Numerical and experimental investigation of heat transfer in double pipe heat exchanger with inner and annular twisted tape

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Abstract— *Heat exchanger is an important device in all the thermal systems. The heat exchanger is widely used equipment in different industries such as process, petroleum refining, chemicals, pharmaceutical and paper etc. after studying different literature about heat exchanger and double pipe heat exchanger problem is identified as To perform simulation and experimental investigation of double pipe heat exchanger with inner and annuals twisted tape at different mass flow rate .*

The system has followed different types of flow arrangement and geometric dimension with twisted tape to attain heat transferred in experimental result and compare with simulation result. The objective of these experiments is to Performance analysis of double pipe heat exchanger with inner and outer twisted tape at different mass flow inlet of hot. The experimental set up consists of double pipe heat exchanger experiment. The apparatus includes tube-within-a-tube heat exchangers and twisted tap with threaded thermocouple at each end, a water pump and electric motor. These methods used to find out the heat transfer rate from the surface and related temperature of fluid motions also used to found the effectiveness. The Annular method in which twisted tape is outside the inner tube has higher rate of heat transfer than other three methods. Also same result near found by simulation using ANSYS.

Keywords— double pipe heat exchanger, inner twisted tape, outer twisted tape.

I. INTRODUCTION

Heat exchangers are widely used in chemical, power generation and petroleum refining industry. Shell and tube heat exchanger have the ability to transfer large amount of heat in relatively low cost , serviceable designs. The important variable in reducing the size and cost of a heat transfer device are pressure drop and heat transfer coefficient. Therefore, it is good to developed method to improve the heat transfer coefficient. The twisted tap insert as flow tabulators are have been widely applied due to their promising performance. Many researchers have reported their influence of tube insert on heat transfer improvement.

The promising challenge for design of heat exchanger is to reducing the pumping power while increased heat transfer rate. Therefore it is essential to develop theory and technique about increased heat transfer in the double pipe heat exchanger to optimize the performance of heat exchanger. The presence of twisted tape gives toward lower the hydrodynamic and thermal boundary layer thickness, leading to greater convective heat transfer. Though pumping power may increase meaningfully and ultimately the cost of pumping is more. Therefore to achieve a desired heat transfer rate with minimum pumping power, the design of twisted tape with proper geometry is necessary.

Twisted tapes are normally inserted into the tube to generate swirl motion of fluid for greater heat transfer. This also leads to improve flow velocity, thermal boundary layer, hydrodynamic boundary layer, heat transfer rate, fluid mixing. However more pumping power is required when twisted tapes are inserted to inner tube.

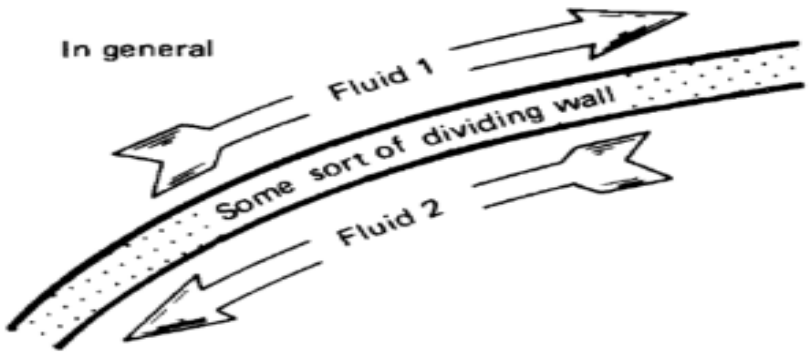

FIG. 1: HEAT EXCHANGER CONCEPT

II. CLASSIFICATION OF IMPROVEMENT METHOD

Heat removal improvement method mentions to the development of thermo hydraulic performance of heat exchanger .These improvement method is categorized in generally three categories. They are as below:

- Active method.
- Passive method.
- Compound method:

Active method: In these methods, exterior power is used to ability the need flow statement and related important in rate of heat transfer.

Passive method: These methods do not necessary any direct input of exterior power.

Compound method: A compound important method is the one wherever more than one of the above stated method is used in mixture by the purpose of further improving the rate of heat transfer.

III. LITRETURE REVIEW

S.k.Saha A.Datta et al . In this study they observed the experimentally double pipe heat exchanger with insulated stainless steel twisted tape. They absorb the conclusion of dissimilar length and pitch of twisted ratio on heat transfer and friction factor. The important outcomes were obtain short length twisted tape it compact the pumping losses but it also decline the heat transfer rate and constant pitch twisted tape provide extreme high heat transfer rate.

