Review study on Enhancement of heat transfer in heat Exchanger

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***Abstract*— Heat transfer devices have been used for conversion and recovery of heat in many industrial and domestic applications. Over five decades, there has been concerted effort to develop design of heat exchanger that can result in reduction in energy requirement as well as material and other cost saving. Pumping power which results in higher cost. Geometrical parameters of the insert namely the width, length, twist ratio, twist direction, etc. affect the heat transfer. For example, counter double twisted tape insert has TPF of more than2 and combined twisted tape insert with wire coil can give a better performance in both laminar and turbulent flow compared to twisted tape and wire coil alone. A variety of nanofluids flowing through multiple parallel pipes were numerically studied to examine the heat enhancement effects. Due to the advantages, they bring in the cooling process, nanofluids have provided a new way to improve the performance of thermal systems.**

1.INTRODUCTION

Heat transfer devices have been used for the conversion and recovery of heat in many industrial and domestic applications. Some examples are boiling of liquid and condensation of steam in power plants, thermal processes involved in pharmaceutical and chemical industries, sensible heating and cooling of milk in dairy industries, heating of fluid in concentrated solar collector and cooling of electrical machines and electronic devices among others These experiments mainly used turbulent flow, as it was the most appropriate flow based on the experimental circumstances. Likewise, in this paper, nanofluids flowing through circular pipes were studied to assess their thermal behaviour. Since there is a huge demand for electrical energy production and distribution, the available energy must be utilized efficiently. In India, nearly 42% of the electric energy in every house is utilized for operating refrigeration systems and Heating Ventilation and Air Conditioning (HVAC) systems. designed and fabricated a heat exchanger, which recovers the waste heat liberated in the air conditioning system, increasing the coefficient of performance (COP) of the system by 13%. Salaita. tested a shell and coil type heat exchanger to recover the waste heat from the condenser of a bulk milk cooler and this heat was used to warm the water.

2. ENHANCEMENT TECHNIQUES

2.1 Passive techniques

In the passive techniques, any external power is not required; rather, geometry or surface of the flow channel is modified to increase the thermohydraulic performance of the systems. The inserts, ribs, and rough surfaces are utilized to promote fluid mixing and the turbulence in the flow, which results in an increment of the overall heat transfer Heat transfer enhancement techniques generally reduce the thermal resistance either by increasing the effective heat transfer surface area or by generating turbulence in the fluid flowing inside the device.

2.2 Active techniques

Active techniques are more complex than the passive techniques in the expression of design and application because of the necessity of external energy to adjust the flow of fluid so as to obtain an improvement in thermal efficiency. Providing external energy in most applications is not easy; for this reason, the use of active techniques in scientific fields is limited. The most common base fluid used is water. Such fluid will have an improved thermal conductivity.

2.3 Compound techniques

Compound technique consists of the combination of more than one heat transfer enhancement method (active and/or passive) to increase the thermohydraulic performance of heat exchangers. It can be employed simultaneously to generate an augmentation that promotes the performance of the system either of the techniques operating independently. Preliminary studies on compound passive augmentation technique of this kind are quite encouraging. enhance the heat transfer within a heat exchanger, different fluid mixtures are used.

2.4 Twisted tape insert pipe

2.4.1 Effect of helical insert

Helical twisted tapes have also been used to enhance the heat transfer rate These authors used the full-length helical inserts with different twist ratios with equal and unequal lengths with right and left turns. Their experiments showed that the helical tape insert improves the heat transfer compared to a plain tube and the TPF with right-left helical insert could be obtained an up to 3 for different configurations. used the helical screw tape inserts in an elliptical tube. For low Re, it was found that the maximum TPF of 1.2 could be obtained with a combination of pitch ratio of 1 and twist ratio of 0.22. Multiple helical twisted tapes have been an at different helix angles (9o, 13o, 17o,and 21o). The power consumed by the blower increases 2–3 times with decrease in helix angle. TPF achieved is from 1.08 to 1.30. numerically investigated TPF of a double pipe heat exchanger fitted with helical baffles in the annulus side. They used Fluent to solve three dimensional computational fluid dynamics model. From their analysis, it was found that in all cases TPF was less than one which was mainly due to higher-pressure drop-in entrance region effect.

