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# A Review On Optimization Of Counter flow Heat Exchanger Using Rsm Method

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**Abstract- Thermal power stations, chemical processing plants, air conditioning equipment, freezers, petrochemical, biomedical, and food processing facilities are only some of the many current uses for heat exchangers with twisted-tape inserts, which promote convective heat transmission. The thermal performance of heat exchangers can be enhanced by the application of heat transfer improvement methods. Therefore, improving heat exchange efficiency can have a significant influence on thermal efficiency and cost-effectiveness in systems that use heat transfer processes in their design and operation. The most common applications for DPHEs are in high-temperature and high-pressure environments because of their small size. It is possible to achieve the desired heat transfer rate within the limits of the heat exchanger's design and length with a minimum amount of pumping power by employing one of many strategies. Active and passive augmentation techniques were distinguished.**

**Keywords- Counterflow heat exchanger, performance, optimization.**

## I. INTRODUCTION

The thermal performance of heat exchangers has been greatly improved by optimizing heat transfer surfaces in a variety of ways, but this improvement has come at a cost: higher pressure drops associated with these optimizations necessitate more powerful recycling fluid pumps to maintain flow.A heat exchanger is a tool for maximizing the transmission of heat between two mediums, whether they are separated by an impassable barrier or in direct contact with one another.

They are used in many fields, from the processing of natural gas to the cooling and heating of buildings to the production of electricity. A heat exchanger is a mechanical device that transfers heat between two different systems or materials in order to preserve a desired temperature gradient. The purpose of a heat exchanger is to allow one fluid to transfer heat to another fluid while remaining physically separated from both. Heat exchangers come in a broad range of sizes and forms, but they all use some type of thermally conductive technology to physically separate the fluids.

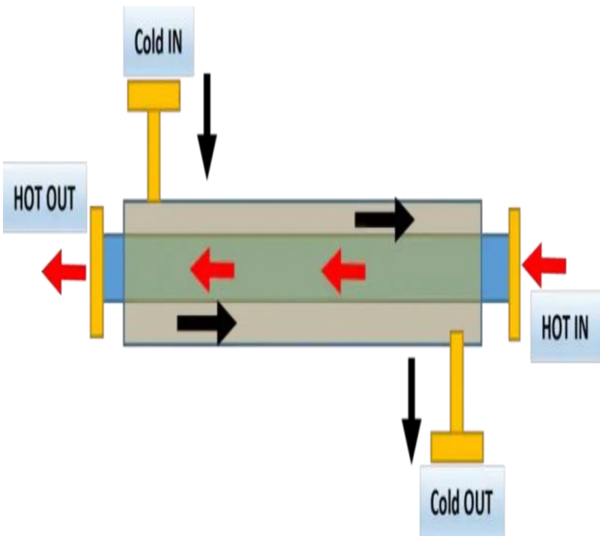


Fig. 1 Double pipe heat exchanger.

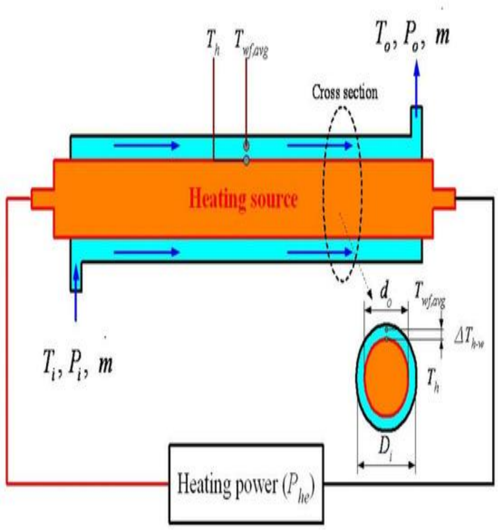


Fig. 2: Working principle of double pipe heat exchanger

## II.RELATED WORK

**Azher et al. (2018)**Under a uniform heat flux situation, a numerical study was conducted on forced convection heat transfer in a horizontal pipe with and without twisted tape-inserts. The fluid that does the work is water. Using the Realizable - (RKE) model, the governing equations are numerically solved in the domain by the finite volume technique (FVM). **Sivakumar et al. (2018)**The twist ratio Y is 5.4 and the depth of the triangular cut was 1.2 cm; these parameters were analyzed to determine the friction factor and heat transfer properties of a concentric tube with a triangle cut twisted tape (TCTT) insert for laminar flow.

**Mahipal et al. (2018)**deals with the use of swirlflow devices with different combinations as passive heattransferaugmentation technique. In this article, the twodifferent swirl flow devices used are namely twisted tape (TT)and wire coil (WC) turbulator. The present work deals withthe counter flow type condition of heat exchanger. Effect ofdifferent length combination of these two different turbulatortwisted tape and wire coil on the heat transfer, friction factorand pressure drop for Reynolds number ranges from 2000-10000, has studied in double pipe heat exchanger (singlepass).

