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Experimental Analysis of Heat Transfer by Forced Convection with Twisted Strips – A Critical Review

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Abstract – *Heat transfer rate can also be increased with the help of some active or passive technique of enhancement of heat rate in a heat exchange as it gives a vital role in several industries. The changes which are done by using techniques convert simple natural heat exchanger to augmented heat exchanger. The intention to present this paper is to study the effect of twisted strip on heat transfer rate by natural convection which is useful in design and analysis of heat exchangers. In recent years, the high cost of energy and material has resulted in an increased effort aimed at producing more efficient heat exchange equipment. The heat transfer rate can be improved by introducing a disturbance in the fluid flow (breaking the viscous and thermal boundary layers), but in the process, pumping power may increase significantly and ultimately the pumping cost becomes high. Twisted-tube is one of the most important members of passive technique group which employed extensively in heat exchangers, solar water heater, and chemical process industry. In the present study the heat transfer coefficient for various configurations will be investigated and compared by using forced convection mode.*

Keywords- ***Forced convection, heat transfer enhancement, twisted strips, and passive techniques.***

I- INTRODUCTION

Heat transfer is the science which predicts the rate of energy transfer taking place between the material bodies as a result of temperature difference between them. The science of heat transfer not only explains how heat energy is transferred but also predicts the rate at which the exchange will take place under certain specific condition.

The importance of study of heat transfer lies in many areas like energy production and conversion, refrigeration and air conditioning, electric machine, chemical and petro chemical operations, civil engineering, space vehicle, manufacturing process, etc. The study of heat transfer has become an increasingly intense concern in modern technology in earth science and environmental engineering. Heat transfer is a subject of wide spread interest to the students of engineering curriculum, practicing engineer and technicians in the design construction, testing and operation of many diverse forms of heat exchange equipment required in our scientific and industrial technology.

When external sources such as fans and pumps are used for creating induced convection, it is known as forced convection. Examples of forced convection are using

water heaters or geysers for instant heating of water and using a fan on a hot summer day.

At present, the technology of the twisted Strips insert is widely used in various industries. Insertion of twisted Strips in a tube provides a simple passive technique for enhancing the convective heat transfer by introducing swirl into the bulk flow and by disrupting the boundary layer at the tube surface due to repeated change in surface geometry. The system has followed type of flow arrangements and geometric dimension with twisted Strips. The intention to present this paper is to study the effect of twisted strip on heat transfer rate by forced convection which is useful in design and analysis of heat exchangers.

1.1 Twisted Strips:

In general a twisted Strips is a metallic strip having twist from its central axis whose design depends only on three main factors which are material of strip, pitch of the twist and the twist ratio which is define by the ratio of the pitch length to the inside diameter of the tube but this is some old era. Now the modified twisted are the replacement of the plane twisted Strips. Some of the modified twisted Strips are the Strips with attached baffles, slotted Strips or Strips with holes etc.

The simple heat exchanger equation for the convective heat transfer between a pipe and a fluid is Newton's Law of Cooling:

$$q'' = h\,(T_o - T_\infty)$$

The symbols q'', h, T_o, and T_∞ represent the heat wall heat flux, the heat transfer coefficient, the temperature of the flat plate and the temperature of the fluid respectively.

II- LITERATURE REVIEW

A tube inserted with a twisted-tape performs better than a plain tube, and a twisted-tape with a tight twist ratio provides an improved heat transfer rate at a cost of increase in pressure drop for low Prandtl number fluids. This is because the thickness of the thermal boundary layer is small for a low Prandtl number fluid and a tighter twist ratio disturbs the entire thermal boundary layer as discussed by different authors.

C Rajesh Babu And Santosh Kumar Gugulothu [1] Analysis Of Heat Transfer Enhancement By Using Passive Tecchniques In Heat Exchanger. The heat transfer enhancement is very important many engineering applications to increase the performance of heat exchangers. The active techniques required external power like surface vibrations, electrical fields etc and the passive techniques are those which does not required any external power but the inserts are required to disturb the flow like tape inserts etc moreover literature survey says passive techniques gives more heat transfer rate without external power requirement by keeping different tape inserts. However CFD tool is very important and effective tool to understanding heat transfer applications. Computational heat transfer flow modelling is one of the great challenges in the classical sciences. By incorporating the inserts the heat transfer enhancement is increased due to its importance in different applications. By CFD modelling by taking concentric tube by considering with and without inserts we conclude that heat transfer enhancement by using ANSYS.

