HEAT TRANSFER ENHANCEMENT BY USING INSERT TWISTED TAPE (A REVIEW)

Prof. Avinash Mankar[1], Md. Sarfaraz Ansari[2], Shubham G. Borkar[3], Rushabh K. Thakare[4], Tushar V. Dongare[5], Ankit G. Wandhare[6], Shubham V. Umap[7], Shubham B. Bhise[8].

(Dept of Mechanical Engg. Gurunanak Institute of Technology, Nagpur, Maharashtra, INDIA)

ABSTRACT

Heat transfer enhancement techniques refer to different methods used to increase rate of heat transfer without affecting much the overall performance of the system. These techniques are used in heat exchangers. Some of the applications of heat exchangers are-in process industries, thermal Power plants, air-conditioning equipments, refrigerators, radiators for space vehicles, automobiles etc. These techniques broadly are of three types viz. passive, active and compound techniques. The present paper is a review of the passive enhancement techniques used in the recent past. Twisted tapes play a very important role in heat transfer enhancement of electronic 1cooling systems, heat exchangers etc.

The present work shows the results obtained from experimental investigations of the augmentation of turbulent flow heat transfer in a horizontal tube by means of varying width twisted tape inserts with air as the working fluid. In order to reduce excessive pressure drops associated with full width twisted tape inserts, with less corresponding reduction in heat transfer coefficients, reduced width twisted tapes of widths ranging 12 mm, which are lower than the tube inside diameter of 50 mm are used. Experiments were carried out for plain tube with/without twisted tape insert at constant wall heat flux and different mass flow rates. The twisted tapes are of three different twist ratios (5,5 and 5.8 mm) each with three different widths (12,12 and 12 mm) respectively.

KEY WORDS :- Heat transfer enhancement, twisted tape, twist ratio, passive methods.

INTRODUCTION

Nowadays, twisted-tape inserts have widely been applied for enhancing the convective heat transfer in various industries, due to their effectiveness, low cost and easy setting up. Energy and material saving consideration, as well as economical, have led to the efforts to produce more efficient heat-exchanger equipment. Therefore, if the thermal energy is conserved, the economical handling of thermal energy through heat-exchanger will be possible.The development of high performance thermal systems has stimulated interest in methods to improve heat transfer. The goal of enhanced heat transfer is to encourage or accommodate high heat fluxes. The heat transfer techniques enables heat exchanger to operate at smaller velocity, but still achieve the same or even higher heat transfer coefficient. This means that a reduction of pressure drop, corresponding to less operating cost. Heat transfer augmentation techniques refer to different methods used to increase rate of heat transfer without affecting much the overall performance of the system. These techniques are
used in heat exchangers. Some of the applications of heat exchangers are-in process industries, thermal Power plants, air-conditioning equipments, refrigerators, radiators for space vehicles, automobiles etc. These techniques broadly are of three types viz. passive, active and compound techniques.

Materials and Methods :-

The apparatus consists of a blower unit fitted with a pipe, which is connected to the test section located in horizontal orientation. Nichrome bend heater encloses the test section to a length of a 80 cm. six thermocouples T1, T2, T3,

T4,T5 and T6 thermocouples are placed in the air stream, one at the entrance (T1) and the other at the exit (T2) of the test section to measure the temperature of flowing air . The pipe system consist a valve, which controls the airflow rate through it and an orifice meter to find the volume flow rate of air through the system

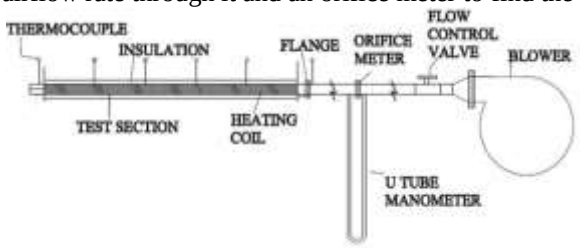

Figure : Experimental Set up Layout

Two calibrated pressure gauges are provided to measure the pressure drops across the test section. Input to heater is given through dimmer stat. The inner tube of the heating part, which is the test tube with
inside diameter 80mm . Display unit consists of voltmeter, ammeter and temperature indicator. The circuit was designed for a load voltage of 0-220 V, with a maximum current of 10A. Difference in the levels of
manometer fluid represents the variations in the flow rate of air. The velocity of airflow in the tube is measured with the help of orifice plate and the water manometer fitted on board.

DIFFERENT METHODS OF HEAT TRANSFER ENHANCEMENT

Generally, heat transfer enhancement methods are classified in three broad categories:

Active method: This method involves some external power input for the enhancement of heat transfer;some examples of active methods include induced pulsation by cams and reciprocating plungers, the use of a magnetic field to disturb the seeded light particles in a flowing stream, etc.