**Agrawal et al. (2018)**Heat transfer enhancement technique refers to different methods used to increase rate of heat transfer withoutaffecting much overall performance of the system. These techniques are used in heat exchangers, Some of the applicationof heat exchangers are in process industries, thermal power plant, air conditioning equipment, refrigerator, radar forspace vehicles, automobiles etc. In the past decades several studies on passive techniques of heat transfer enhancementhave been reported. This paper reviews mainly on twisted tape heat transfer enhancement and its design modificationtowards the heat transfer enhancement and saving pumping power.

**Bhattacharyya et al. (2017)** Numerical investigation of heat transfer characteristics in a tube fitted with inserted twistedtape swirl generator is performed. The twisted tapes are separately inserted from the tubewall. The configuration parameters include the, entrance angle (α) and pitch (H).Investigations have been done in the range of α = 180°, 160° and 140° with Reynolds numbervarying between 100 to 20,000. In this paper, transition - SST model which can predict thetransition of flow regime from laminar through intermittent to turbulent has been utilized fornumerical simulations. The computational results are in good agreement with experimentaldata. The results show that higher entrance angle yields a higher heat transfer value. Theusing of single twist twisted tape supplies considerable increase on heat transfer and pressuredrop when compared with the conventional twisted tapes. A large data set has been generatedfor heat transfer and thermal-hydraulic performance which is useful for the design of solarthermal heaters and heat exchangers.

**Maradiya et al. (2017)**Heat transfer devices have been used for conversion and recovery of heat in many industrial and domesticapplications. Over five decades, there has been concerted effort to develop design of heat exchanger thatcan result in reduction in energy requirement as well as material and other cost saving. Heat transferenhancement techniques generally reduce the thermal resistance either by increasing the effective heattransfer surface area or by generating turbulence. Sometimes these changes are accompanied by anincrease in the required pumping power which results in higher cost.

**Mahdi et al. (2016)** reported the use of variant twisted tapes fitted in a double pipe heat exchanger to improve the fluid mixing that leads to higher heat transfer rate with respect to that of the plain-twisted tape. Heat transfer, flow friction and thermal enhancement factor characteristics in a double pipe heat exchanger fitted with plain and variant twisted tapes using water as working fluid are investigated experimentally. Tests are performed for laminar flow ranges. The experimental data for a plain tube and plain-twisted tapes are validated using the standard correlations available in the literature. Two different variant twisted tapes which include V cut-twisted tape and Horizontal wing cut-twisted tape with twist ratios of y = 2.0, 4.4 and 6.0 are used. In addition, the variation of heat transfer coefficient of copper–nanofluids with different of Reynold's number and volume concentration of nano particles in plain tube without twisted tape.

**Jedsadaratanachai et al. (2014)** presents a numerical analysis of laminar fully developed periodic flow and heat transfer in a constant temperature-surfaced circular tube with single twisted tape inserted. The twisted tape is introduced and inserted in the middle of the tested tube. The effects of twisted ratios (y/W = 1, 2, 3, 4, 5and 6) are presented for Reynolds number (Re) values ranging from Re = 100 to 2000. The SIMPLE algorithm and periodic condition are used in the current study. The computational results are shown inthe topology of flow, heat transfer and thermal improvement. It is found that the heat transfer in thecircular tube with the twisted tape is more effective than that with no twisted tape inserted. The increasein the y/W ratio leads to decrease in the Nusselt number and friction factor. In addition, the numerical result shows that the reduction in the y/W ratio not only helps to create strong longitudinal vortex flows which enhance heat transfer, but also increase the pressure loss in the tested tube. The computed result reveals that the maximum value of the thermal enhancement factor, TEF is found to be 3.52 for using the twist tapes with y/W = 5 at the highest Reynolds number regime.

## III. CONCLUSION

The counter flow heat exchanger has demonstrated a high heat transfer efficiency due to its unique design, which allows for a significant temperature difference between the hot and cold fluid streams along the entire length of the exchanger. This characteristic enables optimal thermal energy exchange, resulting in better overall performance compared to other heat exchanger configurations. The presence of temperature crosses in the counter flow heat exchanger has been observed and analyzed. These temperature crosses occur when the hot and cold fluid streams' temperatures at the inlet and outlet points intersect. This phenomenon, while beneficial for maximizing heat transfer, requires careful consideration during the design and operation to avoid potential issues like thermal stress and material degradation.The counterflow arrangement, with fluids flowing in opposite directions, has proven advantageous in enhancing the heat exchanger's performance. This configuration ensures a more uniform temperature distribution across the exchanger's surface, minimizing thermal losses and improving overall heat transfer efficiency.

