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STUDY OF HEAT TRANSFER IN A TUBE WITHOUT USING INSERT

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Abstract: An experimental and numerical study was conducted to investigate the flow friction and heat transfer performance in tube with twisted tape having circular hole at the centre, Reynolds number range of 25000–95000. The study aims at improving the heat transfer efficiency of heat exchanger. The friction factor, Nusselt number and the overall thermal performance parameters of an align, twisted tape having circular hole at the centre have been obtained and compare with the plain tube. The comparisons showed that, compared with the plain tube, the tube with twisted tape without circular hole has further improved convective heat transfer performance by about 40% and whereas lowered flow friction. The twisted tape having circular hole at the centre tube shows about 50% greater thermal performance than, twisted tape without circular hole. In this paper we are only studying the case of simple forced convection heat transfer, in which we are using twisted tape, we are concentrating on correcting and making better working direction which is suggested and finalized for further work, from which we have to work toward enhancement process by using twisted tape, and by using twisted tape with hole (Elliptical in shape) geometry.

Keywords: Heat transfer improvement technique, Passive methods, Tape inserts Heat transfer Rate, Data Reduction, Set up Detail Specification.

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INTRODUCTION

Heat transfer enhancement techniques refer to the improvement of thermal performance of heat exchangers. Existing enhancement techniques can be broadly classified into three different categories:

(a) 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.

(b) 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.

(c) Compound method: When any two or more of these techniques are employed simultaneously to obtain enhancement in heat transfer that is greater than that produced by either of them when used individually, is termed as compound enhancement.

In this paper, a review of heat transfer enhancement using twisted tape and its modification is done. This paper also gives the performance criteria of different twisted tape inserts. Finally it is expected to be the pioneer source as an intensive literature review for twisted tape swirl generator

Passive heat transfer enhancement methods:

A passive heat transfer enhancement method as mentioned does not need any external input. In the convective heat transfer good ways to enhance heat transfer rate is to increase the effective surface area and residence time of the heat transfer fluids. The passive methods are based on the same principle. Use of this technique causes the swirl in the flow of air and disturbs the actual boundary layer so as to increase effective surface area, residence time and consequently heat transfer coefficient in existing system.

Following Methods are used generally used,

1. Inserts

2. Extended surface

3. Surface Modifications

4. Use of Additives.

First method as explain bellow.

Inserts:

Inserts refer to the additional arrangements made as an obstacle to fluid flow so as to augment heat transfer as explained earlier. Different types of inserts are

1. Twisted tape and wire coils

2. Ribs, Baffles, plates

Common attributes of tape:

Width: Small width tapes are preferred to minimize pressure drop.

Thickness: Thickness of the tape plays important role in its fabrication and also has contribution in fin effect

Pitch: It is the distance between two consecutive twists measured axially.

Twist ratio: It is the ratio of pitch of tape to tape width. So, if width of the tape considered as a constant (as found generally) twist ratio depends on pitch only. Under this condition if pitch is more it means less number of turns.

Fin effect: If the tape material is conductive then during the flow some heat will be absorbed by the tape material itself till its saturation. This is simply the loss of available heat energy.

Pitch The Pitch is defined as the distance between two points that are on the same plane, measured parallel to the axis of a Twisted Tape.

Twist Ratio The twist ratio is defined as the ratio of pitch length to inside diameter of the tube.

Twisted tape

Twisted tapes are made of from the metallic material. These strips are been twisted with some suitable techniques with desired shape and dimension, inserted in the pipe between air flow. Following are the main categories of twisted tape which are noted.

DATA REDUCTION

The data reduction of the measured results is summarized in the following procedures:

$T_s=(T_1+T_2+T_3+T_4)/4$

$T_b=(T_a+T_5)/2$

Discharge of Air:

$Q=Cd\,(a_1 a_2 \sqrt{2gH(\rho_w/\rho_a)})/\sqrt{a_1^2-a_2^2}$

Mass flow rate of air $=Q\times\rho_a$

Velocity $V=m/(\rho a_1)$

Cross sectional Area:

$a_1=\pi/4\, di^2$

Reynolds Number:

$Re=\rho vD/\mu$

$Q=m\,Cp\,(\Delta T)=h\,As(\Delta T)$

Where $\Delta T=T_a-T_5=T_s-T_b$

Heat transfer coefficient:

$h=(mC_p(T_a-T_5))/(A_s(T_s-T_b))$

Experimental Nusselt number:

