HEAT TRANSFER ENHANCEMENT

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Abstract— Heat Transfer enhancement used to enhance the heat transfer rate. It is categorized into passive and active methods. Active methods require external power while passive methods do not require any external power to improve the thermo hydraulic performance of the system. Passive methods are widely used in both experimental and numerical applications. Passive methods include various components which are located in the fluid flow path such as twisted tapes, coiled wires.

Keywords—heat transfer enhancement, coiled wire, thermo hydraulic, heat transfer, twisted tape.

I. INTRODUCTION

Passive techniques

Passive techniques does not require any external power; rather geometry or surface of the flow channel is modified to increase the thermohydraulic performance of the systems.

The inserts, ribs, and rough surface are utilized to promote fluid mixing and turbulence flow, whichresults inan increment of the overall heat transfer rate.

Heat transfer enhancement is a process of increasing heat transfer rate and thermohydraulic performance of the system using various methods. Heat transfer enhancement technique are commonly used in areas such as process industries, heating and cooling in evaporators, refrigerators, radiators, automobiles etc.

Heat transfer enhancement methods are classified into three categories which include active method, passive method, and compound method. Active method require external power to input the process while passive method don’t require any external power. Two or more active and passive method can be compound together that is called compound method which is used to produce a higher enhancement.

Active Techniques

Active technique is used to enhance the heat transfer transfer rate by using an external power source to adjust the flow field so as to obtain an improvement in thermal efficiency. Providing an external power in most application is not easy for this reason use of active techniques is limited.

Compound technique

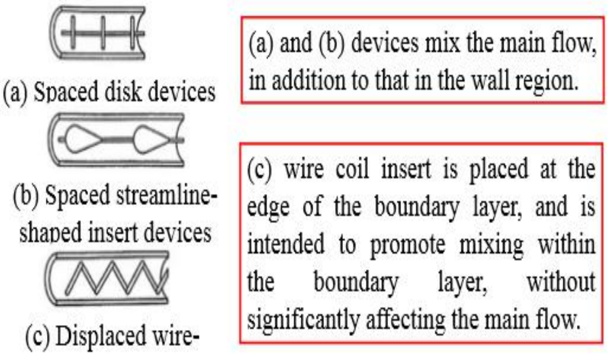
A compound technique consist of the combination of more than one heat transfer enhancement method to increase the thermohydraulic performance of heat exchangers. It can be employed simultaneously to generate an augmentation that promotes the performance of the system either of the techniques operating independently.

Passive technique

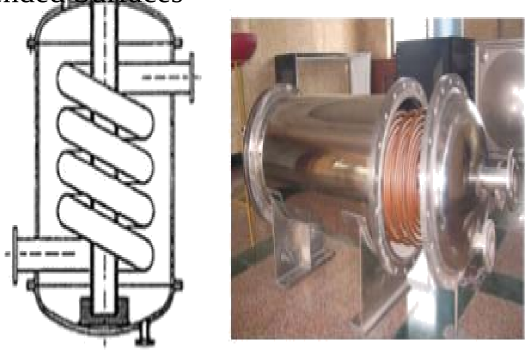
Rough surface

They may be either integral to the base surface or made by placing a roughness adjacent to the surface.

Integral roughness is formed by machining or restructuring the surface. For single phase flow the configuration is generally chosen to promote mixing in the boundary layer near the surface, rather than to increase the heat transfer surface area.



Extended Surfaces



They are routinely employed in many heat exchangers.

Thermal resistance may be reduced by increasing the heat transfer coefficient or the surface area of both heat transfer coefficient and surface area. Use of plain fin may provide only area increase. However, formation of a special shape extended surface may also provide increased hs.

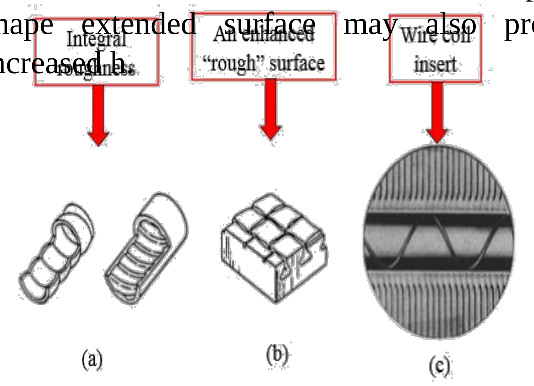


Fig. 1.2 (a) Tube-side roughness for single-phase or two-phase flow, (b) "rough" surface for nucleate boiling, (c) wire-coil insert.

Displaced inserts

Displaced insert devices are devices inserted into the flow channel to improve energy transport at the heated surface indirectly.

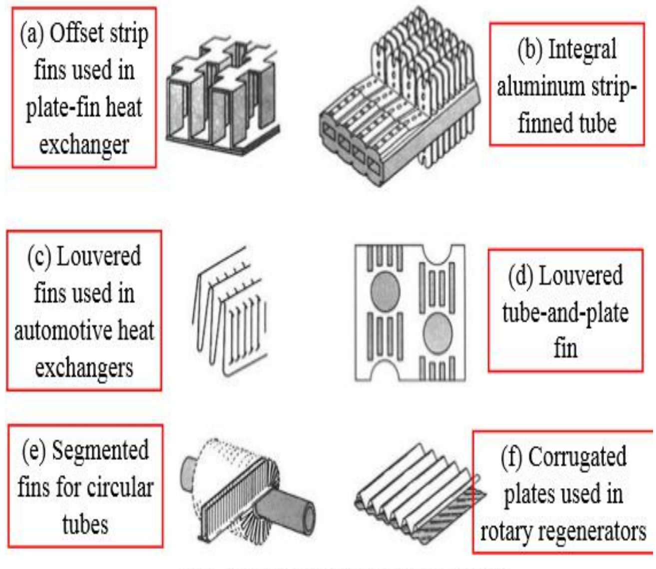
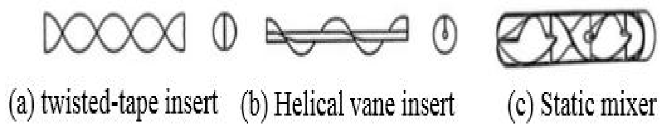


Fig. 1.3 Enhanced surfaces for gases

Swirl flow device

Swirl flow device include number of geometrical arrangements or tube inserts for forced flow that create rotating or secondary flow.