M.Kannan et al . The propose of these Investigates is to support the overall heat transfer procedures and the approaches and strategies that can be applied to improve additional heat transfer rate. The device contains pipe-within-a-pipe heat exchangers with threaded thermometer at every end, measuring flask, a water pump and electric geyser method. Three of the four heat exchangers are altered by one kind of the beyond-declared heat transfer improvement procedures. These devices used to create available the heat loss from the surface and connected temperature of fluid waves also used to create the efficiency, the efficiency are consuming to associate the dissimilar flow rates for which one is maximum likely heat transfer in double pipe heat exchanger. Annular technique is higher rate of heat transfer than other three methods

C.K.Pardhi et al The propose is to decrease as several of the reasons as likely Capital Price, Power price, Maintenance price, Space and Weight, Reliable with security and consistency. Current work defines the main methods of engineering significance for the growth of single phase heat transfer on the inside of pipes specifically twisted tapes. So twisted tape should be used in heat exchanger when high heat transfer rate is necessary and pressure drop is of no importance. When one heat transfer capability of heat exchanger is standards irrespective of pressure drop or pumping power the twisted tape is extra higher as associated with plane pipes(1.6 to 1.8 times). On equivalent pressure drop and equivalent pumping power basis the plane pipes is well to twisted tape (1.3 to 1.7 times). With rise in flow rate of oil keeping flow rate of water continuous the thermal performance reductions slightly for each other. Twisted tape of minor twist ratio (p/d =3.5) gives higher heat transfer coefficient (by 1.39 times) than greater twist ratio of p/d = 7.

EbruKavakAkpinar et al. In this study they observed the result of heat transfer rate , friction factor , exergy injuries with swirl . At dissimilar swirl producer with spherical hole at altered number and diameter were used in this experiment. This investigational was completed for counter flow and parallel flow at the series of Reynolds number between 8500–17500 .

Heydar Maddah et al : Experimental study on double pipe heat exchanger with twisted tape using AL2O3 nano fluid. They have design different geometry of twisted tapes and experiment with different nanofluid concentration. They found based on experimental data, heat transfer and friction factor increased by 12% to 52% and 5% to 28% as compared with tube with typical twisted tape (GPR=1) and nanofluid. The performance were lower by using IGPR twists 0.6 to 0.92 and 0.75 to 0.95. they also found that thermal performance of heat exchanger with nano fluid and modified twisted tap are better. They developed generalized correlation for estimation of Nusselt number, friction factor, and thermal performance factor under turbulent flow condition.

K. Hata et. Al (2013): they studied twisted tap induced swirl flow pressure drop and heat transfer in vertical circular tube by computational method. Heat flow in this type of exchanger found exponentially increased whereas twisted tape induced pressure drop.

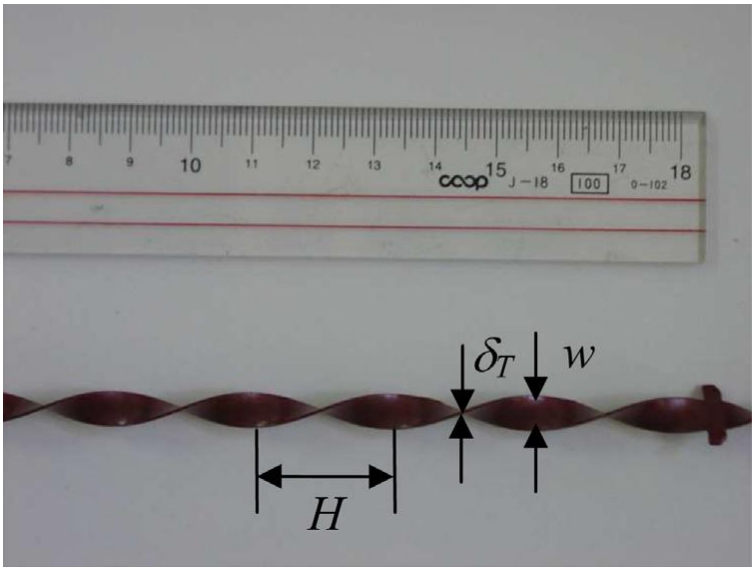

FIG 2 : PHOTOGRAPH OF SU304 TWISTED TAPE

Experiment carried out for mass velocity G= 4120 to 13570 kg/m2 /s, inlet temperature 300.13 to 305.78 K and pressure 866.52 to 945.86 kPa by water loop flow. The result found by them are inner and outer surface temperature for three section become gradually higher with an increased in heated length from t leading edge of the tube eith twisted tape insert, whereas the heat flux almost constant for each position of the section.

