Comparison of Heat Transfer Performance with Inserts by Using Air and Water As A Flowing Fluid.

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Abstract— This research article highlights on the execution of warmth Exchanger with different sorts of inserts. Since device are widely utilized in different industries, hence there's a requirement of utilization of varied sorts of Heat Transfer enhancement Techniques (Active, Passive, combined), which in turns optimizes the performance of obtainable device setup with differing types of inserts. This results in transformation of fluid flow characteristics from Laminar to flow which leads to increase in Heat Transfer characteristics. Finally the conclusion are going to be drawn by summarizing the literature study and suggesting the new design and modifications within the present inserts. The warmth exchangers are wont to enhance heat transfer by providing high heat fluxes or heat transfer coefficient. The second law efficiency increases and therefore the entropy generation decreases by reducing the temperature drive which is caused with the rise in heat transfer coefficient.

Keywords: Enhancement Efficiency, Heat Transfer, Inserts, Laminar Flow, Heat Enhancement, Pressure Drop

I. INTRODUCTION

Due to the scarcity of fossil fuel in the world. The area of energy consumption and utilization in various industrial processes becomes vital need. In chemical processing industries most of the processes and the devices connected to energy and heat transfer are heat exchangers. Heat exchangers are the devices which are used to enthalpy between two or more fluids or between a solid surface and a fluid or between solid particulate-matter and a fluid which are at distinct temperatures. Heat exchanger is based on the principle that the loss of heat on the high temperature end is exactly the same as the heat gained in the low temperature end after the heat and mass carry through the heat exchanger machine. This results in reducing the temperature of higher temperature end and incrementing the temperature of lower temperature end. In a heat exchanger machine, the temperature of fluid differentiate as it flows through the tubes and also the temperature of the dividing wall situated between the fluids varies along the length of heat exchanger. Heat exchangers are utilized in various processes like conversion, utilization & recovery of heat energy in various industrial, domestic applications & commercial process most common examples include steam generation & condensation in power & cogeneration plants. Heating & cooling in thermal processing of chemical, pharmaceutical products. The increase in Heat exchanger's Performance can lead to more economical design of heat exchanger inserts, etc. Twisted tape inserts cause the flow to spiral on the tube length. They typically don't have smart modern contact with addition of tube wall. Wire coil inserts assit a turbinate whorled spring that works as a non-integral roughness. A number of the inserts scale back the hydraulic diameter relate in Nursingd act as an extended surface. The choice of the tube inserts depends on 2 factors: performance and prices. The performance execution comparison for different tube inserts could be a helpful complement to the retrofit style of every heat exchangers and warmth exchanger's networks. In fact, twisted tape inserts and wire coil inserts area unit additional wide applied than the others. Therefore, this paper concentrates on the comparison of the thermal and hydraulic performance for twisted tape insert and wire coil insert, within the retrofit state of affairs. Firstly, the tube inserts area unit delineated, and general comments on their applications area unit given. Secondly, connections for twisted tape and wire coil inserts area unit granted within the turbulent region, and performance comparison is provided.

II. LITERATURE REVIEW

Heat enhancement has been achieved in many ways by different researcher all over the world. Following are different studies and analysis suggested for heat analysis.

1) S.S.Giri, V.M.Kriplani, [1] they did the review on heat Transfer Characteristics using inserts in Tubes. The overall conclusions which they search during the study the twisted type insets heat transfer rate increase in turbulence of the flow and also the pressure drop increases. For conical ring inserts, the heat transfer rate more than that of the plain surface tube simultaneously increases the frication factor. In a wire inserts, the friction factor increases in the fully laminar region and increased the heat transfer coefficient with respect to the smooth tube. In mesh insert, pressure drop rises by increasing the ratio of porous material and enhancement of heat transfer rate when compared with the plain tube. Equivalently In a baffle insert, the rate of pressure drop increases with varying the Reynolds number for transient flow conditions.
2) Om Shankar Prajapati, A. K. Rajvanshi, [2] experimentally investigated on effect of AL_2O_3/water nano fluids in convective heat transfer. In this paper the work is carried out in turbulent flow forced convection heat transfer of Al_2O_3/water nano fluid inside an annular tube with variable wall temperature was investigated experimentally. Which we have review the Nusselt numbers of nano fluid they obtained for various heat fluxes which are in the range of 0 - 60 and Nusselt number increases with increase in heat flux. Reynolds numbers ranges from 3500-11500 and a nanoparticles concentration was to be taken in the ranges from 0.25%-1% at atmospheric pressure. They found that the usage of nanoparticles in water heat transfer coefficient surges and increases with increase in the nanoparticles concentration with heat flux and flow rate.
3) M. Raja, R. M. Arunachalam and S. Suresh, [3] studied heat transfer characteristics of Alumina/water nano fluid in a shell and tube heat exchanger with the aid of coil insert. They studied effects of Peclet number and the effect of the Al_2O_3/water nano fluid concentration on the