## REFERENCES

[1] Azher M. Abed, Hasan Sh. Majdi, Zainab Hussein, Doaa Fadhil, Ammar Abdulkadhim(2018), Numerical Analysis Of Flow And Heat Transfer Enhancement In A Horizontal Pipe With P-TT And V-Cut Twisted Tape, Case Studies In Thermal Engineering,Vol 12,Pp 749–758.

[2] Pawan A. Sawarkar, Pramod R. Pachghare(2013), Experimental Analysis Of Augmentation In Heat Transfer Coefficient Using Twisted Tape With Semi- Circular Cut Insert, International Journal Of Science And Research, Volume 4 Issue 4,Pp 1174-1179.

[3] S. Liu, M. Sakr(2013), A Comprehensive Review On Passive Heat Transfer Enhancements In Pipe Exchangers, Renewable And Sustainable Energy Reviews,Vol 19, Pp 64–81.

[4] Mazen M. Abu-Khader (2012), Plate Heat Exchangers: Recent Advances, Renewable And Sustainable Energy Reviews, Vol 16, Pp 1883–1891

[5] M.A. Akhavan-Behabadi, Ravi Kumar, A. Mohammadpour, M. Jamali-Asthiani (2009), Effect Of Twisted Tape Insert On Heat Transfer And Pressure Drop In Horizontal Evaporators For The Flow Of R-134a, International Journal Of Refrigeration Vol 32, Pp 922-930.

[6] Halit Bas, VeyselOzceyhan(2012), Heat Transfer Enhancement In A Tube With Twisted Tape Inserts Placed Separately From The Tube Wall, Experimental Thermal And Fluid Science, Vol 41, Pp 51–58.

[7] Suvanjan Bhatt acharyyaa, Himadri Chatto padhyay, Ayan Haldar (2017), Design Of Twisted Tape Turbulator At Different Entrance Angle For Heat Transfer Enhancement In A Solar Heater,

Beni-Suef University Journal Of Basic And Applied Sciences,Pp 1-24.

[8] Smith Eiamsa-Ard, ChinarukThianpong, PetpicesEiamsa-Ard, PongjetPromvonge (2009), Convective Heat Transfer In A Circular Tube With Short-Length Twisted Tape Insert, International Communications In Heat And Mass Transfer,Vol 36, Pp 365–371.

[9] Jian Guo, Aiwu Fan, Xiaoyu Zhang, Wei Liu (2011), A Numerical Study On Heat Transfer And Friction Factor Characteristics Of Laminar Flow In A Circular Tube Fitted With Center-Cleared Twisted Tape, International Journal Of Thermal Sciences, Vol 50, Pp 1263-1270.

[10] V. Hejazi, M.A. Akhavan-Behabadi , A. Afshari(2010), Experimental Investigation Of Twisted Tape Inserts Performance On Condensation Heat Transfer Enhancement And Pressure Drop, International Communications In Heat And Mass Transfer,Vol 37, Pp 1376–1387.

[11] Qasim S. Mahdi, Ali Abdulridha Hussein (2016), Enhancement Of Heat Transfer In Shell And Tube Heat Exchanger With Tabulator And Nanofluid, International Journal Of Mechanical Engineering And Technology,Volume 7, Issue 3, Pp.125–138,

[12] Mr. Mahipal, A. Parmar (2018), Numerical Analysis For Effect Of Different Length Combination Of Turbulators On Heat Transfer And Pressure Drop In Double Pipe Heat Exchnager, International Research Journal Of Engineering And Technology, Volume: 05 Issue: 12,Pp 1557-1566.

[13] With adaJedsadaratanachai, Amnart Boonloi (2014), Effect Of Twisted Ratio On Flow Structure, Heat Transfer And Thermal Improvement In A Circular Tube With Single Twisted Tape, Journal Of Mathematics And Statistics, Vol 10 (1), Pp 80-91.

[14] Raj M. Manglik, Arthur E. Bergles(2002), Swirl Flow Heat Transfer And Pressure Drop With Twisted-Tape Inserts, Advances In Heat Transfer, Vol. 36,Pp 1-184

[15] Chirag Maradiya, Jeetendra Vadher, Ramesh Agarwal (2017), The Heat Transfer Enhancement Techniques And Their Thermal Performance Factor, Beni-Suef University Journal Of Basic And Applied Sciences,Vol 45,Pp 1-21.

[16] Taye Stephen Mogaji, Fabio Toshio Kanizawa, EnioPedoneBandarra Filho, GherhardtRibatski (2013), Experimental Study Of The Effect Of Twisted-Tape Inserts On Flow Boiling Heat Transfer Enhancement And Pressure Drop Penalty, International Journal Of Refrigeraion,Vol 36,Pp 504-515.

[17] P. Murugesan, K. Mayilsamy,S. Suresh,P.S.S. Srinivasan(2011), Heat Transfer And Pressure Drop Characteristics In A Circular Tube Fitted With And Without V-Cut Twisted Tape Insert, International Communications In Heat And Mass Transfer,Vol 38,Pp 329–334.