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EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER USING NANOFLUID IN COMBINATION WITH TWISTED TAPE WITH ELLIPTICAL HOLES AND TWISTED TAPE WITHOUT HOLES.

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Abstract-

An experimental investigation was carried for measure tube-side heat transfer coefficient, friction factor, heat transfer enhancement efficiency of water for flow in an exceedingly circular tube fitted with rectangular-cut twisted tape insert. A copper tube of twenty six millimeter internal diameter and thirty millimeter outer diameter and 900 millimeter check length was used. A stainless-steel rectangular-cut twisted tape insert of five.25 twist magnitude relation was inserted into the sleek tube. The rectangular cut had eight millimeter depth and fourteen millimeter dimension. A regular heat flux condition was created by wrapping Nichrome wire round the check section and fiber glass the wire. Outer surface temperatures of the tube were measured at five totally different points of the check section by T-type thermocouples. 6 thermometers were used for measure the majority temperatures. At the outlet section the measuring system was placed in an exceedingly combination box. The painter numbers were varied within the vary 10000-19000 with heat flux variation fourteen to twenty two kW/m^2 for swish tube, and twenty three to forty kW/m2 for tube with insert. Nusselt numbers obtained from swish tube were compared with Gnielinski correlation and errors were found to be within the vary of -6% to -25% with r.m.s. price of two hundredth. At comparable painter variety, Nusselt numbers in tube with rectangular-cut twisted tape insert were increased by a nonanofluid of 0.3 to 2.9 times at the value of increase of friction factors by 1.4 to 1.8 times compare thereto of swish tube. Heat transfer improvement efficiencies were found to be within the range of 1.9 to 2.3 and magnified with the rise of painter variety.

1. INTRODUCTION

To improve the performance of heat exchanging devices for reducing material value and surface area and decreasing the distinction for heat transfer thereby for reducing external irreversibility, lot of techniques are used. Among totally different passive means that to extend heat transfer coefficient, twisted tape inserts are promising. The secondary flow (swirl flow) generated by twisted tape effects nanofluid flow across the tape-partitioned tube, promotes bigger admixture and better heat transfer coefficients. Experimental investigation of heat transfer and friction issue characteristics during a double pipe device fitted with often spaced twisted tape parts were studied by Eiamsa-ard et al., 2006. Heat transfer, friction issue and warmth transfer improvement potency characteristics during a circular tube fitted with conical-ring turbulators and a twisted-tape swirl generator are investigated through an experiment by Promvonge and Eiamsa-ard, 2007. Influences of insertion of wire coils in conjunction with twisted tapes on heat transfer and friction characteristics during a circular tube using nanofluid because the take a look at nanofluid were through an experiment investigated by Promvonge, 2008. Eiamsa-ard et al., 2009, through an experiment investigated the influences of the tube with short-length twisted tape inserts on the warmth transfer, friction factor, and heat transfer improvement efficiency. Heat transfer, friction factor and heat transfer improvement efficiency behaviors during a tube equipped with the combined devices between the twisted tape and constant/periodically varied wire coil pitch quantitative relation were through an experiment investigated by Eiamsa-ard et al., 2010a. Eiamsa-ard et al., 2010b through an experiment determined the influences of twin-counter/co-twisted tapes on heat transfer rate, friction factor, and warmth transfer improvement efficiency. Heat transfer, flow friction and heat transfer improvement efficiency characteristics during a tube fitted with delta-winglet twisted tape, using water as operating nanofluid were investigated through an experiment by Eiamsa-ard et al., 2010c. Murugesan et al., 2010, through an experiment investigated heat transfer, friction factor, and heat transfer improvement efficiency characteristics of a double pipe device fitted with square-cut twisted tapes. Shabanian et al., 2011 according the experimental and process nanofluid dynamics modeling studies on heat transfer, friction issue and heat transfer improvement efficiency of Associate in Nursing nanofluid cooled device equipped with classic and jagged twisted tape.

The scope of the current work is to through an experiment investigate the tube facet heat transfer and friction factor of a circular tube fitted with twisted tape with elliptical holes insert. knowledge area unit compared with sleek tube heat transfer and friction values and therefore the values of heat transfer improvement efficiency are according.