A.H. Dhumal, G. M. Kerkal, K.T. Pawale [2] Heat Transfer Enhancement for Tube in Tube Heat Exchanger Using Twisted Tape Inserts.
Heat transfer augmentation techniques refer to different methods like Swirl-om devices include a number of geometric arrangements or nibe inserts for forced flow that create redating and secondary low. Cestled tubes. inlet vortex generators, histed-tape inserts, and axial core interts with a screw-type winding ased an increase rate of heat transfer without affecting much the overall performance of the system. These techniques are used in heat exchangers which are and in process industries, air conditioning equipments refrigerators thermal Power plants, dators for space vehicles and automobiles This work mainly focuses on the winted pe inserts with different pitch and twist ratio and its effect on friction

Ahmed Hashim Yousif, Maher Rehaif Khudhair [3] Enhancement Heat Transfer in a Tube Fitted with Passive Technique as Twisted Tape Insert . The process of improving heat transfer is one of the important topics that are constantly studied. There are three techniques to improve the heat transfer (passive, active and compound). Most studies are dene using the pasive technique because it does not need external energy is work is only to mix the flow to control the growth of the boundary layer and to increase the thermal exchange between the wall and the fluid flow by placing the techniques inside the flow. In this study, emphasis was placed on the studies and research carried out on the first technique (passive techniques and put in a table according to the years of publication as a reference for the students studying in this subject and for heat

exchangers designers who aim to reduce weight and cost in the process of manufacturing heat exchangers for reduce their effort and time to reach the optimal design.

RV Manikanta', DVN Prabhakar, NVS Shankar [4] Effect Of Twisted Tape Insert Transfer During Flow Through A Pipe Using CFD. The effect of nanoparticles on the performance of nanguids during how through paper with dual nested tape inserts. A detailed literature rarry on the are of twisted tape inserts and computation thermal properties of namefaids is presented. Expressions for unflaid thermal properties computation are discimed Properties for Al;0, and TiO, and with volame fraction of 0.1 are computed CFD simulations to study the behaviour of fluid during heat transfer when flowing through pipes with dual neinted supe inserts Revalts of these simulations are discussed in the paper.

Kamlesh R. Raut , Prof. H.S. Farkade [5] Convective Heat Transfer Enhancements In Tube Using Insert .
Enhancing heat trander surface are used in many engineering applications such as heat exchanger, air conditioning. chemical reactor and refrigeration system, hence many techniques have been investigated on enhancement of heat transfer rate and decrease the size and cost of the involving equipment especially in heat exchangers. One of the most important techniques used are passive heat transfer technique. These tchniques when adopted in Heat exchanger proved that the overall thermal performance improved significantly. This paper reviews experimental and numerical works taken by researchers on this technique since 2004 such as twisted tape, wire cuil, swirl flow generator, etc. to enhance the thermal efficiency in heat exchangers and useful to designers implementing passive augmentation techniques in heat exchange. The authors found that variously developed twisted tape inserts are popular reached and used to strengthen the heat transfer efficiency for heat exchangers. The other techniques used for specific work environments are studied in this paper. Twisted tape inserts perform better in laminar flow than turbulent flow. However, the other several passive techniques such as ribs, conical nozzle, and conical ring, etc. are generally more efficient in the turbulent flow than in the laminar flow,

Snehal S. Pachegaonkar et. Al [6] gives the result for the performance analysis of double pipe heat exchanger of inner pipe inner diameter 16.5mm, outer diameter 21.5mm and outer pipe inner diameter 42mm, outer diameter 48.5mm with Annular M.S. Twisted Tape Insert of Width 10mm, pitch 67mm,107mm, twist ratio 6.7, 10.7 , tape thickness 1.4mm length of 1.5m. For plain double pipe heat exchanger result shows linear tendency, since the Nu No. is directly proportional to Reynolds number. The results for heat exchanger with twisted tape has parabolic tendency From the results obtained it is concluded that the best performance with twisted tape inserted into annulus of double pipe heat exchanger is obtained at twist angle 450 due to more swirl and turbulence induced by tape insert.
Shubham Jadhav et. Al [7] Augmentation techniques refer to different methods used to increase rate of heat transfer without increasing size and without affecting overall performance. These techniques used in Heat Exchangers. Some of the applications of heat exchanger are in process industry, thermal power plants, air conditioning equipment's, radiator for space vehicles, automobiles etc. So, for various application heat exchangers are designed, which needs exact analysis of heat transfer rate and pressure drop estimations.

