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HEAT TRANSFER ENHANCEMENT IN DIMPLED TUBE WITH TWISTED TAPE

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Abstract

A heat exchanger is a device that is used to transfer thermal energy (enthalpy) between two or more fluids. The objective of this paper, is to study available methods of heat transfer enhancement in tube heat exchanger. Previously the heat transfer is improved by using dimpled copper tubes with this another way by which heat transfer rate is increased is the used of twisted tape in the tube with experiments conducted by research based on the dimpled &twisted tube, the heat transfer rate are successfully 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. Therefore, to achieve a desired heat transfer rate in an existing heat exchanger at an economic pumping power may increase significantly and ultimately the pumping cost becomes high. Therefore to achieve a desired heat transfer rate in an existing heat exchanger at an economic pumping power, several techniques have been proposed continuously over the period of time. Some of the passive techniques using inserts are studied. Heat transfer is directly proportional to the surface area and the temperature difference. While temperature difference is restricted by the application, so the surface area per unit volume is the only parameter which controls the heat transfer rate. As device having higher surface area per unit volume as compared to conventional channels is frequently used. With the development of variations in the field of fluid flow and heat transfer are increasing. Heat transfer enhancement can be achieved through dimpled tubes. This is an interesting technique in order to obtain more compact and efficient equipment. Tubes with artificial roughness obtained by providing dimples on the external tube surface are competitive in comparison to performance and cost of other enhanced techniques currently employed in turbulent flow. By using dimpled tubes heat transfer is enhanced compared to regular tubes. Enhanced tubes can be used for many applications such as Boilers, evaporators, condensers, Heaters, oil radiators and heat exchangers.

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1. INTRODUCTION

One of the important processes in engineering is the heat exchange. The means of heat exchanger is that to transfer the heat between flowing fluids. A heat exchanger is the phenomenon to transfer heat from one fluid to another fluid. Heat exchangers are used in the process, power, petroleum, transportation, air conditioning, refrigeration, Cryogenic, heat recovery, alternate fuels, and other industries.

The main aim of this paper is to study the heat transfer enhancement of air flowing through a horizontal circular dimpled tube with twisted tape inserted in it .Heat exchangers have several industrial and engineering applications.

2. LITERATURE SURVEY

Over the past couple of years the focus on using dimples, to improve the heat transfer rate has been predicted by a number of researchers. It is obvious from studies that the use of dimples not only provides enhanced heat transfer but also it can overcome most of the drawbacks of the other methods laboring for boosting heat transfer. Studies by various researchers have repeatedly produced heat transfer enhancement comparable to ribs with pressure losses of almost half that experienced under the use of ribs, and even reduced drag coefficient in some cases.

Heat transfer distribution as well as local Nusselt number variations on the dimpled surface of channels is analyze by Mahmood[1]. They appealed that there was a low heat transfer region in the upstream half of the dimple cavity, which was followed by a high heat transfer region in the downstream half, and additional regions of high heat transfer at the downstream rim of the dimple. Nusselt number can be calculated by

$$Nu = hD / k$$

Chyu et al. [2] studied the enhancement of surface heat transfer in a tube using two different concavities- hemispheric and tear drop. Concavities serve as vortex generators to support turbulent mixing in the bulk flow to increase the heat transfer at ReH = 10,000 to 50,000, H/d of 0.5, 1.5, 3.0 and δ /d =0.575. Heat transfer enhancement was 2.5 times greater than smooth tube and with very low pressure losses that were almost half that caused by conventional ribs turbulators. Reynolds number can be calculated by

$$Re = \rho UD / \mu$$

Wang et al. [3] studied a novel enhanced heat transfer tube with ellipsoidal dimples. Their computed results shows that the Nusselt number for ellipsoidal dimpled tube and spherical dimpled tube are 38.6–175.1% and 34.1–158% higher than that for the smooth tube, respectively. The friction factors of dimpled tube increase by 26.9–75% and 32.9–92% for ellipsoidal and spherical dimples compared with the smooth tube respectively.

