Review on Heat Transfer Enhancement by Using Twisted Tape with Square Holes  
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Abstract:  
The performance development of thermal systems has more interest in heat transfer enhancement techniques. By using the Heat transfer augmentation techniques to increase rate of heat transfer without affecting much the overall performance of the system. The Heat exchangers are used in industry for both heating and cooling. The main purpose of this review paper presents the effect of twisted tape inserts on the heat transfer enhancement, flow friction, pressure drop and thermal performance factor in a heat exchanger tube. The main purpose of creation of the turbulence with help of twisted tape in the flow passage is one of the passive heat transfer augmentation techniques due to their advantages of easy operation, fabrication as well as low maintenance.

Keywords:  Heat transfer, twisted tape inserts, Swirl flow motion, Flow friction

I. INTRODUCTION

The Heat transfer enhancement technology has been used to heat exchanger applications in refrigeration, process industries, automobile etc. The great deal of research effort has been performing experiments and developing apparatus under which an enhancement technique will be heat transfer. The thermal performance of heat exchangers, effecting energy, material and cost savings have led to development and use of many techniques termed as heat transfer augmentation. These techniques are also referred as Heat Transfer Enhancement or Intensification. Augmentation techniques increase convective heat transfer by reducing the thermal resistance in a heat exchanger. The goal of enhanced heat transfer is to encourage or accommodate high heat fluxes. In order to improve the heat transfer efficiency and operation safety of heat transfer equipment, many techniques have been proposed, such as treated surfaces, rough surfaces, extended surfaces, swirl flow devices, shaped pipes, surface tension devices, technical aids, electrostatic fields, suction or injection. However, all of these techniques will inevitably bring too much flow resistance, resulting in unnecessary power consumption. This method of heat transfer enhancement is required to not only improve the heat transfer greatly, but also minimize the flow resistance as much as possible. The pumping cost becomes high. Therefore, to achieve a desired heat transfer rate in the heat exchanger at an economic pumping power, several heat transfer augmentation techniques have been proposed in recent years. The 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: The active method techniques are more complex from the use and design point of view as the method requires some external power input to cause the desired flow modification and improvement in the rate of heat transfer. In this active method involves some external power input for the enhancement of heat transfer; some examples of active methods include induced pulsation by cams the use of a magnetic field to disturb the seeded light particles in a flowing stream, and reciprocating plungers, etc. It finds limited application because of the need of external power in many practical applications. Examples of the mechanical aids include rotating tube exchangers and scrapped surface heat and mass exchangers.

(b)  Passive method: In this passive techniques generally use surface or geometrical modifications to the flow channel by incorporating inserts or additional devices. It promote more heat transfer coefficients by disturbing or altering the existing flow behavior (except for extended surfaces) which also leads to increase in the pressure drop. For example use of rough surfaces, use of inserts etc.

(c)  Compound method: In this compound augmentation technique is the one or more of the techniques is used in combination with the purpose of further improving the thermo-hydraulic performance of a heat exchanger. When any two or more of these techniques are employed simultaneously to obtain enhancement in heat transfer that is more than that produced by either of them when used individually, is termed as compound enhancement.

Different types of inserts are:
1. Twisted tape and wire coils
2. Ribs, Baffles, plates

The present paper contributes for review of tape inserts.

Twisted tape: Twisted tapes are the metallic strips twisted with some suitable techniques with desired shape, inserted in the flow and dimension.

II. LITERATURE SURVEY:-

Eiamsaard et al [1] experimental investigation of “A case study on thermal performance assessment of a heat exchanger tube equipped with regularly-spaced twisted tapes as swirl generators” In this paper explain the experimental investigation on pressure drop and heat transfer characteristics of turbulent flow in a heating tube equipped with twisted tapes in the parallel wings for the range of Reynolds number in...
In this paper design of PTT studied the following concepts: (1) Thus efficiently disrupt a thermal boundary layer and wings induce an extra turbulence near tube wall. (2) Empirical correlations of the friction factor, heat transfer holes existing along a core tube, diminish pressure loss within the tube and thermal performance for tubes with PTTs were also developed.