heat transfer and pumping power characteristics. The concentrations were taken 0.5%, 1% and 1.5% was prepared and made solution with base fluid namely water. An increment in the volume concentration of the nanoparticles in the base fluid caused a significant enhancement in the overall heat transfer coefficient compared to that of water. When a wire coil insert was used, further rise in overall heat transfer coefficient was found for a particular Peclet number. The overall heat transfer coefficient was increased by 12.6%, 20% and 25% for Alumina/water nano fluid when the percentage of volume concentrations were 0.5, 1 and 1.5 respectively at a Peclet of 3000, compared to those of distilled water. There was significant increase of about 13% in the pumping power for wire coil insert, when compared to that of the pumping power obtained with distilled water. The superior thermal characteristics of nano fluid gained with the aid of coil insert may be attributed to the thermal dispersion effect, which caused the temperature distribution to flatten and as a result the temperature difference between the fluid and tube wall steepened resulting in the increment of heat transfer.

4) Panida Seemawute, Smith Eiamsa-Ard, [4] studied visualization of flow characteristics induced by twisted tape consisting of alternate-axis has been comparatively investigated to that induced by typical twisted tape. The visualization was carried out by a dye injection technique. They studied the effects of twist ratios on heat transfer and fluid friction. They found that the visualization results shows that the twist axis give better mixing of fluid with higher heat transfer rate than that of twisted tape. In addition of swirl number and thus residence time of a fluid flow is rises as tape twist ratio reduces. This visualization results is compatible with the superior heat transfer at smaller twist ratio.
5) Shyy Woei Chang, Ming Hui Guo, [5] experimentally studied to investigate the heat transfer properties over developing and developed flow regimes. They found that the pressure drop and the thermal performance factors during tubular flows with the continuous and spiky twist tapes increases by perforated, jagged and notched winglets. The axial distributions of Nusselt number and the mean Fanning friction factors of the tubular flows at Reynolds numbers (Re) ranging from 500 to 40000 comparatively examined by them for five different types of twisted tapes with three twist ratios of 1.875, 2.186 and 2.815 for each type of twisted tapes.
6) C. Thianponga, et al., [6] explored experimental investigation on heat transfer and pressure drop characteristics of turbulent flow in a heating tube equipped with perforated twisted tapes with parallel wings for Reynolds number range from 5500 to 20500. They performed the design of perforated twisted tape with the following concepts: - The wings induced an extra turbulence near tube wall which caused to disrupt the thermal boundary layer efficiently.

III. Methodology

The apparatus consists of a blower unit fitted with a pipe in horizontal orientation. Nichrome bend heater encloses the test section to a length of 40cm, four thermocouples are embedded on the walls of the tube and two thermocouples are placed within the air stream, one at the doorway and the other at the exit of the test section to live the temperatures of inlet and outlet air streams respectively. The outlet of test pipe is connected to an orifice to live the flow of air through the pipe. Input electric supply to heater is given through dimmer stat. The tube of the heating part which is that the tube inside diameter 27.5mm is formed of three .2mm thick copper plate. A heat generating element is wound around this tube in order that the specified heat input is given. The thermocouples installed are drilled in to the rear side of the tube wall. Instrument panel consists of voltmeter, ammeter, dimmer stat and digital temperature indicator. Heat input are often varied by changing the voltage and current which are successively altered by the dimmer stat position. The circuit was designed for a load voltage of 0-220V with a maximum current of 2A. Outlet of the test pipe section is connected to an orifice meter and a manometer in order that the pressure drop and mass flow are often measured. Difference within the fluid levels of the manometer represents the variations within the pressure drop to the orifice meter. The fluid properties were calculated by the bulk mean temperature i.e. average of inlet and the outlet temperature. Pressure gage utilized in the apparatus for measuring the pressure difference across the ends of the test section. Two pressure gauges P1 and P2 are wont to measure the inlet and outlet pressures of the test section. Experiment was administered at constant heat flux conditions and a continuing heat input of 30 W at different mass flow rates with and without the inserts. It’s assumed that, the air flowing through the circular tube to be hydro dynamically and thermally fully developed flow. The connections between the various parts of the setup are as shown in Figure. Within the present work, experimental investigations using six sorts of tube inserts were performed. Reynolds number ranged from 7000 to 15000 during the experimentation. Basic block diagram of setup is shown in Fig. 1.