S. Naga Sarada et. Al [8] Heat transfer augmentation refers to the process of increasing the heat transfer coefficient which leads to the improvement in the performance of the system. The twisted tape insert is a device used for increasing the heat transfer rate in the heat exchanger system due to its advantages of easy fabrication, operation as well as low maintenance. Some of the applications of heat exchangers are in process industries, thermal power plant, air conditioning equipment, refrigerators, radars for space vehicles, automobiles etc.

Chirag Maradiya et. Al [9] Heat transfer devices have been used for conversion and recovery of heat in many industrial and domestic applications. Over five decades, there has been concerted effort to develop design of heat exchanger that can result in reduction in energy requirement as well as material and other cost saving. Heat transfer enhancement techniques generally reduce the thermal resistance either by increasing the effective heat transfer surface area or by generating turbulence. Sometimes these changes are accompanied by an increase in the required pumping power which results in higher cost.

Pradip Pathade et. Al [10] Many industrial facilities face problem of effective heat transfer due to the performance issues of heat exchangers. Optimizing changes in flow regime and redesigning heat exchangers for best possible heat exchange for maximizing profits. Twisted tube type shell and tube heat exchanger (TTSTHE) combats nearly all performance drawbacks in conventional heat

exchangers. 'Twisted Tube Technology' is the new technology in the era of heat transfer equipment. The concept of swirl flow moment of fluid creates turbulence enhancing thermal-hydraulic performance of TTSTHE. The TTSTHE increases the overall efficiency of heat transfer. The advantage of twisted type shell and tube heat exchanger over conventional heat exchanger are Studied in this paper on the basis of economics, performance and material of construction including reactive metals for improved performance, no vibration, and no dead spots etcetera. The retrofit situation is increased capacity, lower installed cost, lower shell side pressure drop and low fouling over shell and tube heat exchanger. The literature also supports the application of twisted type shell and tube heat exchanger in large scale and small scale industries. The challenges faced are mostly in operating and maintaining this type heat exchangers. However, engineering and design standards are crucial for design and construction consideration of heat exchanger needs to be looked into.

After doing this wide literature survey, it has been observed that enough work has not been carried out so far, hence this work is undertaken.

III - PROPOSED EXPERIMENTAL SET-UP DETAILS

Table1: Details of experimental set-up

S.N.	Material	Dimensions
1	Copper strip (Flat)	450 x 25 x 5 mm
2	Copper strip (Single twist)	450 x 25 x 5 mm
3	Pitch for each strip	150mm
4	Copper strip (Double twist)	450 x 25 x 5 mm
5	Thermocouples	J-Type
6	Dimmer stat	240V 5A
7	Voltmeter	0-230V
8	Ammeter	0-5A

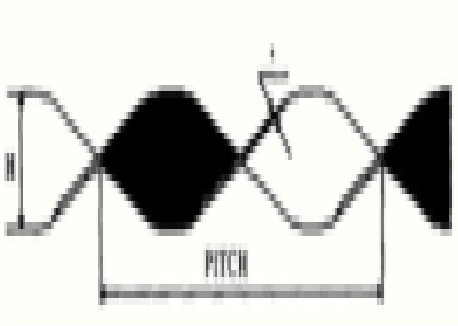

Fig.1: Typical twisted strip

Fig. 2: Proposed Experimental Set-up

Fig. 3: Experimental Set-up

IV - CONCLUSION

After doing the exhausting literature survey on "Analysis of heat transfer by Forced convection using twisted strip". It has been observed that the enough work has not been carried out hence this work has to be undertaken. Further the present study deals with the comparison of the average heat transfer coefficient of flat ,single twist and double twist using forced convection mode is to be studied the experimentation of the same is undergoing fabrication and then we have to collect the data analysis of the data and finally compare the results for different strips configurations.

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