2. EXPERIMENTAL SET UP

The equipment consists of a centrifugal blower unit fitted with a circular tube that is connected to the tube placed in horizontal orientation. Flexi glass heater encloses the take a look at section to an entire length of 1m. Input to heater is given through variable resistor. Four thermo couples T1, T2, T3 Associate in Nursingd T4 at an equal distance of fifteen cm from the origin of the heating zone are embedded on the walls of the tube and one thermometer is placed within the nanofluid stream at the exit (T5) of the take a look at section to live the temperature of flowing nanofluid. The digital device Multimeter is employed to show the temperature measured by thermometer at numerous position. The temperature measured by instrument is in 0C. The tube of 3 mm thickness is employed for experimentation. A U tube pressure gage measures the pressure drop across the take a look at section stuffed with water. The pipe system consists of a valve that controls the nanofluid flow rate through it Associate in Nursingd an opening meter to search out the quantity rate of flow of nanofluid through the system. The diameter of the opening is .0125m and constant of discharge is 0.61. the 2 pressure tapings of the opening meter area unit connected to a water U-tube pressure gage to point the pressure distinction between them. show unit could be a digital Multimeter accustomed indicate temperature indicator. The circuit is intended for a load voltage of 0-100 V; with a most current of 10 A. distinction within the levels of pressure gauge nanofluid represents the variations within the rate of flow of nanofluid. the rate of nanofluid flow within the tube is measured with the assistance of opening plate and therefore the water pressure gage fitted on board.

Fig: Twisted Tape with elliptical hole

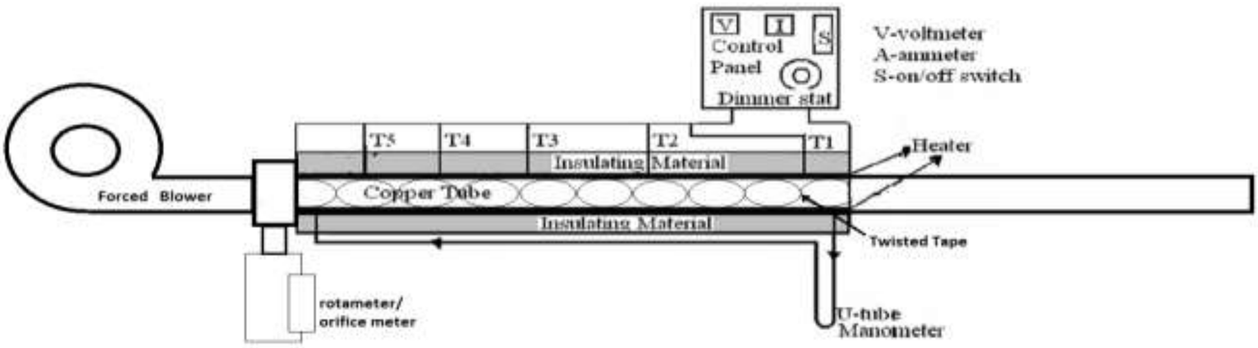

Fig: Schematic diagram of the Experimental Set-up

Fig: Experimental Set-up in LAB

3. DATA REDUCTION

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

$$T_s = \frac{T_1 + T_2 + T_3 + T_4}{4} \quad 2.1$$

$$T_b = \frac{T_a + T_5}{2} \quad 2.2$$

Discharge of Nanofluid:

$$Q = Cd \frac{a_1 a_2 \sqrt{2gH\frac{\rho w}{\rho a}}}{\sqrt{a_1^2 - a_2^2}} \quad 2.3$$

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

Velocity $V = \frac{m}{\rho a_1}$ 2.4

Cross sectional Area:

$a_1 = \frac{\pi}{4} di^2$ 2.5

Reynolds Number:

$$Re = \frac{\rho v D}{\mu} \quad 2.6$$

$$Q = m\ Cp\ (\Delta T) = h\ As(\ \Delta T) \quad 2.7$$

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

Heat transfer coefficient:

$$h = \frac{mC_p(T_a - T_5)}{A_s(T_s - T_b)} \quad 2.8$$

Experimental Nusselt number:

$$Nu = \frac{hD_i}{k} \quad 2.9$$

Theoretical Nusselt number by Dittus Boelter equation

$$Nu_0 = 0.0023Re^{0.8}pr^{0.4} \quad 2.10$$

Blasius equation of Turbulent Flow

$$f = 0.079\ Re^{-0.25} \quad 2.11$$

Enthalpy change = $mC_p(T_o - T_i)$ 2.12

Q= $m\ Cp\ (\Delta T) = h\ As(\ \Delta T_{lm})$ 2.13

Where

$$T_{lm} = \frac{(T_w - T_{in}) - (T_w - T_o)}{\ln\frac{(T_w - T_{in})}{(T_w - T_o)}} \quad 2.14$$