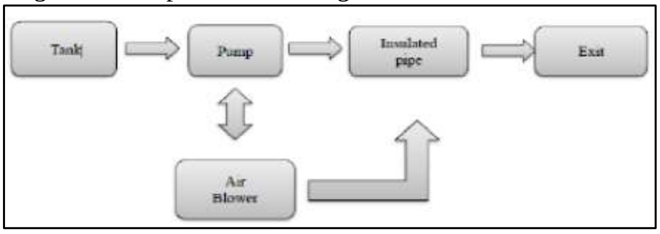

Fig. 1. Basic Block Diagram of Setup

IV. Result

It gives the warmth transfer results for RWTT, BRWTT1 & BRWTT2 alongside the corresponding performance evaluation criteria R1 & R3 for every of the readings, there is a very small difference between hexp & htheo, so we will easily assume that the warmth transfer equations hold true for our experimental setup. Higher deviation (-108.82%) between hexp & htheo for low Reynolds number are often attributed to the phenomenon of natural convection taking place alongside forced convection. The phenomenon of natural convection is negligible in comparison to forced convection for higher Re but is critical at low Re. the share difference for Re>5000 were found to be within ±8% for many of the readings. This will be taken as a sign of warmth transfer leads to the case of smooth tube, to be reasonably accurate. Fig. 2 shows the comparison of heat transfer coefficient and Reynolds number.

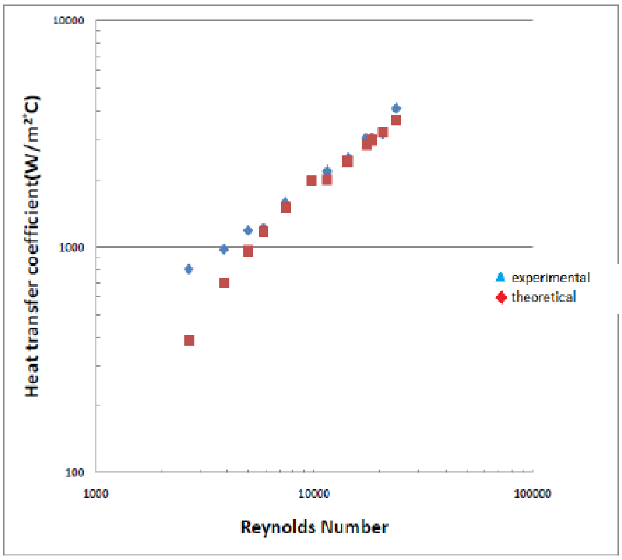

Fig. 2: Heat Transfer Coefficient vs. Reynolds Number

V. Conclusion

1) For same twist ratio, Baffled reduced width twisted tape with holes & Baffled reduced width twisted tape shows higher heat transfer coefficient & friction factor increase because of higher degree of turbulence created.
2) On the basis of performance evaluation criteria R1 & R3, we can say that Baffled reduced width twisted tape with holes (BRWTT2) & Baffled reduced width twisted tap (BRWTT1) provides great performance than previously studied twisted tapes like decremented width twisted tapes (RWTT).
3) For same twist ratio, Baffled reduced width twisted tape with holes & Baffled reduced width twisted tape gives higher heat transfer coefficient than the reduced width twisted tapes.
4) The correlations derived from friction factor values have R2 (Correlation coefficient) values very close to 1. So, the connections can be used for finding friction factor values for respective designs in the provided range of Reynolds number.
5) With decrease in twist ratio, heat transfer coefficient increases but at the same time pressure drop also increases.
6) For RWTT, R3 is found to increase with decrease in twist ratio yw. But for BRWTT1 & BRWTT2, the values of R3 were found to be escessive for tapes with twist ratio yw=4.39 & lower for the twist ratio of yw=3.69. This is probably because of a higher rise of frictional losses in the case of yw=3.69 without a corresponding increment in heat transfer coefficient.
7) On the basis of performance evaluation criterion R3, twisted tapes-BRWTT1 & BRRWTT2 with yw=4.39 were found to be the best tape for heat transfer augmentation.

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