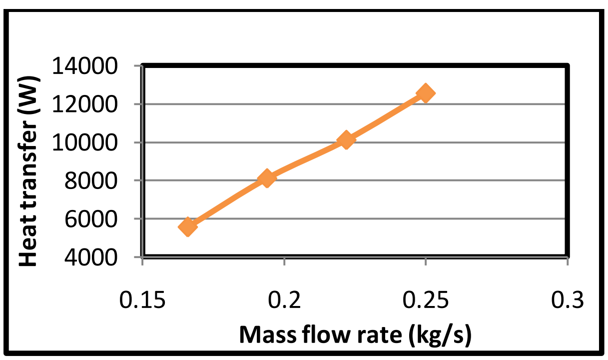
Fig. 5 Mass flow rate v/s hot water outlet temperature

Fig. 6 Mass flow rate v/s hot water outlet temperature (HE with fins)

Mass flow rate v/s heat transfer for heat exchanger without and with fins are shown in fig 7 & 8 respectively. It is clear seen from figures 7 & 8 that heat exchanger with fins has shown good heat transfer rate as compared to heat exchanger without fins. It is also observed that heat transfer increases with the increase of mass flow rate.



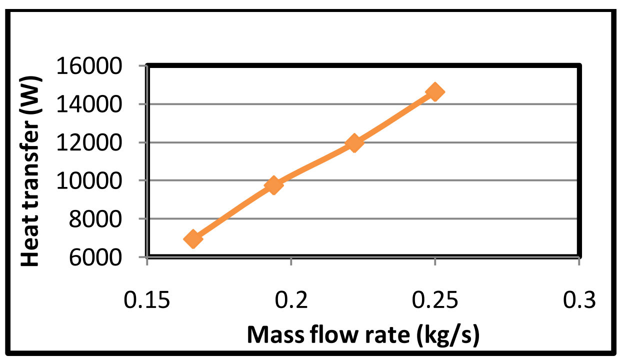


Fig. 7 Mass flow rate v/s heat transfer

Fig. 8 Mass flow rate v/s heat transfer (HE with fins)

Figure 9 & 10 indicates the variation of pressure drop with mass flow rate for heat exchanger without and with fins respectively. It is seen from figures 9 & 10 that as mass flow rate is increases the pressure drop is increases and pressure drop is higher in heat exchanger with fins.

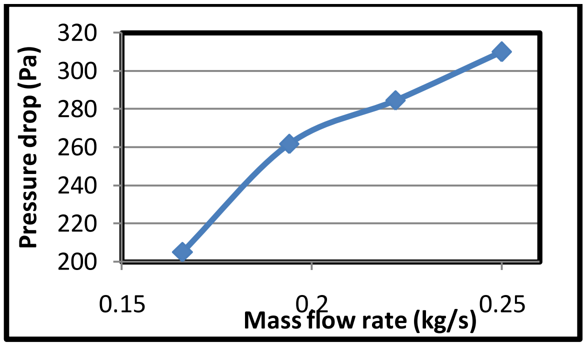


Fig. 9 Mass flow rate v/s pressure drop

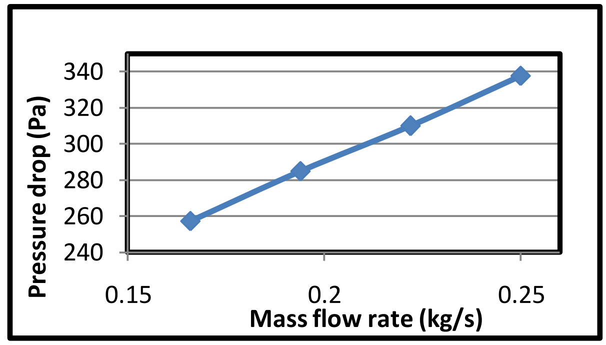


Fig. 10 Mass flow rate v/s pressure drop (HE with fins)

Figure 11 & 12 indicates the variation of pressure drop with mass flow rate for heat exchanger without and with fins respectively. It is seen from figures 11 & 12 that as mass flow rate is increases the pressure drop is increases and pressure drop is higher in heat exchanger with fins

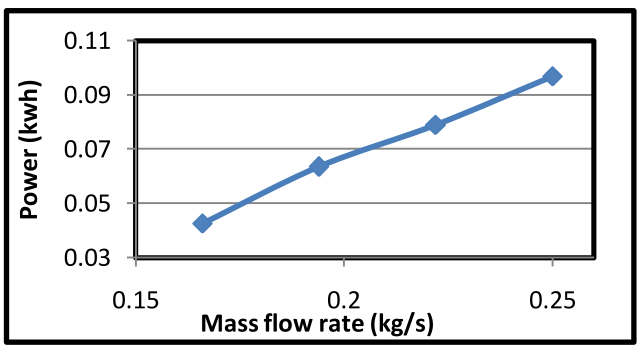


Fig. 11 Mass flow rate v/s pumping power

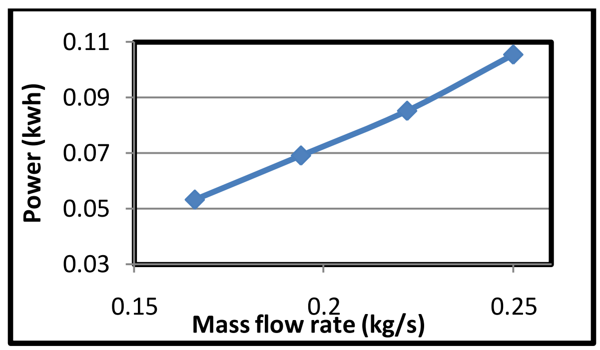


Fig. 12 Mass flow rate v/s pumping power (HE with fins)

CONCLUSION

From the above results and graphs it may conclude that For both heat exchanger with and without fins the heat transfer increases linearly with the increase of mass flow rate. As the mass flow rate increases, fluid velocity, Reynolds number, Nusselt Number, heat transfer co-efficient also increase, but friction factor decreases. The pressure drop increases sharply with the increase in mass flow rate. Overall heat transfer also increases as the mass flow rate increases. Heat transfer performance of heat exchanger with fins is better as compare to simple heat exchanger. But pumping power occupied by heat exchanger with fins is also higher than the simple heat exchanger. When only heat transfer capacity of heat exchanger is criteria regardless of pressure drop and pumping power heat exchanger with fins is more superior as compared simple heat exchanger. Heat exchanger with the modification of extended surfaces proved greater in heat transfer rate as compared to heat exchanger without modification but pumping power cost is also higher.

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