S.R. Shabanian et,al. CFD and experimental studies carried out on air cooler with different tube insert for enhancement of heat transfer. Tube insert including butterfly, classic, jagged twisted tape.

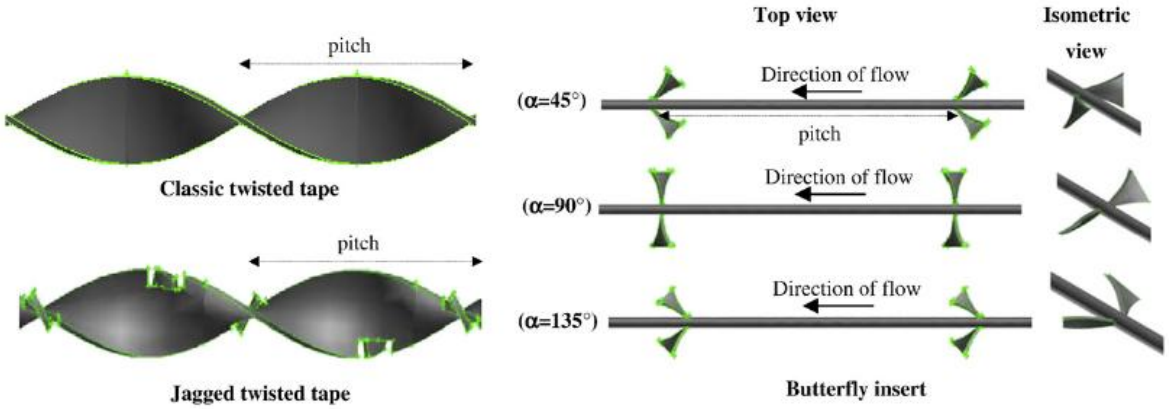

FIG. 3: CLASSIC, JAGGED TWISTED TAPE AND BUTTERFLY TUBES

They found that maximum thermal performance factor obtained by the butterfly insert with an included angle of 900 . by employed classical and jagged tube in air cooler they found difference in heat transfer and also done experiment by decreasing twist angle. The same configuration was created in CFD and results obtained for different set of twist ratio. The three dimensional CFD modeling result shows that an increase in turbulence intensity could be one of the reasons for higher performance of butterfly compared to jagged and classic ones.

IV. CONCLUSION

In double pipe twisted tap heat exchanger attempt has to design and developed heat exchanger and simulation using ANSYS. Experiment has been carried out for measuring Performance analysis of double pipe heat exchanger with inner and outer twisted tape at different mass flow inlet of hot pipe. By conducting experiment as well as simulation result shows that heat transfer rate of double pipe heat exchanger with outer twisted tap and hot fluid flowing outside of inner tube has maximum and log mean temperature difference is linearly with respect to different mass flow rate and also increase heat transfer coefficient at interchanging domain Results obtained from CFD are validating with experimental values and % deviation from it is also very small .

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REFERENCES

[1] Saha, S. K., Dutta, A. and Dhal, S. K. "Friction and heat transfer characteristics of laminar swirl flow through a circular tube fitted with regularly spaced twisted-tape elements." Int. J. Heat and Mass Transfer, 2001, 44,4211-4223

[2] M.kannan et al., "Experimental and analytical comparison of heat transfer in double pipe heat exchanger" International Journal of Mechanical Engineering applications Research – IJMEAR, ISSN: 2249- 6564.

[3] C.K.Pardhi, "Performance improvement of double pipe heat exchanger by using turbulator", IJESAT, Volume-2, Issue-4, 881 – 885.

[4] Ebru Kavak Akpinar , YasarBicer"Investigation of heat transfer and exergy loss in a concentric double pipe exchanger equipped with swirl generators" Received 3 May 2004; accepted 22 November 2004 in international journal of\ thermal science.

[5] Heydar Maddah " Experimental study of al203/ water Nano fluid turbulent heat transfer enhancement in the horizontal double pipes fitted with modified twisted tape." International Journal of Heat and Mass Transfer 78 (2014) 1042–1054

[6] K. Hata "Computational study of twisted-tape-induced swirl flow heat transfer and pressure drop in a vertical circular tube under velocities controlled." Nuclear Engineering and Design 263 (2013) 443– 455

[7] S.R. Shabanian " CFD and experimental studies on heat transfer enhancement in an air cooler equipped with different tube inserts." International Communications in Heat and Mass Transfer 38 (2011) 383–390.