Design and Fabrication of Experimental Setup for Convective Heat Transfer in a Pipe by Using Twisted Inserts

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Abstract— To achieve high heat transfer rate in an existing or new heat exchanger while taking care of the increased pumping power, several techniques have been proposed in recent years. Twisted tapes-a type of passive heat transfer augmentation techniques have shown significantly good results in past studies. There has been a considerable amount of research in the area of heat transfer enhancement available in the form of experimental results. Our main objectives are, to design an experimental setup for convective heat transfer. To fabricate experimental setup.
Keywords: Twisted Tape, Heat Transfer, Twist Ratio

I. INTRODUCTION

Heat exchangers area unit utilized in completely different processes starting from conversion, utilization & recovery of thermal energy in numerous industrial, utilized in & domestic applications. Some common examples embrace steam generation & condensation in power & cogeneration plants; sensible heating & cooling in thermal process of chemical, pharmaceutical & agricultural products; fluid heating in producing & waste heat recovery etc. Increase in heat money handler's performance will cause additional economical style of warmth exchanger which might facilitate to create energy, material & price savings associated with a heat exchange method. the requirement to extend the thermal performance of warmth exchangers, thereby effecting energy, material & price savings have crystal rectifier to development & use of the many techniques termed as Heat transfer Augmentation. These techniques are referred as Heat transfer improvement or Intensification. Augmentation techniques increase convective heat transfer by reducing the thermal resistance in an exceedingly device.

Use of warmth transfer improvement techniques causes increase in heat transfer constant however at the value of increase in pressure drop. So, whereas coming up with a device mistreatment any of those techniques, analysis of warmth transfer rate & pressure drop should be done. Excluding this, problems like long run performance & elaborated economic analysis of warmth money handler should be studied. to attain high heat transfer rate in AN existing or new device whereas taking care of the enlarged pumping power, many techniques are planned in recent years and area unit mentioned within the following sections. Twisted tapes-a kind of passive heat transfer augmentation techniques have shown considerably smart ends up in past studies. For experimental work, Reduced breadth twisted tapes, having breadth but ID of within tube (W/di=0.727)) area unit used.

II. DESIGN MODELING

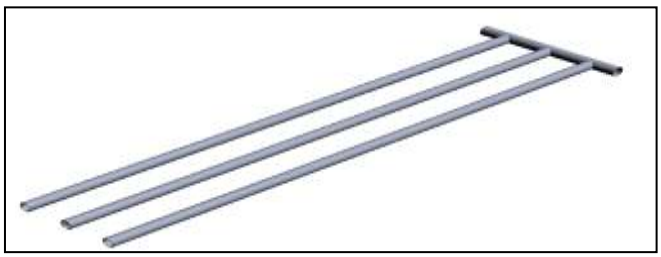

Fig. 1

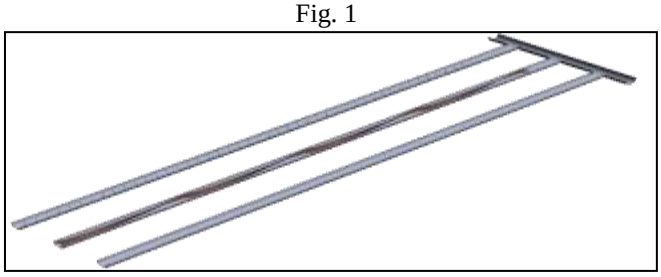

Fig. 2

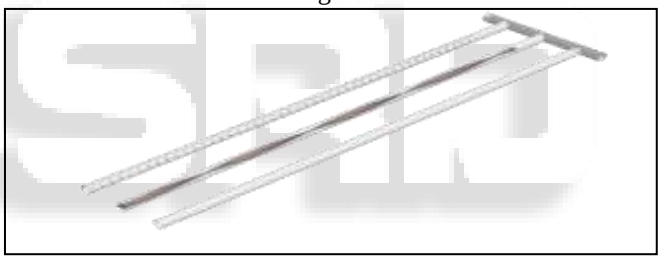

Fig. 3

A. Specifications of Heat Exchanger Tubes Used:

The experimental study is done in a copper pipe having the specifications as listed below:-
Specifications of pipe:
Pipe ID = 22.36mm
Pipe OD= 25.42mm
Pipe thickness = 1.53mm
Material of construction= Copper
Heat transfer length= 1.15metres
For experimentation, the twisted tape insert made from aluminum strips of width 21 mm were used. The third pipe insert consists of wire mesh made of mild steel in the form of coiled spring.

