Review of Heat Transfer Enhancement by Different Techniques

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Abstract **The heat exchanger has the main role in the heat transfer processes such as energy storage and recovery. To increase the performance of the heat exchanger, the heat transfer enhancement methods are utilized in much industrial application. The heat transfer techniques are mostly used in areas such as thermal power plants, air conditioning equipment automobile**

These methods are classified into three categories- 1.Active methods 2.Passive methods 3.Compound methods.

In recent days, the compound methods will be useful to designers to enhancement the heat transfer in heat exchanger.

Keywords* — *Heat exchanger, heat transfer enhancement techniques, compound methods.

I. INTRODUCTION

A heat exchanger is a device used to transfer heat between two or more fluids. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment.

There is a need to be enhancement in the heat transfer of heat exchanger hence, in the past decades, heat transfer enhancement technology has been developed. Much effort in the past decades has been aimed to provide economical methods for improving the performance of heat exchanger. Heat transfer enhancement techniques are very important to save energy and using of optimal energy sources. There are different methods to improve the heat transfer rate those are active, passive and compound techniques. Active method those which require external power to maintain the enhancement mechanism are named active methods. Passive techniques mostly consist of increasing the transfer surface area. Examples of active enhancement methods are well stirring mechanical aid, surface vibrations, electrostatic fields, jet impingement, and spray. Furthermore, the passive enhancement methods are those which do not require external power source to enhancements characteristics. Examples of passive enhancing methods are smooth surfaces, rough surfaces, extended surface displaced enhancement devices. Nowadays, there have been a large number of attempts to reduce size and cost of heat exchangers, in reducing size and cost of a heat exchanger are basically the heat transfer coefficient and pressure drop.

II. LITERATURE REVIEW

Prashant Kumar et al. [1]This author studied the experimental work to enhance the heat transfer by some modification on the surface of the heat exchanger tube. The modification has been made by inserting some protruded shape sheet metal surface within the tube and the surface of sheet metal attached to the surface of the tube. Nusselt number of the protruded surface roughened heat exchanger tube increases with increase in Reynolds number. The enhancement of 3.43 times in heat transfer in the case of stream wise spacing of (x/d) = 10 and 2.31 times enhancement in thermo hydraulic performance factor in the case of span wise spacing (y/d) = 10.

M.A. Omara et al. [2]The paper focuses on the circular and rectangular helical-coils were sited in elliptic tube section with four various pitches of 20, 45,135 and 225 mm. The cold air Re number was ranged from (11×103 ≤ Re ≤ 3.375×104). The effect of reverse-flow for different pitches and inserted helical wire cross-sections can improve the heat transfer rate. Nu, f and η for helical-coil with different wire cross-sections are obtained for the considered Re range.

Zhang Cancan et al. [3] author has discusses about heat transfer and pressure drop in helically coiled tube with spherical corrugation are investigated by a three-dimensional numerical simulation. Different geometrical parameters of spherical corrugation in helically coiled-tube heat exchangers are studied to improve the heat transfer rate. The overall heat transfer performance of helically coiled tube with corrugation is better than that of smooth helical tube under the same condition. The augmentation on

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heat transfer performance is about 1.05–1.7 times as compared to the smooth helically coiled tube, while friction factor sharply increases 1.01–1.24 times. With the increase of the corrugation pitch, the enhancement on heat transfer is in the range of 1.37–1.66 times and the friction factor increases 1.18–1.28 times compared to the smooth helically coiled tube. The value of PEC reaches to 1.56

Hyder H. Balla et al. [6]This paper focuses on the use of both numerical as well as experimental settings on the water flowing at lower Reynolds numbers in a corrugated tubes with spiral shape to evaluate the performance of heat in a newly designed corrugation style profile. It shows that for extended period and extensive range use, tubes with severity index values at 36.364×10–3 could produce better heat performance (1.8–3.4) at Reynolds numbers ranging from 100 to 1300.

A. García et al. [7] This paper focuses on the thermal hydraulic behavior of three types of enhancement technique based on artificial roughness: corrugated tubes, dimpled tubes and wire coils. Results show that if Reynolds numbers lower than 200, the use of smooth tubes is recommended. For Reynolds numbers between 200 and 2000, the employment of wire coils is more advantageous, while for Reynolds numbers higher than 2000, the use of corrugated and dimpled tubes is favored over the wire coils because of the lower pressure drop encountered for similar heat transfer coefficient levels.

Shao-Wen Chen et al. [8]This paper focuses on the stainless-steel circular heater rod was first tested for heat transfer performance with and without ultrasonic vibration in a thermostat water tank. The loaded heat flux was about 7.6x103–7.1x104 W/m2, which covered the heat transfer regimes from natural convection to sub-cooled boiling. Results shows that the maximum heat transfer increment can be up to 1557 W/m2K, and the maximum h-increment ratio can be about 3.01 (301 %).

