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Heat Transfer Augmentation - A Review for Helical Tape Insert

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ABSTRACT –*In the chemical plant, petroleum plant, power plant etc. having several application of heat exchanger. The design of heat exchanger may be complicate to increases the heat transfer rate in heat exchanger. There are many heat transfer augmentation techniques as Active, Passive and Compound Techniques. The present paper is a review of Passive and compound Technique to effect on Reynolds number, pressure drop and the friction factor in a circular plain & wavy-surfaced tube with/without a helical-tape insert to change the heat transfer coefficient.*

Keywords - Heat transfer augmentation, Passive, Active and Compound techniques, Corrugated surface, helical-tape.

I.INTRODUCTION

In recent trend, the application of several enhancement technologies in heat transfer to improve performance in process industries, petroleum industries, power plant etc. Basically there are different augmentation techniques to increases the heat transfer rate in heat exchanger. Active, Passive and Compound techniques. The present paper has broad discussion with passive technique using helical tap through generation of swirl flow in pipe.

Passive and compound technique is effective in enhancement of Nusselt number, Reynold number and pressure drop to disturbing the flow in pipe. Here take a review for the characterization in plain tube, tube with /without helical tape and helical tap in corrugated surface of the pipe.

II. METHODOLOGY

Existing enhancement techniques can be broadly classified into three different categories:

1. Active techniques
2. Passive techniques
3. Compound techniques

1) *Active techniques*- In this technique applicable some external power to increases the heat transfer rate in heat exchanger. Complexity in this technique is less as passive and compound technique e.g. Mechanical aids, Surface vibration, Fluid vibration, etc.

2) *Passive techniques*- In this technique change the flow pattern without any external power only by available power in system. This change of flow pattern leads to disturbing thermal boundary layer and pressure drop to enhance the heat transfer rate in heat exchanger e.g. rough surface, Swirl flow, etc.

3) *Compound techniques*- In This technique application of both active and passive techniques. Compound technique is more complexity which increases the pressure drop e.g. Rough tube with twisted tape, finned tubes in Fluidized bed, etc.

III. REVIEW OF EXPERIMENTAL STUDIES

SmithEiamsa-ard, Pongjet Promvonge [2] effect of helical tape in flow through a double pipe heat exchanger has been investigated. The experimentation worked on cold water and hot air system having Reynold number range 2300 – 8800 of flow. Heat transfer coefficient have increased using full length helical tape with/without centered rod and regularly spaced helical tape in heat exchanger. 10 % enhancement in heat transfer coefficient has occurred with helical tape with centered rod than helical tape without centered rod but increased in pressure drop. Different space free ratio (0.5, 1.0, 1.5, and 2.0) has studied to overcome pressure drop difficulties. S=0.5,The mean Nusselt number has increased by 145% for insert of regularly spaced helical tape, 150% for insert of full length helical tape without centered rod and 160% for inset of full length helical tape with centered rod as compared with pain tube.

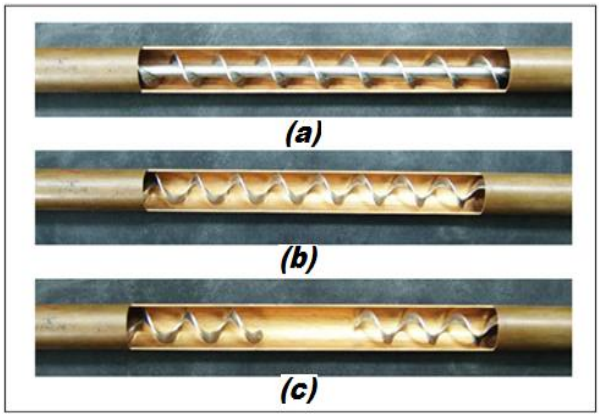

Figure III.1: (a) Full-length helical tape with a rod; (b) Full-length helical tape without a rod; (c) Regularly-spaced helical tape without a rod.

Paisarn Naphon[10] in that paper the investigated application of V corrugated plate on both sides surface of the tube and tested effect of heat transfer characteristics and pressure drop. The tested section has V corrugated plate with tile angles of 20°, 40° and 60° under experimentation condition as Reynold number and heat flux has 2000-9000 at and 0.5-1.2 kW/m2 respectively. Pressur drop and Heat transfer has been enhanced due to formation of recirculation zone in the tube. Formation of reciculation zone disturbing or breaking of thermal boundary

layer of flow stream on the corrugated surface. As compared with the plain surface tube the enhancement in heat transfer has occurred 3.35 and pressure drop has occurred 1.96 times more in V corrugated surface tube.