Passive method: These methods generally use surface or geometrical modifications to the flow channel by incorporating inserts or additional devices. For example, use of inserts, use of rough surfaces etc.

Compound method: Combination of above two methods.

Twisted tape :Twisted tapes are the metallic strips twisted with some suitable techniques with desired shape and dimension, inserted in the flow. Following are the main categories of twisted tape which are analyzed

Full length twisted tape: These tapes have length equal to length of test section.

Fig.Full twisted tape

Varying length twisted tape: These are distinguished from first category with regards that they are not having the length equal to length of test section, but half length, ¾ th length, ¼ th length of section etc.

Fig. Varying length twisted tape

Regularly spaced twisted tapes: These are short length tapes of different pitches spaced by connecting together. Tape with attached baffles: Baffles are attached to the twisted tape at some intervals so as to achieve more augmentation.

Slotted tapes and tapes with holes: Slots and holes of suitable dimensions made in the twisted tape so as to create more turbulence.

Fig. Holes twisted tape

Tapes with different surface modifications: Some insulating material is provided to tapes so that fin effect can be avoided. In some cases dimpled surfaced material used for tape fabrication. Some of the common tape formats are shown in following figure.

REVIEW OF WORK CARRIED OUT

P. Eiamsa-ard [1] reports on heat transfer
enhancement and friction factor characteristics in the tubes inserted with rectangular-winged twisted tapes(TT-RWs). The wing-depth ratio (d/W) was varied from 0.1 to 0.3 while the tape twist ratio was kept constant at y/W = 4.0. According to the results, the TT-RW with d/W = 0.3 yields the highest Nusselt number which is around 100% higher than that of the plain tube.

Smith Eiamsa-ard[2] Influence of helical tapes inserted in a tube on heat transfer enhancement is studied experimentally. The maximum Nusselt number may be increased by 160% for the full-length helical tape with centered-rod, 150% for the fulllength helical tape without rod and 145% for the regularly-spaced helical tape, s = 0.5, in comparison
with the plain tube.

B. Silapakijwongkul[3] In this work, effect of the arrangement (C-CC arrangement) on heat transfer and friction factor characteristics in a double pipe
heat exchanger was investigated experimentally. The mean heat transfer rates obtained from using C-CC twisted-tape arrangement and original twisted-tape
arrangement are found to be 219% and 204%, respectively over the plain tube.
tapes twisted in clockwise and counterclockwise

References

Sivashanmugam .P and Suresh .S, 2006. Experimental studies on heat transfer and friction factor characteristics of laminar flow
through a circular tube fitted with helical screw-tape inserts, *Applied Thermal*

Engineering, Vol. 26, No. 16, pp. 1990-1997
Sivashanmugam P., Suresh .S, 2007. Experimental studies on heat transfer and friction factor characteristics of turbulent flow through a circular tube fitted with helical screw-tape inserts, *Chemical Engineering*

Process, Vol. 46, pp. 1292–1298.
Shou-Shing Hsieh, I.W.Huang, 2000. Heat transfer and pressure drop of laminar flow in horizontal tubes with/without longitudinal
inserts, *Journal of Heat Transfer*, Vol.122, pp. 465-475.

Shou-Shing Hsieh, Ming-Ho Liu, Huang-Hsiu Tsai, 2003. Turbulent heat transfer and flow characteristic in a horizontal circular

tube with strip-type inserts Part-I (Fluid mechanics), *International Journal of Heat and Mass Transfer*, Vol. 46, pp. 823-835.

Wongchareeb, P. Eiamsa-ardc and C. Thianpongc, 2010. Heat transfer enhancement in a tube using delta-winglet twisted tape inserts, *Applied Thermal Engineering*, Vol. 30, No. 4, pp. 310-318.

Al-Fahed S, and Chakroun W, 1996. Effect of tube -tape clearance on heat transfer for fully developed turbulent flow in a horizontal isothermal tube, *Int. J. Heat Fluid Flow*, Vol. 17, No. 2, pp. 173-178.

Al-Fahed S, Chamra L.M, and Chakroun W, 1998. Pressure drop and heat transfer comparison for both microfin tube and twistedtape inserts in laminar flow, *Experimental Thermal Fluid Science*, Vol. 18, No. 4, pp. 323–333.

Akhavan-Behabadi M.A, Ravi Kumar, Mohammadpour .A and Jamali-Asthiani .M, 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, No. 5, pp. 922-930.

Akhavan-Behabadi M. A., Ravi Kumar and A. Rajabi-Najar, 2007. Augmentation of heat transfer by twisted tape inserts during
condensation of R-134a inside a horizontal tube, *Heat and Mass Transfer*, Vol. 44, No. 6, pp. 651-657