Thermal performance factor

$$TPF = \frac{\frac{Nu}{Nu0}}{\left(\frac{f}{f0}\right)^{1/3}} \quad 2.15$$

Pressure drop

$$\Delta p = \frac{fl\rho v^2}{2D} \quad 2.16$$

Enhancement Efficiency

$$\eta = \frac{h}{h0} \quad 2.17$$

4. NUMERICAL RESULTS AND DISCUSSION

4.1 *Heat Transfer*

The results of heat transfer characteristics are presented for turbulent nanofluidflows. 2 totally different twisted tape, one is without hole and another is with elliptical hole were compared with the plain tube. many parameters were used for the aim of heat transfer characteristics comparison. the common surface Nusselt number, average heat transfer coefficient and thermal performance parameter supported the Nusselt number magnitude relation and pressure drop across the channel were used for heat transfer characteristics comparison.

The surface averaged Nusselt number is compared for all the 3 tubes, The Plain tube, the tube with twisted tape without hole and also the tube with the twisted tape with elliptical hole. The surface averaged Nusselt numbers for the plain tube Nu0 square measure taken as baseline knowledge for comparison. The Nusselt number magnitude relation Nu/Nu0comparing surface averaged Nusselt variety of twisted tape and surface averaged Nusselt number of plain tube are planned against the Reynolds number vary studied.

When compared with the on the market literature to be used of the twisted tape within the flow regime, it are often seen that the ratios Nu/Nu0 have higher levels of heat transfer augmentation for the high Reynolds number vary.

It are often seen that the values Nu/Nu0 decrease with increasing Reynolds number for each the twisted tape while not hole and twisted tape with elliptical hole. For twisted tape with elliptical hole it'll stay almost constant. It may also be seen that the twisted tape with elliptical hole has higher Nu/Nu0 values than the twisted tape while not elliptical hole for a corresponding Reynolds number. But the Nusselt number values for each the twisted tape was larger than the plain tube irrespective of Reynolds number.

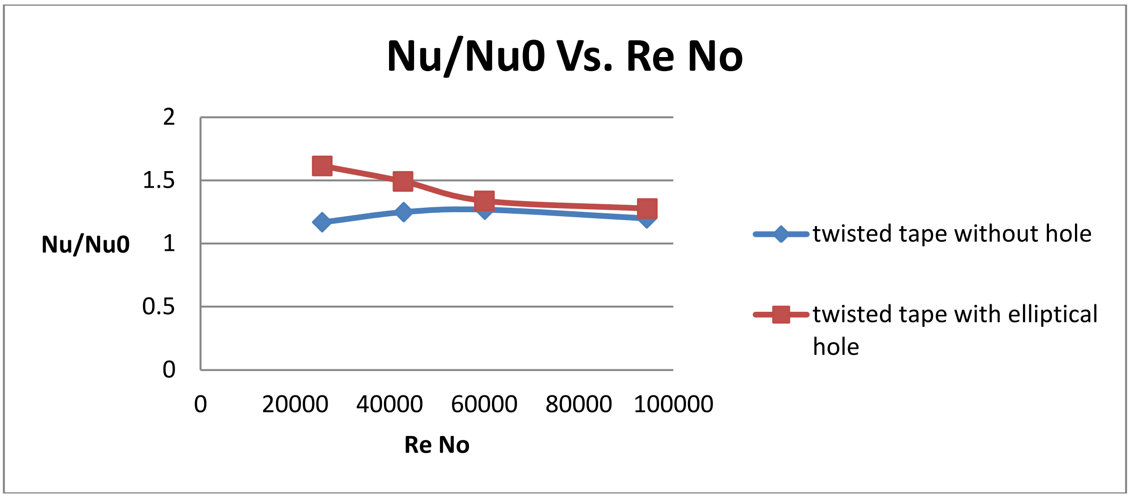

Fig.4.1: Comparison of Avg. Nusselt number of twisted tape without hole and twisted tape with hole Vs. Reynolds number

