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REVIEW ON INCREASING THE HEAT TRANSFER RATE IN DOUBLE PIPE HEAT EXCHANGER USING TWISTED TAPES

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Abstract: **Generating a swirl flow in the flow field is widely employed passive heat transfer augmentation or intensification technique. In present work, twisted tapes are inserted into the inner pipe side of Counter flow Double Pipe Heat Exchanger for creating a swirl flow and thus Enhancing the Heat Transfer. Twisted tapes of different twist ratios with 30^o, 45^o, 60^o and strip insert (i.e. without any twist) are employed to enhance the Heat Transfer. Turbulent swirl flow with forced convection is considered for experimental study. For different twist ratios, mass flow rate of cold fluid in inner pipe side is varied, by maintaining the constant mass flow rate in the annulus side. Experimental data is validated using available correlations. The results show that, for mass flow rate of 8 LPM the enhancement in Heat Transfer is 55.69% compared with that of plain tube and corresponding Pressure Drop is only 20%.**

Keywords: **Heat Transfer Intensification, Heat Transfer Enhancement, Double Pipe Heat Exchanger, Inserts Twisted Tapes.**

I. INTRODUCTION

Heat Transfer is unavoidable process that nature has gifted to Humankind. In engineering applications wherever energy conversion is involved, Heat transfer finds a great importance. Heat Transfer Enhancement or Intensification aims at increasing the rate at which Heat transfers from one body to another or from one medium to another. Improved Heat Exchange over and above the usual and standard practice can significantly improve thermal efficiency in such engineering applications as well as the economics of their design and operation can be optimized. This fact gives lot of scope for Research in this area of Heat Transfer Enhancement.

The analysis of heat exchanger is of great significance from engineering point of view due to various engineering applications and implications dealt with it. Considerable significance has been made on the development of various augmented heat transfer surfaces and devices, in recent years. Energy and material saving reconsideration, space considerations as well as economic incentives have led to the increased efforts aimed at producing more efficient and reliable heat exchanger equipment through the augmentation of heat transfer. The design procedure of heat exchangers is quite complicated, as it needs exact analysis of heat transfer rate and pressure drop estimations apart from issues such as long-term performance and the economic aspect of the equipment. The major challenge in designing a heat exchanger is to make the equipment compact and achieve a high heat transfer rate using minimum pumping power. Enhanced performance of heat exchanger enables the size of the heat exchanger to be decreased. In tube heat exchanger design the tube often represents poor performance when handling viscous liquids in laminar flow because near the tube wall, there is thermally inefficient boundary layer with very little mixing. A majority of heat exchangers used in thermal power plants, chemical processing plants, air conditioning equipment, and refrigerators, petrochemical, biomedical and food processing plants serve to heat and cool different types of fluids. Both the mass and overall dimensions of heat exchangers employed are continuously increasing with the unit power and the volume of production.

II. LITERATURE REVIEW

Below paper subjected to increasing the heat transfer rate in double pipe heat exchanger using twisted tapes.

A). L Sandeep Raj, K. Vijaya Kumar Reddy, 2016[1]

L Sandeep Raj and K Vijaya Kumar Reddy explain in his research work about the enhancing the heat transfer rate in U bend double pipe heat exchanger with twisted tape inserts with twist ratios of different geometry and varying the pressure flow of hot and cold fluid and decreasing the pressure drop and providing the more turbulence to hot water so that it can sustain more in pipe and comparison to plain tube.

L Sandeep and K Vijaya also prepare a prototype of U bend double pipe heat exchanger.