**Bodius Salam et al.** [2] studied of “Heat Transfer Enhancement in a Tube Using Twisted Tape Insert.” This paper suggest shows experimental investigation was for measuring tube-side heat transfer coefficient, friction factor, and heat transfer enhancement efficiency of water for turbulent flow in a circular tube fitted with rectangular-cut twisted tape insert. The range of Reynolds numbers were varied in between 10000-19000 and the heat flux variation 14 to 22 kW/m² for the smooth tube, and heat flux 23 to 40 kW/m² for tube with insert. Nusselt numbers obtained from smooth tube were compared with Gnielinski and errors were found to be in the range of -6% to -25% with R.M.S. value of 20%. But Reynolds number, Nusselt numbers is comparable in tube with rectangular-cut twisted tape insert were enhancement by 2.3 to 2.9 times at the cost of increase of friction factors by 1.4 to 1.8 times compared to that of smooth tube. Also that Heat transfer enhancement efficiencies were range of the value in between 1.9 to 2.3 and Reynolds number is increased.

**Iftikarahamad H. Patel et al.** [3] “Experimental investigation of Heat transfer enhancement over the dimpled surface”. In this paper which helps the strip plate heater (40 W to 200 W) for the to the test surface to provide heat input. This testes were ranged for Reynolds Number 5000 to 15000 with dimple print diameter of 6mm. And the results of this experiment which is as follows, 1) In this method the dimpled surface is better than for the flat plate for friction factor. Also it shows range of friction factor staggered arrangement in greater than for inline arrangement. 2) Nusselt number ratio shows were computed for different dimple densities on plate & found that Nu no ratio for dimpled plate with staggered arrangement 187 nos is greater than compared to 204 dimples, The Nu/ Nu0 ratio is higher due to strong vortices formation in staggered arrangement. 3) Thermal performance of 204 dimples is poor compared to 187 dimple plate Also Thermal Performance of plate with spherical dimples increasing with increasing Reynolds number, but, This is due to high turbulence & hard vortex formation in staggered arrangement plate.

**Kaustubh Kumbhar et al.** [4] experimental studied of “Heat Transfer enhancement by using twisted tapes with elliptical holes” This paper conducted experiment on with elliptical holes was carried out for Heat transfer enhancement using twisted tapes the range of Reynolds Number 25000 to 100000. The Blower and outlet SS pipe arrangement used for the carry out the experimentation. The results of Twisted tapes with elliptical holes are compared with that of plain tube, and twisted tape tube inserts, and results shown that for studied Reynolds Number are 25000 to 90000 friction factor of plain tube agrees reasonable well with Blausis correlation, also experimental results of average Nusselt number of plain tube agrees well with empirical Dittus Boelter’s correlation for circular duct flow.

**A.V. N. Kapatkar et al.** [5] An experimental investigation of heat transfer and friction factor of a plane tube fitted with full length twisted tape inserts for laminar flow have been studied under uniform wall heat flux condition. The experiments has been obtained out to study the tape fin effect by using full length tape inserts of different materials namely Aluminum, Stainless steel and insulated tape. The tapes have twist ratios from 3.2 to 3.4. It is found that, for the flow in smooth tubes, full length twisted tapes yield improvement in average Nusselt number, for Reynolds number range of 200 to 2000. For Aluminum tapes, maximum improvement in Nusselt number range from 40% to 94% and for insulated tapes, the maximum improvement in Nusselt number range from 50% to 100%; for Stainless steel tapes, maximum improvement in Nusselt number range from 40% to 67%.

