Experimental Study on Effect of Pitch of Twisted Tape on Performance of Externally Helical Wire Wound Double Pipe Heat Exchanger

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Abstract— Double pipe heat exchanger (DPHE) or concentric tube heat exchanger is one of the consistency conservation of heat through in pipe of heat exchanger. This kind of heat exchanger is with the process of conduction, convection widely used in chemical, food, and oil and gas industries in maintaining the temperature of storage of inventory. Double pipe heat exchanger having a relatively small diameter and it is easy to fabricate as compare to helical tube, corrugated , baffled tube and many more compact type of heat exchanger. In the present work experiment is carried out on double pipe heat exchanger in which hot water is flowing through inner tube where as cold water is flowing through the annulus and hot water to cold water heat exchange is taken into consideration. During the experiment cold water flow rate is kept constant at 45LPH where as hot water flow rate is varies from 15LPH to75LPH. Three twisted tape inserts of different pitch length (2.5, and 4.5) are used and inlet and outlet temperature and cold fluid is measured by K type thermocouple to calculate the performance of double pipe heat exchanger in parallel and counter flow arrangement.

Key words: Heat Transfer Rate, Heat Exchanger, Helical Wire, Twister Tape

I. INTRODUCTION

Heat exchanger is a device which is working on second law of thermodynamics or difference of energy level by higher grade of energy to lower grade of energy. In this device heat is transferred from hot fluid to cold fluid due to temperature gradient [1]. One of the most simple and applicable heat exchangers is double pipe heat exchanger (DPHE). This kind of heat exchanger is widely used in chemical, food, oil and gas industries [2]. Upon having a relatively small diameter, many precise researches have also held firmly the belief that this type of heat exchanger is used in high-pressure applications [3]. They are also of great importance where a wide range of temperature is needed. It is also well-documented that this kind of heat exchanger makes a significant contribution to pasteurizing, reheating, preheating, digester heating and effluent heating processes [4]. Many of small industries also use DPHEs due to their low cost of design and maintenance. As a result, choosing the methods wisely is of great importance. It is also believed that having a high and appropriate heat transfer rate in devices such as computers, electric power systems, automobile engines and other numerous examples is inevitable [5]. In double pipe heat exchangers, hot and cold fluids flow mostly in concentric pipes in different configurations which are parallel and counter flows [6]. In the first case, both fluids flow in the same direction [7]. While the latter case attributes to ones where fluids flow in an opposite direction [8]. We have traced the history of double pipe heat exchanger back to its beginnings in the late 1940s. The studies broadly support the view that this type of heat exchanger is heading towards a considerable progress [9]. Through these years, a plethora of researches have been carried out which fall into various categories [10]. In some cases, just the working fluids characteristics and their modifications were studied; some investigated active methods, passive methods, compound methods, geometry change and the other heat enhancement methods in figure 1[11].

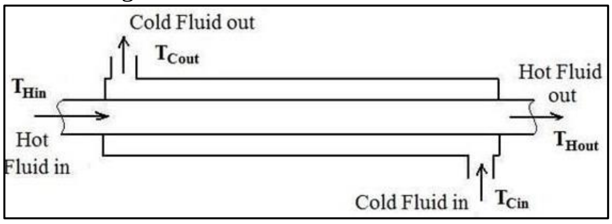

Fig. 1: Counter Flow Type Heat Exchanger

II. METHODOLOGY

Flow rates in the tube and in the shell were varied. The following five levels were used: 15, 30, 45, 60 and 75 LPH. All possible combinations of these flow rates in outside and the inside the tube were tested. These were done for two heat exchangers "Straight steel tube, Externally Helical wire wound steel tube heat exchanger" in parallel flow arrangement as shown in figure 1.The Temperature data used in the mathematical calculation was after the system had achieved equilibrium position. The type-K pt-100 thermocouples used for temperature value. All the thermocouples were constructed from the same thermocouple wire, and hence the repeatability of temperature value was high with temperature reading fluctuations within ±0.3 °C.

III. EXPERIMENTAL SETUP

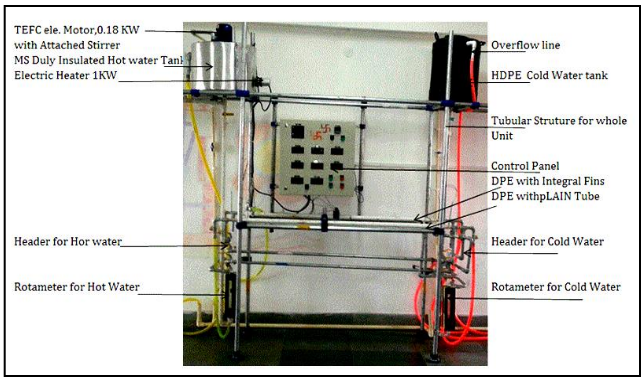

Fig. 2: Shows Experimental Set Up of Heat Exchanger

IV. RESULTS & DISCUSSION

Double pipe heat exchanger available of same diameter and length with experimental setup shown in figure 2. The mass flow rates inside tube and outside tube were varied as well as parallel flow and counter flow arrangement. After experiment we were discussing performance between among four type case of heat exchanger which is plain steel tube, copper wire helically wound steel tube, copper wire helically wound steel tube with 2.5 inch pitch insert, and copper wire helically wound steel tube with 4.5 inch pitch insert. It was observed that the heat transfer rate increases with increase from volume flow rate of hot water in both the cases parallel and counter flow and heat transfer rate in counter flow was greater than the heat flow rate in parallel flow. In both cases it was observed that the heat transfer rate in case of 2.5” pitch length insert was greater than the other three arrangements. The maximum value of heat transfer rate was found in counter flow arrangement with 2.5” insert was 638.52 Watt and it is 14% greater than the heat transfer rate in plane steel tube without insert, 12% greater than the copper wire tube without insert and 2% greater than the 4.5” insert.

V. Conclusion

It was observed that the heat transfer rate increases with increase from volume flow rate of hot water in both the cases parallel and counter flow and heat transfer rate in counter flow was greater than the heat flow rate in parallel flow. In both cases it was observed that the heat transfer rate in case of 2.5” pitch length insert was greater than the other three arrangements. The maximum value of heat transfer rate was found in counter flow arrangement with 2.5” insert was 638.52 Watt and it is 14% greater than the heat transfer rate in plane steel tube without insert, 12% greater than the copper wire tube without insert and 2% greater than the 4.5” insert. Initially value of NTU decrease with increase in volume flow rate of hot fluid and minimum value of NTU was found in case of plane steel tube without insert and it was 0.374 and it is 30%, 23% and 12% lesser than the value found is 2.5”, 4.5” and copper wire tube without insert respectively.

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