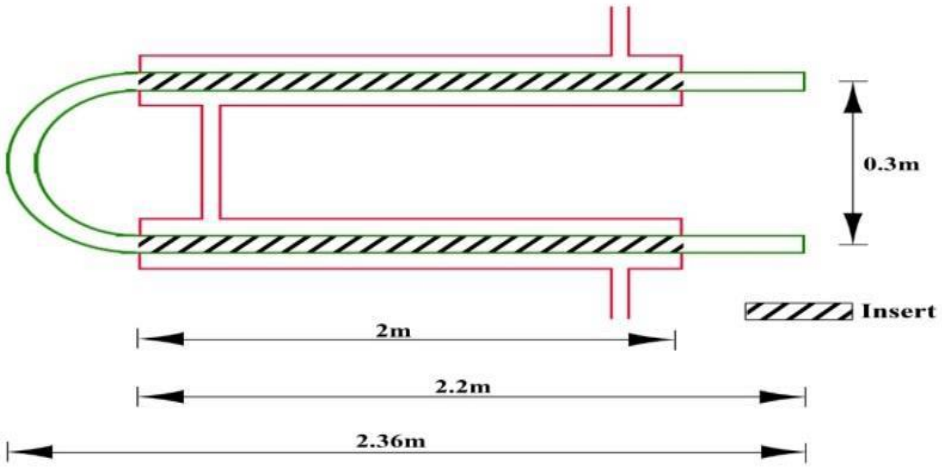

Fig. 1- Dimension of U bend double pipe heat exchanger [1]

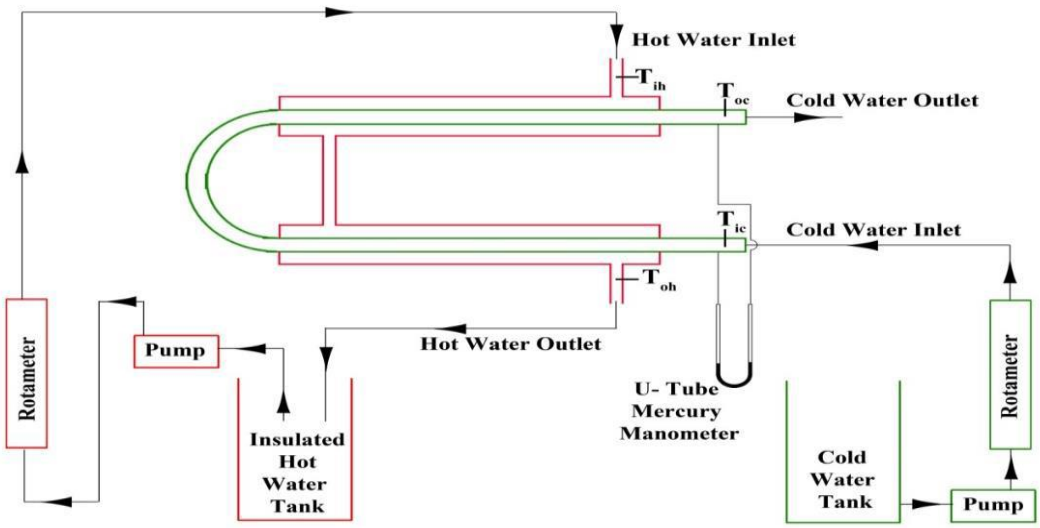

Fig. 2- Experimental setup of U bend double pipe heat exchanger using twisted tape [1]

B). Gurpreet Singh and Swati Singh, 2016 [2]

Gurpreet Singh and Swati Singh explain in his research work about the heat transfer rate of double pipe heat exchanger using baffles and nano fluids. To maximize the heat transfer rate, minimize the heat loss, increase energy, efforts are made such as by increasing area, turbulence, thermal conductivity, by changing flow geometry etc. Experimental work has been carried out in laminar flow region on three different kinds of alumina nanoparticles used in concentric pipe and the improvement in heat transfer rate has been observed. The heat transfer performance was studied with laminar flow arrangement in a vertical double pipe heat exchanger.