**K. Kalyani Radha et al.** [6] Experimental investigations is carried out for 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. To reduce excessive pressure drops associated with full width twisted tape inserts, with less corresponding reduction in heat transfer coefficients, introduce a varying width inserted tapes having range from 10 mm to 22 mm. Experiments were carried out for plain tube with/without twisted tape insert at constant wall heat flux and different mass flow rates. The twisted tape use are of three different twist ratios (3, 4 and 5) each with five different widths (26-full width, 22, 18, 14 and 10 mm) respectively. The Reynolds number varied from 6000 to 13500. Both pressure drop and heat transfer coefficient are calculated and the results are compared with those of plain tube. It was found that the enhancement of heat transfer with twisted tape inserts as compared to plain tube varied from 36 to 48% for full width (26mm) and 33 to 39% for reduced width (22 mm) inserts.

**Naga Sarada S. et al.** [7] “Experimental investigations of the augmentation of turbulent flow heat transfer in a horizontal tube by insert of mesh with air as the working fluid”. Sixteen types of mesh inserts with screen diameters of 22mm, 18mm, 14mm and 10mm for varying distance between the screens of 50mm, 100mm, 150mm and 200mm in the porosity range of 99.73 to 99.98 are used for experimentation. The Reynolds number is obtained from 7000 to 14000. On comparing the result obtained It is observed that the enhancement of heat transfer by using mesh is increase by a factor of 2 times where the pressure drop is only about a factor of 1.45 times at the same mass flow rate.

**Jin Shuen Liou et al.** [8] “An experimental study measuring the axial heat transfer distributions and the pressure drop coefficients of the tube fitted with a broken twisted tape of twist ratio 1, 1.5, 2, 2.5 is performed in the Re range of 1000–40,000”. In this paper the local Nusselt numbers and mean fanning friction factors in the tube fitted with the broken twisted tape more as the twist ratio less. The thermal performance factors, mean fanning friction factors and Heat transfer coefficients in the tube fitted with the broken twisted tape are find respectively, 2–4.7, 0.99–1.8 and 1.28–2.4 times of those in the tube fitted with the smooth twisted tape.

**Suhas V. Patil et al.** [9] “experimentally heat transfer and friction factor characteristics in a concentric double pipe heat exchanger (square duct inner and circular tube outer) using full length twisted tapes of different twist ratios.” In this investigation for Reynolds number well in the laminar region (Re =30-1100) with twisted tapes of twist ratios (y=2.66 and y=3.55). Experiments were carried out for constant wall temperature boundary condition using Ethylene glycol as
working fluid. The results obtain from that the twisted tape gives best heat transfer enhancement and twist ratio less. Also the isothermal friction factors were found to be 6 to 13 times the plain duct values. It means that the Nusselt number for twisted tapes is higher than the plain duct.

Naphon et al. [10] “heat transfer characteristics and the pressure drop in the horizontal double pipes with twisted tape insert”. In this paper the investigation of results shows from the tube without twisted tape is compare with those with twisted insert. From this comparison the variations in heat transfer coefficient and friction factor of the horizontal pipe with twisted tapered insert.

III. PROPOSED WORK:

As per Literature study, it is observed that the work on heat transfer enhancement by using twisted tape with square holes is very less. In this paper work on Various Inserts Computational Fluid Dynamics or CFD is the analysis of systems involving fluid flow, heat transfer and associated phenomena such as chemical reactions by means of computer-based simulation. The technique is very powerful and spans a wide range of industrial and non-industrial application areas.

Figure 1. Block Diagram of Experimentation

IV. FUTURE SCOPE:

i) The Heat transfer enhancement techniques are applied in industries to obtain the more compact heat exchanger, energy savings and a lower operating cost.

ii) Heat transfer enhancement techniques is utilization of twisted tape is a promising method. This approach possesses not only an effective heat transfer enhancement but also the advantage of an ease of installation a low cost.

iii) The insertion of twisted tape generates the swirl flow in the tube which improves fluid mixing, helically twisting fluid motion which offers an effectively longer flow path and blockage of the flow cross section which leads to a higher flow velocity are directly responsible for the improvement of heat transfer within heat exchanger.

V. REFERENCES