Fig-1: Copper Tube

Katkhaw et al. [4] calculated the heat transfer of air flow over dimpled flat surface with the 14 types of dimpled arrangement. Their results show that heat transfer coefficients for dimpled surfaces are about 26% better than smooth surface for staggered arrangement. And for the inline arrangement, the results illustration that heat transfer coefficients for dimples surfaces are about 25% better than smooth surface.

$$Qa = mCp\,(To - Ti)\ ,\quad Qc = hAs(Ts - Tm)$$

$$Qa = Qc$$

Saha, S. K. and Dutta,[5] found that placing twisted tape concentric to the inside channel gives better heat transfer rate than a twisted tape inserted by a loose fit.

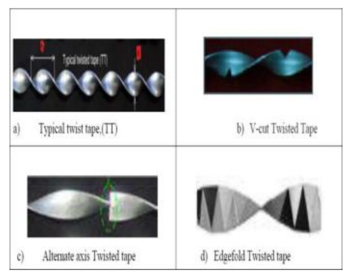

Fig-2: Twisted Tape

Smith Eiamsa-ard [6] evaluated practically the effect of twisted tape insert on heat transfer and friction factor characteristics in tube heat exchanger for Reynolds number 2000 to 12000. The twist ratio is defined as the ratio of pitch to inside diameter of the tube y ¼H/di, where H is the twist pitch length and d is the inside diameter of the tube. They observe that efficiency enhancement and Nusselt number increases with decreasing the twist ratio and friction factor also increase with decreasing the twist ratio.

Smith et. al. [7] investigated the heat transfer enhancement and pressure loss by put in to single twisted tape, full length dual and regularly spaced dual twisted tapes as swirl generators in round channel under axially uniform wall heat flux conditions.

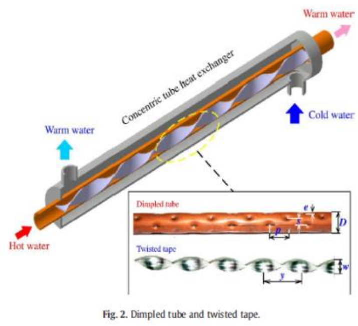

Fig-3: Dimpled tube and twisted tape

ChinarukThianponget.al.[8] Experimentally calculated the friction and compound heat transfer behaviour in dimpled tube fitted with twisted tape swirl generator for a fully settled flow for Reynolds number in the range of 12000 to 44000.
Eiamsa-ard et al[9] numerical calculated in circular tube with turbulent flow and invent heat transfer rates for the tube with twisted tape inserted for y/w=2.5 and CR=0.0,0.1,0.2 and 0.3 were respectively,73.6%, 46.6%,17.5% and 20.1% higher than for the plain tube.

S.Gulia and A.Parinam[10] numerical study in circular tube with turbulent flow and found heat transfer rates for the tube with twisted tape inserted for y/w=4. The twisted tapes with LR=0.29,0.43,0.57 and 1, heat transfer rate increases 15%,18.8%,22.6% and 31% more than plain tube having medium is air. The maximum thermal performance for using LR=0.29, 0.43, 0.57 and 1 is found to be 1.23, 1.3, 1.32 and 1.37.

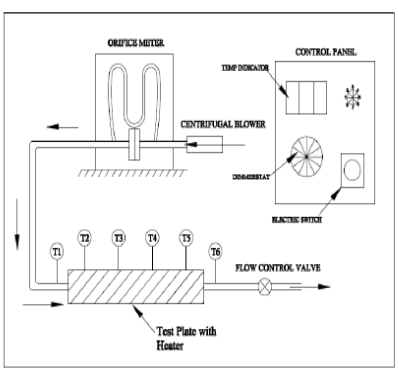

Fig-4: Experimental Setup

3. CONCLUSION

The experimental investigation was carried out on dimpled tube in comparison with plain tube The dimples are created on tube in staggered way. The twisted tapes used in heat exchanger areto enhance the flow rate. Conclusions from studied experiment are as follows,

(1) The heat transfer coefficient is increases if dimple diameter decreases in constant flow of air.
(2) In Full length twisted tape, Heat transfer rate increases increase in friction factor also observed. Twisted tape is a better option for the heat exchanger owing to its easy installation and removal for cleaning purposes.
(3) Heat flow rate increase with decreasing twist ratio.

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