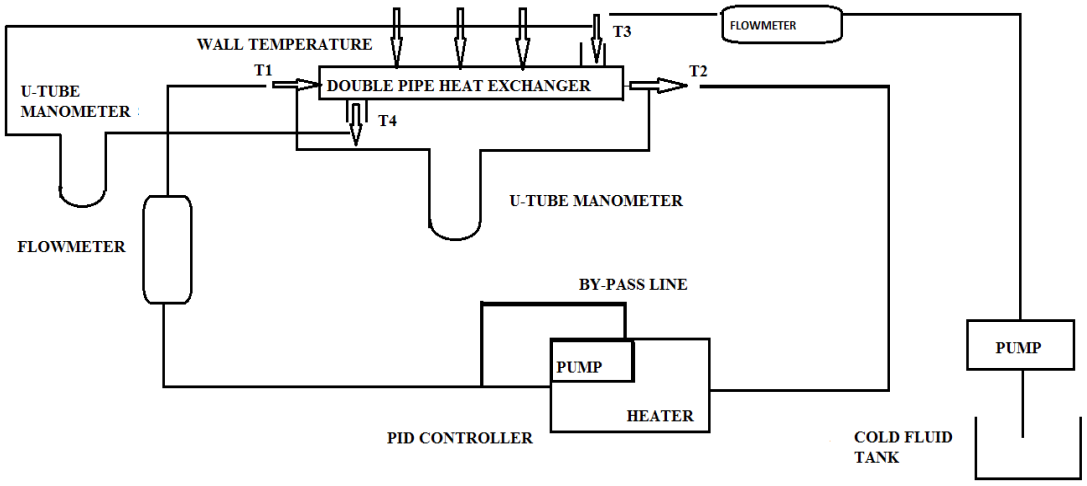

Fig. 3- Schematic diagram of experimental setup. [2]

Fig. 4- Photographic image of experimental setup. [2]

C). Pragnesh Kumar Prajapati, Umang Soni and Ashvin Suthar, 2016 [3]

Pragnesh Kumar Prajapati, Umang Soni and Ashvin Suthar explain in his research work about the Increasing the double pipe heat exchanger using quadratic baffle and twisted tape inserts. Formulated optimal design of the exchanger as a geometric programming with a single degree of difficulty. For yield problem the optimum values of inner/ outer pipe diameter and utility flow rate used for a double pipe heat exchanger of a given length, when a specified flow rate of process stream is to be treated for a given inlet to outlet temperature. They observed outlet temperature of the process stream is around 323 K which is well below the approachable temperature indicating the practicality of the solution. They found efficiency of the exchanger is around 63.6% which is reasonably high.

Fig. 5- Twisted Tapes. [3]

Fig. 6: Experimental Setup. [3]

Experimental work- Heater is on to heat the water to 50°C to 60°C water tank of capacity. The tank is provided with a centrifugal submersible pump & a bypass valve for recirculation of hot water to the tank & to the experimental setup. Hot water at about 50°C TO 60°C is allowed to pass through the annulus side of heat Exchanger. Cold water is now allowed to pass through the tube side of heat exchanger in Counter current direction at a desired flow rate. The water inlet and outlet temperatures for both hot water & cold water (T1-T4) are recorded only after temperature of both the fluids attains a constant value. Readings will be taken with Different Types of inserts and noted in the observation table. Then collect all reading and Find out the heat transfer coefficient and uncertainty analysis from the equation. The procedure was repeated for different cold water flow rates ranging from 0.034-0.102 Kg/sec. and hot water flow rate any one constant value was selected ranging value from 0.028-0.28Kg/sec. Compare the theoretical and experimental results for plain tube to validate the result of experiment. Measure the effect of twisted tape insert on the heat transfer and the effect of modified twisted tape with quadratic turbulator (baffle) attached with insert and compare the results. At constant flow rate of hot side varying the cold side flow rate in which twisted tape is inserted. Find out the heat transfer co efficient and effect on friction factor.