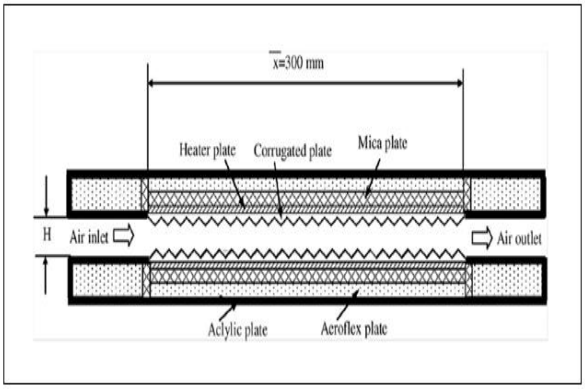

Figure III.2: V corrugated surface plate in tube

S. Eiamsa-ard and P. Promvonge[9] studied the heat transfer characteristic with helical tape with rod inserted in circular wavy surface wall of heat exchanger tube. They have examined the Nusselt number and pressure drop for the flow has Reynold number range 3000 to 9200 with uniform heat flux in tested section of tube. Experiment studied for the two set up (1) Circular wavy surface wall (2) Circular wavy surface wall along with the inserted of helical tape with rod, constricted of 7.5 kW Brower and orifice meter as flow rate meter. Circular wavy surface ruptured the stabilized thermal boundary layer and inserted of helical tape with rod within tube which generate the swirl flow along the core region. Construction of such arrangement in experimentation they have observed that Nusselt number became enhanced with 1.9 to 2.0 times in tube with circular wavy surface wall than the pain surface wall tube. As well as, Nusselt number became enhanced with 2.48 to 2.67 times in tube with circular wavy surface wall along with helical tape than plain surface wall tube and pressure drop 9.2 to 22.3 times than plain tube has been observed. Also concluded that heat transfer rate augmented by 23 – 35 % and pressure drop augmented by 98 – 125 % times in tube combined with circular wavy surface and helical tape than circular wavy surface wall tube alone. Figure III. 4 show investigated result of heat transfer characteristics in their paper.

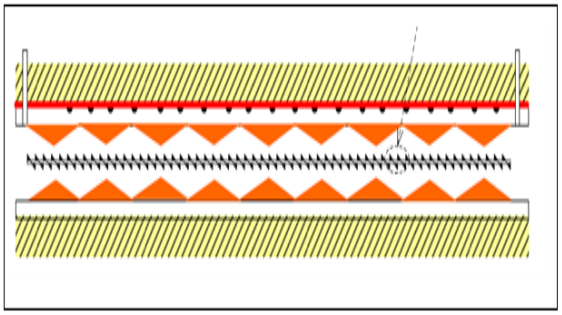

Figure III.3: a tube combined with circular wavy-surfaced and helical-tape insert

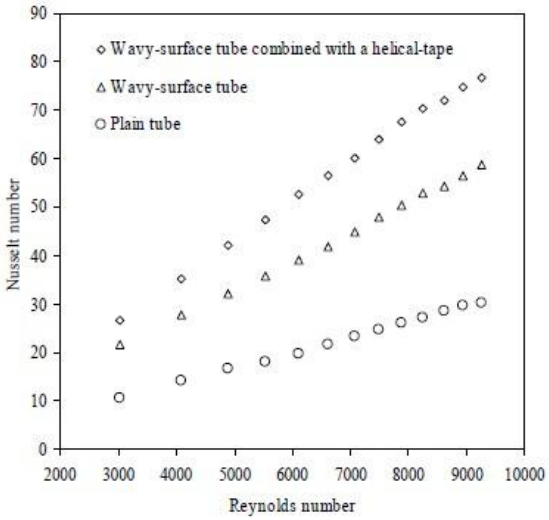

Figure III.4: Relation between Nusselt number and Reynold number [9]

CONCLUSION

The above literature review, heat transfer augmentation techniques are very useful to enhancement in heat transfer characteristics and the pressure drop. Basically, passive / compound techniques used in heat exchanger shown in that review have better result than plain tube. Heat transfer rate and pressure drop along with Nusselt number increases by using helical inserted in plain surface tube or in wavy surface tube. But high enhancement occurs in wavy surface along with helical tape than enhancement in plain surface inserted with helical tape. Also shown here we can enhancement heat transfer rate and pressure drop by different construction in helical tube. These are very useful conclusion in development of heat exchanger design and augmentation techniques network.

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