Coiled tubes

They may provide more compact heat exchangers secondary flow in the coiled tube produces higher single phase coefficients and improvement in most boiling regimes.

Twisted tapes

Twisted tapes are the metallic strips twisted using some of the suitable techniques as per the required shape and dimension, which are inserted in the flow to enhance the heat transfer. The twisted tape inserts are most suitable and widely used in heat exchangers to enhance the

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heat transfer.

Twisted tape inserts increase heat transfer rates with less friction factor. The use of twisted tapes in a tube gives simple passive technique for enhancing the convective heat transfer by making swirl into the heavy flow which disrupting the boundary layer at the tube surface due to rapidly changes in the surface geometry. Which means to say that such type of tapes induce turbulence and swirl flow which induces inside the boundary layer and which gives better results of heat transfer coefficient and Nusselt number due to the changes in geometry of twisted tape inserts. Simultaneously, the pressure drop inside the tube will be increases when using twisted-tape as an insert. For this a many researchers have been done by experimentally and numerically to investigate the desired design to achieve the better thermal performance with less frictional losses. The heat transfer enhancement of twisted tapes inserts depends on the Pitch and Twist ratio.

Experimental Section

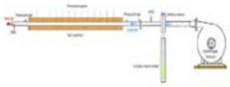
The twisted tapes are made of mild steel and have tape width (w) of 10 mm, 15 mm & 20mm. Tape thickness (d) of 0.8 mm, and tape length (l) of 900 mm. Also a wire coil having pitch of 30 mm is used to generate co-swirl. All tapes were prepared with different twist ratios, y/w =3.5, 2.66 and 2.25 respectively where twist ratio is defined as twist length

(l) to tape width (w). Schematic view of twisted tape & wire coil is shown in Fig. On the other hand, to avoid an additional friction in the system that might be caused the thicker tape. To produce the twisted tape, one end of a straight tape was clamped while another end was carefully twisted to ensure a desired twist length. As shown in Fig these twisted tapes are fixed one by one inside the pipe having wire coil to generate co-swirl

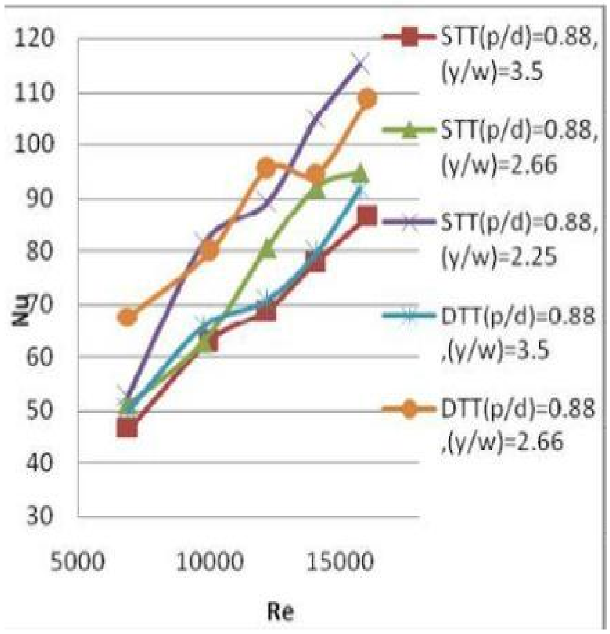
The test section is surrounded by nichrome heating wire, which is wrapped around the test section with a

pitch distance of 5 mm. This pitch is good enough to provide a nearly uniform heating on the outer surface of the test section tube. The heating wire was powered by a variable AC power supply. The overall electrical power added to the heating section, Q, was calculated by measuring the voltage (0–200 V) and the electrical current (0–2 A). To control the convection losses from the test section and other components, foam insulation and glass wool used. Four thermocouples are to be embedded on the test section to measure surface temperature of pipe and two thermocouples are placed in air stream at entrance and exist of test section to measure air temperature. To avoid floating voltage effects, the thermocouple bead is insulated from the electrically heated tube wall surface with a very thin sheet of mica between the thermocouple and the tube surface so as not to be effected from electricity.

Fig shows the schematic view of experimental set-up.



Experimental results show that the Nusselt number (therefore, the heat transfer coefficient) increases with increasing Reynolds number for the conventional turbulent tube flow. This is the most likely caused by a stronger turbulence and better contact between fluid and heating.



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The variations of Nusselt number with Reynolds number for three different twist ratios (y/w = 3.5, 2.66, 2.25) with wire coil of pitch ratio (p/d = 0.88) shown in figure 6.1. Nusselt number increaseswith the decrease of twist ratio and the increase of Reynolds number. The highest Nusselt number is achieved for twist ratio (y/w = 2.25) and pitch ratio (p/d =0.88).

Conclusions:

We know the heat transfer enhancement can be done by using treated surfaces, using inserts, using extended surfaces which are the most important passive methods to enhance the heat transfer

The twisted tape inserts are most suitable and widely used in heat exchanger to enhance the heat transfer. Twisted tape inserts increases heat transfer rate with less friction factor. The coiled circular wire should be applied instead of smooth one to obtain higher heat transfer.

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