D). Amol Ashok Patil and M H Patil, 2016[4]

Amol Ashok Patil and M H Patil explain in his research work about the Design, Development & Testing of Double Pipe Heat Exchanger with Heat Transfer Enhancement Liners. All Heat exchangers are devices built for efficient heat transfer from one fluid to another and are widely used in engineering processes. Some examples are intercoolers, pre-heaters, boilers and condensers in power plants. By applying the first law of thermodynamics to a heat exchanger working at steady-state condition, we obtain: $\sum m \Delta hi=0$ where, mi= mass flow of the fluid Δhi= change of specific enthalpy of the fluid There are several types of heat exchanger:

- This Recuperative type, in which fluids exchange heat on either side of a dividing wall.
- Regenerative type, in which hot and cold fluids occupy the same space containing a matrix of material that works alternatively as a sink or source for heat flow
- Evaporative type, such as cooling tower in which a liquid is cooled evaporatively in the same space as coolant. The recuperative type of heat exchanger which is the most common in practice may be designed according to one of the following types.
- Parallel-flow
- Counter-flow
- Cross-flow

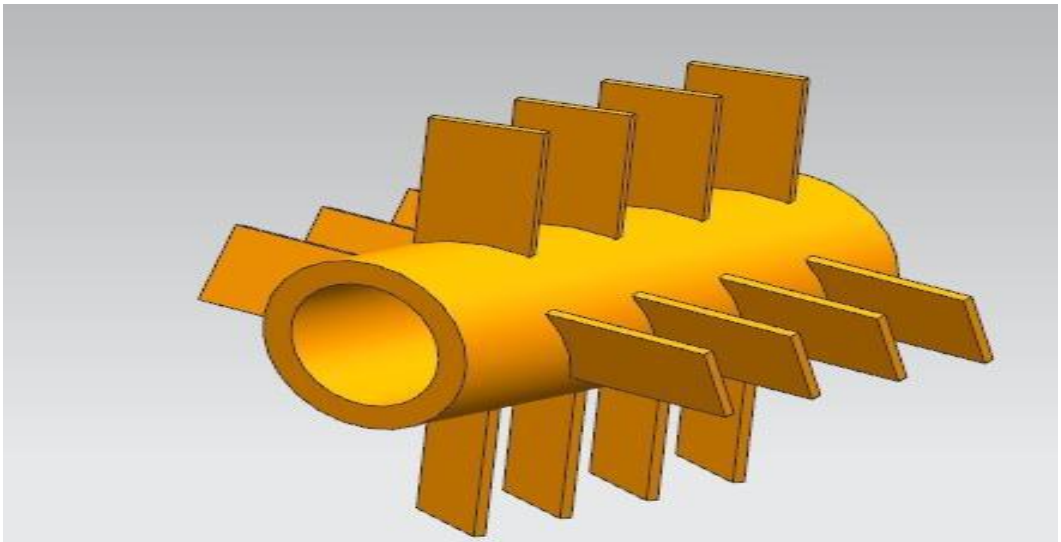

Fig. 7- Fins arrangement. [4]