III. FABRICATION OF TWISTED TAPES

The aluminum strip of length 45cm, dimension 21mm and thickness zero.6mm were taken. Holes were trained at each ends of each tape so the 2 ends may be mounted to the antimonial clamps. Desired twist was obtained employing a shaper machine. One finish was unbroken mounted on the tool post of the shaper whereas the opposite finish was given a slow motion by rotating the chuck aspect. Throughout the full operation the tape was unbroken beneath tension by

applying a light pressure on the tool post aspect to avoid its distortion. One tape with twist magnitude relation were invented (yw=4.76) as shown in fig three.2. The tip parts of the invented tape were cut and punched employing a punch and a hammer to supply a hole of 3mm size roughly for change of integrity the tapes.

The following are the inserts that have been used in the pipes for experimentation:

Fig. 4: Experimental Setup
Twist ratio= 4.76 Fig. 4 Tape insert

Fig. 5: Coiled springs for wire mesh insert

IV. EXPERIMENTAL SETUP

The experimental setup used for the present study is explained in this section.

It consists of a frame on which are laid four pipes that are to be investigated for the heat transfer. The frame is constructed out of mild steel angles articulated with the help of electric arc welding process. The dimensions of the setup are given in the diagram given below. Over this are supported four copper pipes of different passive designs that are connected to one common entrance pipe made of galvanized iron (GI) of same diameter as that of the copper pipes. The part of GI pipe joining the entrance pipe with the test pipe (copper pipe) is provided with ON/OFF flow control valve for opening and closing the flow path for each of the copper pipes. The GI pipe is joined with the copper pipe by brazing a mild steel collar to the copper pipe. The outlet of each copper pipe is sent back to the inlet tank via a flexible green pipe. Also a measuring tank with an appropriate scale has been used for measuring the flow rate from a variable discharge centrifugal pump during the experiment. The entrance GI pipe is connected to the pump outlet pipe with another flexible pipe. The entire inlet pipe fitting to the copper pipes are well insulated by thermocol insulation to take care of any heat loss from the inlet side.

A thermocouple is mounted at the inlet of the entrance pipe to measure the inlet temperature of water which is assumed to be the same for all the four pipes and can be taken as the temp of water entering the copper pipes. Also thermocouples are mounted at the exit of each of the copper pipes to measure the outlet temperature for each of the copper pipes. The thermocouples are mounted into flexible green pipe at inlet as well as at the outlet by piercing a small hole into it and inserting the thermocouple end inside the pipe followed by sealing it using Teflon tape thus making it leak-proof.

Care has been taken while fabricating the entire setup to make all the joints leak-proof by using M-seal wherever required.

The following are the images of present experimental setup:

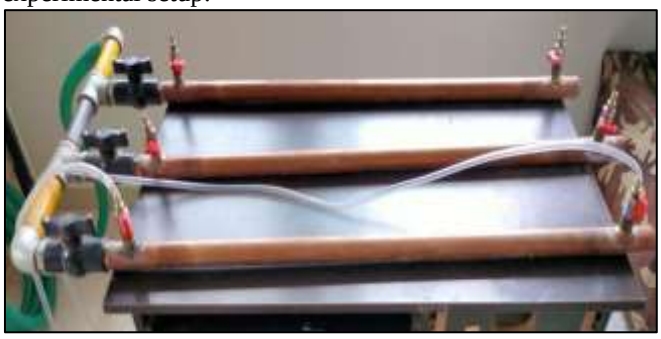

Fig. 6

Fig. 7

V. FUTURE SCOPE

1) The study can be further extended to investigate the heat transfer evaluation in tube fitted with twisted tape insertions with spacer.
2) The study can be extended by using active technique such as making vibration to copper tube.
3) The study can be extended by using passive technique such as insertion of nano partials in fluids.

VI. CONCLUSION

1) Experimental investigation of heat transfer and pressure drop characteristics of circular tube fitted with twisted tape insertions with twist ratio 4.76 and a tube with wire mesh inserts have been presented.
2) The experimental data obtained for each pipe design were compared with those obtained from plain tube data.
3) The heat transfer coefficient enhancement for twisted tape inserts is quite comparable with wire mesh inserts.
4) Heat transfer evaluation analysis has been made and found that the heat transfer increases with increasing Reynolds and decreasing twist ratio with the maximum for the twist ratio 4.76 both all flows.

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