$Nu=(hD_i)/k$

Theoretical Nusselt number by Dittus Boelter equation

$Nu_0=0.0023Re^{0.8}\,pr^{0.4}$

Blasius equation of Turbulent Flow

$f=0.079\,Re^{(-0.25)}$

Enthalpy change $= mC_p(T_o-T_i)$

$Q=m\,Cp\,(\Delta T)=h\,As(\Delta T_{lm})$

Where $T_{lm}=((T_w-T_{in})-(T_w-T_o))/(\ln((T_w-T_{in}))/((T_w-T_o)))$

Thermal performance factor

TPF=□(Nu/Nu0)/(□(f/f0))^(1/3)

Pressure drop

Δp= 〖flρv/2D〗^2

Enhancement Efficiency

ɳ=h/h0

EXPERIMENTAL SETUP AND PROCEDURE

The apparatus consist of blower fitted with the test pipe. The test section is surrounded by Nichrime band heater. Six thermo couples are placed in the air system at the entrance and exit, of the test section and two thermocouples are embedded on the test section to measure the air temperature. Test pipe is connected with the delivery side of the blower along with the orifice to measure flow of air through pipe. Input through the heater is given to a dimmer state and measured by Voltmeter and Ammeter. A temperature indicator is provided to measure surface temperature of wall in the test section.

Set up Detail Specification

Heat Supplied to Wall = 80 Watt

Dia. of orifice do = 1.25mm

Inner dia. of tube di = 19mm

Outer dia. of tube D =22 mm

Length L =1000mm

Surface Area m2 A=πDL = π (0.019) (1) = 0.069115038m2

Cross sectional area m2 a_1 = π/4 di^2

= 0.000283539 m2

Cd of orifice Cd =0.61

Orifice Area m2 a2 = π/4 do^2

= 0.000122718 m2

Density of air :(ρa) = 1.17128 kg/m3`

Specific heat: (Cp) = 1005 kg/m3`

Thermal conductivity of air:

(k) =0.0242W/mk

Viscosity of Air (μ) =0.000017 Pa.s

Density of water :(ρw) = 1000 kg/m3`

Prandtl No= 0.0705

Diagrams:

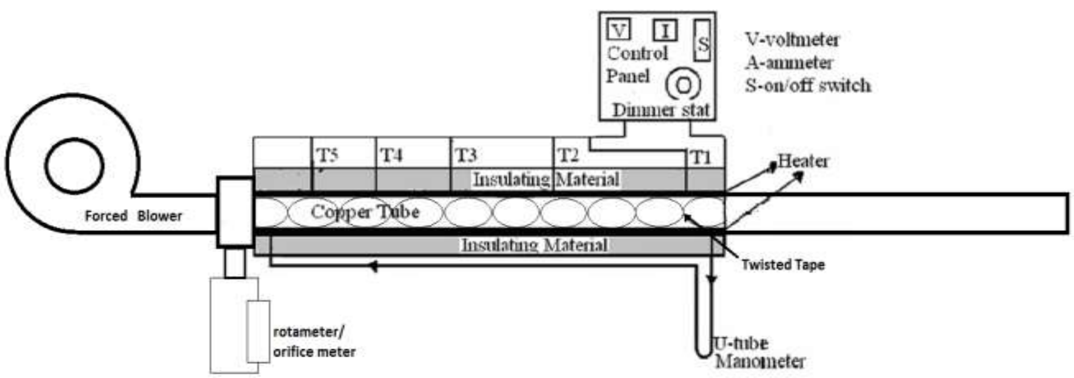

Fig. 1 experimental setup.

Observation Table:

For Plain Tube

Sr.	Manometer Difference			Temperature ^{0}C				Mass Flow rate (kg/sec)
No.	H2 (cm)	H1(cm)	H =H2-H1 (m)	T1	T2	T3	T4	
1	15	14	0.01	48	50.45	53.68	58	0.006546
2	15.2	14	0.01	45.05	48.65	51.75	57.14	0.010908

3	15.4	13.3	0.02	42	46.85	51	54.2	0.015271
4	15.4	13.4	0.0241	40.78	46.12	48.51	50.88	0.023997

RESULT AND DISSCUSSION

In this paper above discussion is on the working strategy or direction for further study. Also before this, the topic was discussed under title of Heat Transfer Enhancement by Using Twisted Tape. Which include both direction plus work study of heat transfer without any type of insert. Now this is the Suggested and finalized way of study has been chosen for further study.

But this is not the end of work here. We have studied just simple one case up to now, in which we are on the base only. Now we will start further study for next case of Twisted Tape. In which Full length Twisted Tape without Hole and Twisted Tape with Hole (Elliptical Shape) type of cases will taken under study with variation in discharge of fluid. After which we will compare them and give or sagest the best case according to study.

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