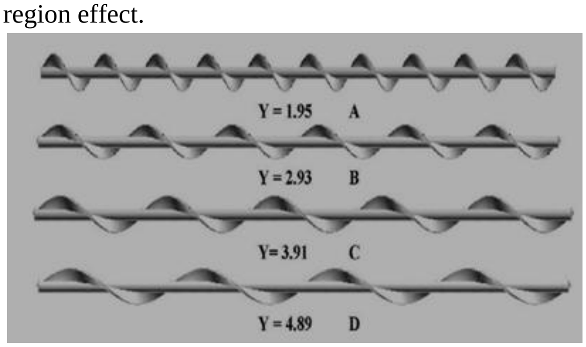

Fig. 1. Helical screw inserts of different twist ratio

2.4.2. Effect of wings and winglet twisted tape

The effect of delta winglet twisted tape inserts on heat transfer and pressure drop characteristics. The investigation was made for straight and oblique delta winglet (Fig. 2) along with twin delta winged twisted tape insert (Fig. 3). They analysed twisted tapes for different twist ratios and depth of wing cut ratios. From results, it was concluded that oblique delta-winglet is more efficient than straight delta winglet. Over the range of Re studied, TPF for oblique delta winglet twisted tape and straight delta winglet twisted tape were found to be 0.92–1.24 and 0.88–1.21 respectively. The twin delta winged twisted tape wings were cut in three different positions: up, down and opposite. Wings were inclined at an angle of 15o with the tape surface. The effect was examined for three different wing tip angles of. The result revealed that upside position performs well compared to down and opposite side wings; heat transfer rate increases with wing tip angle; twin tape wing up with 20o wing tip angle gives the highest TPF of 1.26. Instead of using twisted tape inserts,used curved delta type vortex generator (Fig. 2) to analyse the heat transfer. rate increases with wing tip angle; twin tape wing up with 20o wing tip angle gives the highest TPF of 1.26. Instead of using twisted tape inserts, used curved delta type vortex generator (Fig. 4) to analyse the heat transfer.