III. DIFFERENT METHODS OF HEAT TRANSFER ENHANCEMENT

A] ACTIVE METHODS

Active method those which require external power to maintain the enhancement mechanism are named active methods. examples of active enhancement methods are well stirring mechanical aid, surface vibrations, electrostatic fields, jet impingement, and spray. active techniques have attracted little financially interest because of the costs involved, and the problems that are profitably associated with vibration or acoustic noise.

ELECTRO HYDRODYNAMICS (EHD)

Electro hydrodynamics heat transfer enhancement which uses joint of electric field with flow field. In this technique high voltage and current is applied to fluid. It refers to the joint (coupling)of an electric field with the flow field in a dielectric fluid medium. One of the main aims of the electro hydrodynamics technique is to convert electrical energy into kinetic energy: Electro hydrodynamics forces set the dielectric fluid in motion.

JET

The method used as active method for enhancement of heat transfer is use of jet in between fluid flow. It uses principle that increase in projection of fluid at high velocity increases heat transfer coefficient. it automatically increases heat enhancement. Jet having property to give higher heat transfer at stagnation point.

SPRAY

A spray consists of liquid droplets generated by air or by a pressure-assisted atomizer. Because the drops spread over the surface and evaporate or form a thin film of liquid Impinging on the heated surface with droplets increases the heat transfer .It another active method of increase enhancement by use spray.

SURFACE VIBRATION

Surface vibration may be at low or high frequency has been used firstly to rise or increase single-phase heat transfer. To vibrate a surface and spray few droplets onto a heated surface to promote spray cooling, a piezoelectric devices are used.

FLUID VIBRATION

It is more experimental type of vibration enhancement because of the mass of most heat exchangers .The vibrations spread from pulsations of about 1 Hz to ultrasound. Single phase fluids are of primary task. They are applied in many variant ways to dielectric fluids. Generally speaking, electrostatic fields can be directed to cause greater mixing of fluid in the vicinity of the heat transfer of surface.

B] PASSIVE METHODS

The passive enhancement methods are those which do not require external power source to enhancements characteristics. Examples of passive enhancing methods are smooth surfaces, rough surfaces, extended surfaces, displaced enhancement devices. These methods need no external power and usually utilize geometrical or surface modifications to the flow tube by additional devices or joining inserts. These methods increase the rate of heat transfer by changing the flow treatment which also causes the pressure drop to increase.

ROUGH SURFACES

These surface modifications, particularly create the disturbance in the viscous sub-layer region. These

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techniques are applicable primarily in single phase turbulent flows.

EXTENDED SURFACES

Plain fins are one of the earliest types of extended surfaces used extensively in many heat exchangers. Finned surfaces have become very popular now days owing to their ability to disturb the flow field apart from increasing heat transfer area.

DISPLACED ENHANCEMENT DEVICES

These inserts are used primarily in confined forced convection. They improve heat transfer indirectly at the heat exchange surface by displacing the fluid from the heated or cooled surface of the duct with bulk fluid from the core flow.

SWIRL FLOW DEVICES

They produce swirl flow or secondary circulation on the axial flow in a channel. Helical twisted tape, twisted ducts & various forms of altered (tangential to axial direction) are common examples of swirl flow devices. They can be used for both single phase and two-phase flows.

SURFACE TENSION DEVICES

These devices direct and improve the flow of liquid to boiling surfaces and from condensing surfaces. Examples include wicking or grooved surfaces

ADDITIVES FOR LIQUIDS

This technique involves the addition of solid particles, soluble trace additives and gas bubbles added to the liquids to reduce the drag resistance in case of single phase flows. In case of billing systems, trace additives are added to reduce the surface tension of the liquids.

ADDITIVES FOR GASES

These include liquid droplets or solid particles, which are introduced in a single-phase gas flows either as dilute phase (gas–solid suspensions) or as dense phase (fluidized beds).

C] COMPOUND METHODS

When any two or more of these techniques are employed simultaneously to obtain enhancement in heat transfer that is greater than that produced by either of them when used individually, is termed as compound enhancement. Compound techniques offer a way to further elevate heat transfer coefficients and this area of enhancement technology holds much promise for future development.

IV. CONCLUSION

1) Paucity of information exist on studies focusing on thermal performances of transverse corrugated tubes, with special interest on the lack of corrugation effect on heat transfers.

2) Not many studies in the field of compound heat transfer enhancement (vibrations on fluids) have been published so far.

3) There is only limited systematic database for analyzing the effects of the parameters, and the reliable models or correlations for predicting heat transfer enhancement under ultrasonic vibration are very limited and essential.

4) There is few experimental study available in the literature regarding EHD-enhanced forced convection heat transfer with conduction pumping mechanism in internal flows.

5) There is a need for a better understanding of the impact of fluid-wall flow schemes on the thermal performance of heat exchangers is still needed for the development of highly efficient equipment

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