Over the studied Reynolds number vary, twisted tape while not hole numerically shows slightly higher Nusselt values than the plain tube; whereas the twisted tape with hole show distinctively higher nu values than the plain tubes numerically also through an experiment. For the twisted tape with hole Nusselt number is regarding 30 to 40 % to a higher than the plain tube among the Reynolds number vary of 25,000 to 95,000. It's found that, over the studied Reynolds number vary moderately sensible agreements between the experimental and numerical Nusselt values are achieved for the plain tube and twisted tape without hole and twisted tape with hole with average deviations of 8 % to 10 % respectively.

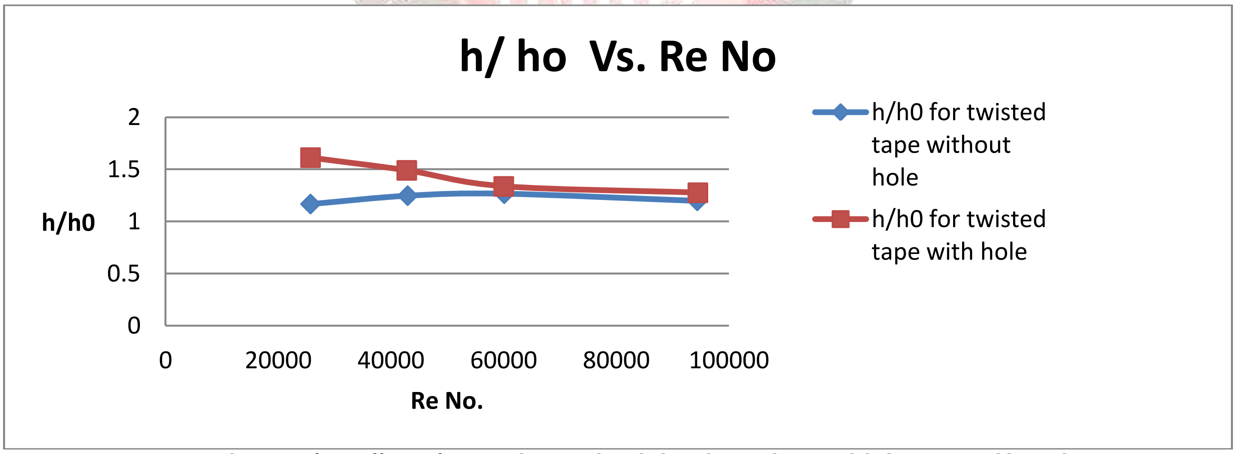

Fig.4.2. Avg. heat transfer coefficient for twisted tape without hole and twisted tape with hole Vs. Reynolds number

The heat transfer coefficient is calculated from the thermal conductivity of the working nanofluid and also the Nusselt number. just like the Nusselt number comparisons, the typical heat transfer coefficient ratios h/h0 with relevance the baseline information at the interface are premeditated for each the twisted tape with hole and twisted tape while not hole. The h/h0 Plot show same pattern because the Nu/Nu0 plot. The h/h0 Plot of twisted tape with hole case is above the twisted tape without hole case.

5. CONCLUSIONS AND SUMMARY

This study focused on work whether or not the employment of twisted tape with elliptical hole will enhance heat transfer characteristics for a circular tube. 2 forms of twisted tapes were tested for four totally different Reynolds numbers ranging from 25000 to 95000. The twist pure mathematics unbroken constant. The experimentation is applied for each twisted tape while not hole and twisted tape with hole which provides the great heat transfer improvement.

1. The measurements are in smart agreement with one another. The maximum error between the averaged experimental heat transfer improvements with numerically expected enhancement is twenty fifth.
2. Letter no will increase regarding twenty eight to half-hour in twisted tape without hole, and by forty seven to hour in twisted tape with hole. Variations in experimental values are as a result of producing and measuring errors.
3. Enhancement efficiency obtains by twisted tape with hole through an experiment regarding 2 to 4 you larger than plain tube.
4. As the friction factor goes on decreasing as Reynolds numbers will increase. Through an experiment for highest values of Reynolds numbers it shows less deviation.

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