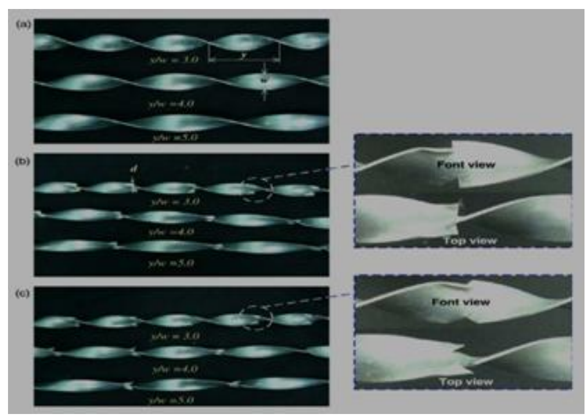

Fig. 2. Oblique delta winglet

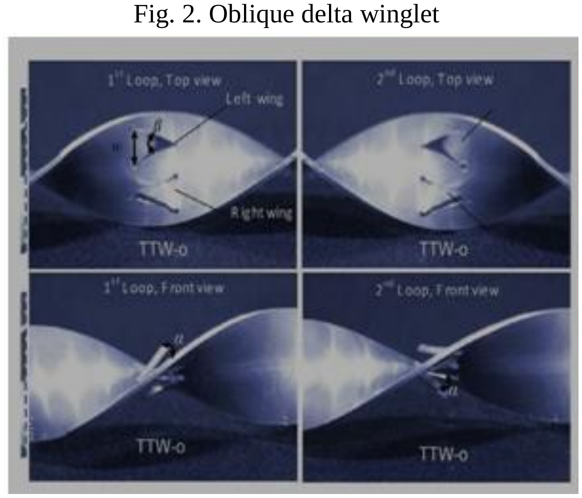

Fig. 3. Twisted tape with twin delta wings

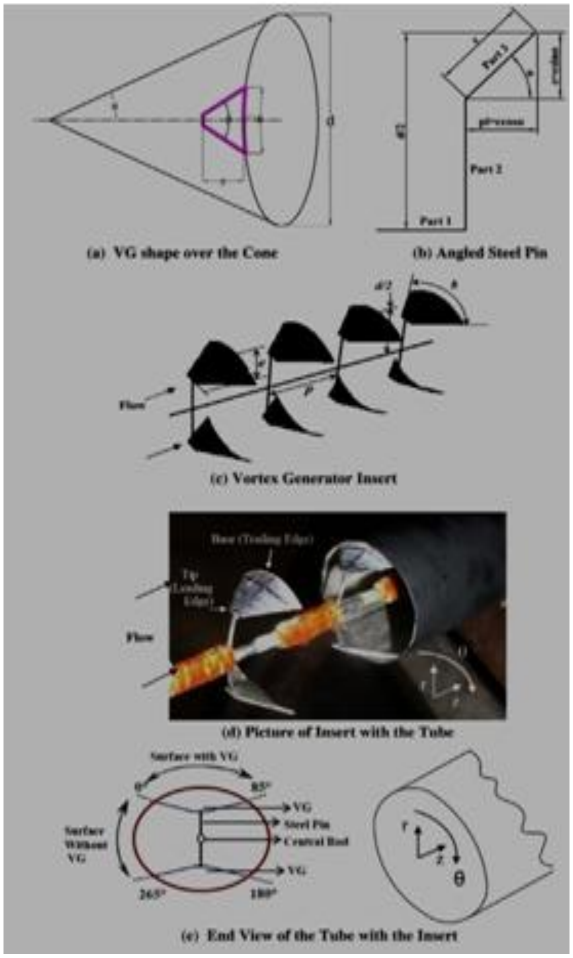

Fig. 4. Geometrical details of delta wing vortex generator

and friction factor characteristics of flow through a circular tube. The insert was constructed with a central rod on which curved delta wings were attached at specific locations. Local heat transfer coefficient and average pressure drop were examined for different pitch to projected length ratio, height to tube inner diameter and angle of attack. Nu/Nu0 ratio was found to be in the range of 1.3–5.0 and TPF from 1.0 to 1.8. twisted tape.

2.4.3 Configuration of tube-side helical tape insert and annulus-side helical screw strips

Heat exchangers are extensively used in various industrial and engineering applications including power plants, chemical and food industries, solar receivers, electronics, waste heat recovery and refrigeration. Therefore, efficiency improvement of heat exchangers has been a subject of intensive research during the past decades. Among different types of heat exchangers, doublepipe heat exchangers (DPHXs) offer economic advantages over other configurations—including lower design, maintenance and installation costs. In a recent paper. the authors attributed this finding to the higher residence time of fluid flow due to the swirling flow generated by helical-tape insert. Their results showed that although the average Nusselt number for 0.03% nanofluid is increased by 32.91% as compared to pure water, this comes at the expense of 38% higher friction factor.

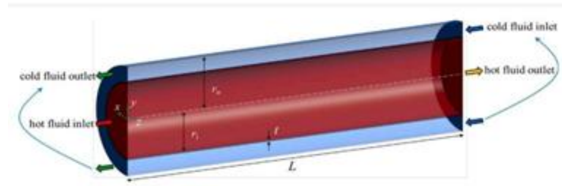

Fig. 5. Counter-flow double-pipe heat exchanger.

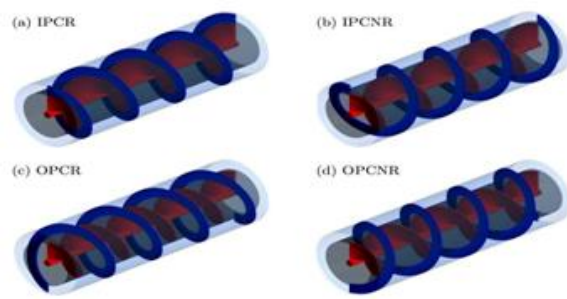

Fig. 6. Configuration of tube-side helical tape insert and annulus-side helical screw strips with p = 4.

2.4.4Coiled wire inserts

Transverse or helical ribs, for example, coiled wire inserts, are an attractive method to create the surface roughness. The coiled wire inserts intensify the disturbance of laminar boundary layer and promote redevelopment of the thermal and hydrodynamic boundary layers in the tube flow effectively. Moreover, helically coiled wire can be used to generate secondary flow which helps to enhance the heat transfer rate with the increment of vorticity in the tubular flow. They have also some advantages in relation to the other passive methods such as easy manufacturing and installation; lower manufacturing cost; better fluid mixing and disturbance of laminar boundary layer; possibility to use different fluid types, e.g., nanofluid, water, viscous oil, and air; and possibility to install with various passive techniques together.

2.4.5 Heat transfer and fluid flow analysis

The steady-state mathematical model consists a set of governing equations for each region along with the appropriate conditions applied at the interface between the solid and fluid regions as well as the boundaries of the domain. The outer wall of the DPHX is considered as adiabatic. Uniform distributions of temperature and velocity is applied at the inlets of the tube- and annulus-side. Zero relative pressure is employed at the outlets. In addition, it is assumed that viscous dissipation is negligible, and no heat generation exists within the domain. The continuity and momentum conservation equations for the fluid flow, respectively.

3.CONCLUSION

From the present review, it can be concluded that the heat transfer enhancement occurs in all cases due to reduction in the flow cross section area, an increase in turbulence intensity and an increase in tangential flow established by various types of inserts. Geometrical parameters of inserts like width, length, twist ratio, etc. affect the heat transfer enhancement considerably. Twist direction is also an important parameter in case of multiple twisted tapes since the counter-swirl performs better than the co-swirl. The role of inserts in increasing the turbulence intensity is more significant in laminar regime than in turbulent regime. Therefore, to enhance the heat transfer in turbulent flow, wire coil inserts are used. In recent years, second generation enhancement techniques that combine the twisted tape inserts and wire coil have been used to get better heat transfer performance in laminar as well as turbulent flows. Some researchers have also used regularly spaced and perforated twisted tape for the purpose of material saving;