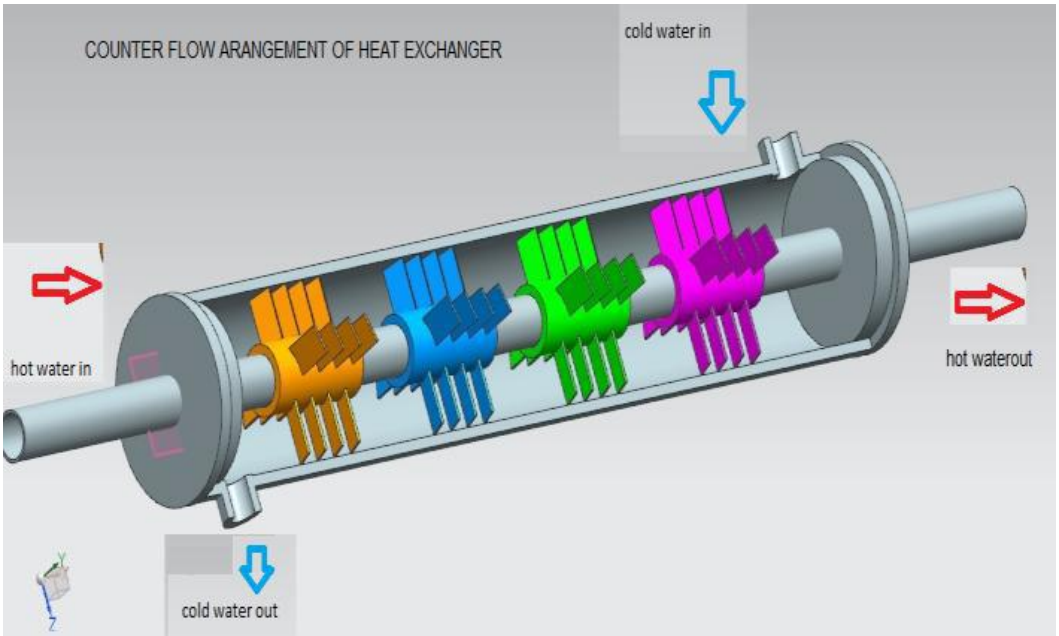

Fig. 8- Heat exchangers and fins arrangement. [4]

Methodology-

- Heat Transfer enhancement or augmentation techniques refer to the improvement of thermo hydraulic performance of heat exchangers.
- Existing enhancement techniques can be broadly classified into three different categories:

I. Active Techniques

II. Passive Techniques

III. Compound Techniques

E). Veeresh Fuskele and Dr. R M Sarviya, 2012[5]

Veeresh Fuskele and Dr. R M Sarviya explain on his research work about the investigation of double pipe heat exchanger to enhance the heat transfer rate using twisted dense wire mesh insert.

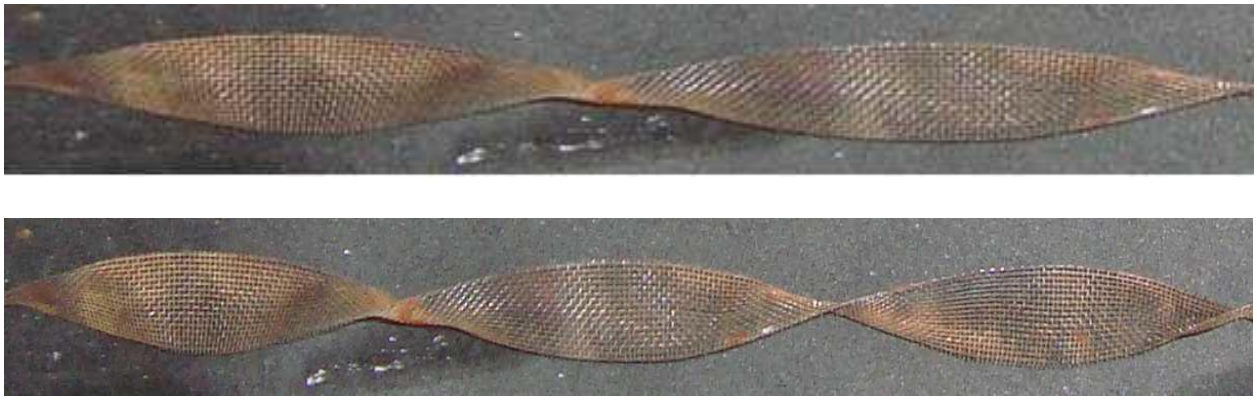

Fig. 9- Twisted dense wire mesh with twisted ratios y=5 and y=7. [5]

III. CONCLUSION

For better heat transfer enhancement in double pipe heat exchanger we need to use different geometry and different liners and twist the tape at different angles and also by varying the pressure flow rate of hot and cold fluid and also need to reduce the pressure drop and friction factor. For this it's better to use the copper pipe for hot fluid flow and can also use PVC and CPVC pipe for cold fluid and for twisted tape material we can use CU strip and GI strip also.

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