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"A REVIEW ON HEAT ENHANCEMENT METHODS"

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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 Inman industrial application. The heat transfer techniques are most use in areas such as thermal power plants, air conditioning equipment automobile, aerospace. These methods are classified into three categories- 1. Active methods 2. Passive methods 3. Compound methods. In recent days, the passive methods will be useful to designers to enhancement the heat transfer in heat exchanger. Passive heat transfer augments method does not use any external power input. One of the way to in which enhance heat transfer performance in passive method is to increase the effective surface area and residence time of the heat transfer fluid.

Key Words: *Heat Exchanger, Effective Surface Area, Residence Time*

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1. INTRODUCTION

The heat exchangers has an important roles in the energy storage and recovery. Enhancement of heat transfers are of vital importance in many industrial applications. Due to the developments of modern technologies, the heat exchanger required in various industries for high heat-flux cooling to the level of mega watt per meter square. At this stage, cooling with conventional fluids such as water and ethylene glycol are challenging. Hence, it is necessary to increase the heat transfer performance of working fluids in the heat transfer areas.

In the last decades, significant effort has been made to develop heat enhancement techniques in order to improve the overall performance of heat transfer devices. The interest are in the these techniques are closely tied to energy prices and, with the present increase in energy cost, it is expected that the heat transfer enhancement field will go through a new growth area. Although there is need to develop new technologies, experimental work on the older ones is still necessary. The knowledge of its performance shows a huge degree of uncertainty which makes their industrial implementation difficult. The efficiency of heat transfer devices is essential in energy conservation. Also, a more efficient heat exchanger can reduce the size and shape of the heat exchanger, thus reducing the costs associated with both material and manufacturing of the heat exchanger. Improved heat transfer can make heat exchangers smaller and more efficient.

Heat enhancement techniques have been extensively developed to improve the thermal performance of heat exchanger systems with a view to reducing the size and cost of the systems. Swirl flow is the one of the enhancement technique widely applied to heating or cooling systems in many engineering applications. Heat transfer enhancement techniques are classified as in the - Passive Methods, Active Methods, and Compound Methods. These methods are commonly and usually used in areas such as process industries, heating and cooling in evaporators, thermal power plants, air-conditioning equipment, refrigerators, radiators for space vehicles, automobiles, etc.

The rate of heat transfer will be increase passively by increasing the surface area, roughness, and by changing the boundary conditions. The active method involving addition of nano sized, high thermal conductivity, and metallic powder to the base fluid, to increase the heat transfer rate. Passive techniques, where inserts are using in the flow passage to enhance the heat transfer rate, are best suited compared to active techniques. Because the insert manufacturing process is simple and easy and these techniques can be easily applied in an existing applications.

This Heat transfer techniques are refer to different methods by using to increase rate of heat transfer without affecting much the overall performance of the system. This Active methods are involving some external power input for the enhancement of heat.

Passive heat transfer augmentation method do not use any external power input. One of the way to enhance heat transfer performance in passive method is to increase the effective surface area and residence time of the heat transfer fluid. Use of this technique causes the swirl in the bulk of the fluid and disturbs the actual boundary layer so as to increase surface area, given time and similarly heat transfer coefficient in existing system.

2. Literature Review

Prabhakar Ray et al. conclude that, wire coiled tube increases the pressure are drop comparing to an empty tube. The pressure drop depends on the wire geometry and are always act a significant. Wire coil inserts perform better in transition and turbulent regian flow. With the transition region of wire coils has fitted inside a smooth tube heat exchangers, heat transfer rate has been increased up to 200% keeping pumping power constant. In laminar flow wire coil inserts, they aren't very effective and results show that wire coils behaves like smooth tube but accelerate transition to critical Reynolds numbers down to 700.

G. D. Gosavi et al. they experimentally investigated that, as far as the review is concerned, fins was the method of enhancing heat transfer. The perforated fin may not be dissipate about 50 to 60 % more heat. Heat transfer becomes most uniform by applying the perforations. The are the onfin efficiency of perforated fin is greater than the solid fin. The perforated materials can have better strength.

Allan Harry Richard. T. L et al. conclude that the experimental analysis in the project of the enhancement of heat transfer of fin for different materials is analyzed and it can be improved. Fin efficiencies of materials are 66%, 91%, 94% are achievedin both. And among these are of the materials from the analysis that copper has high thermal conductivity than brass and aluminum.

N. C. Kanojiya et al. conclude that from this review, various ways of enhance the heat transfer rate of the generating the swirl flow by passive method can be observed by using various types of inserts. In perforated twisted tape inserts of the heat are in the transfer rate increases hence, heat transfer coefficient increases with decreases in pressure drop. In a perforated twisted tape of the inserts, the friction factor increases in the laminar region and increase the heat transfer coefficient as compares to without perforated twisted tape inserts. In most of was the review, nanofluid are not used for examine the heat transfer rate in heat exchanging device. The examination was done in the main perforated twisted tape insert either in thermal analyses, flow visualization, in heat exchangers, etc...

Nikhil S Shrikhande et al. from these review conclude that, various ways of enhancing the heat transfer rate in automobile radiator by using different types of nanofluids, Reynolds number, fluid flow rate, and the volumetric or weight concentration. Addition of various nanoparticles or additives to the liquid slightly increases in the viscosity and the thermal conductivity moderately.

Dr. A. G. Matani et al. conclude that, thermal characteristics in a tube fitted with twisted-tapes in co-swirl arrangement with wire coil are presented in the present in the study. Results shows in the that wire coil of pitch ratio 0.88 is more superior to all twisted tapes. In twisted tape double twisted tape are act as counter swirl generator, which shows better performance than single twisted tape.

P. N. Shrirao In this study, thermal analysis are investigated in a conventional (uncoated) cylinder head of diesel engines, made of cast iron in previous stage. when the thermal analysis is performed on cylinder head, coated with 3Al2O3 .2SiO2 (mullite) (Al2O3= 60%, SiO2= 40%) material by means of using a commercial code, namely ANSYS. Finally, these temperature distributions are compared with each other. Heat transfer models has been developed for cylinder head with and without thermal insulation coating, which is incorporated in the simulated program. Gas wall heat transfer calculations are based on Annand's heat transfer model for IC engines. The effect of the coating on the thermal behavior of the cylinder head is investigated using finite element analysis. It has been shown in that the maximum surface temperature of the coated cylinder head with low thermal conductivity mullite material is improved approximately by 22-38%.

3. Different Methods Of Heat Transfer Enhancement

Heat transfer enhancement, augmentation deals with the improvement of thermo hydraulic performance of heat exchangers. Different enhancement techniques have been broadly classify as passive, active and compound techniques.

3.1 Active method

The active method involve external power inputs for the enhancement in heat transfer method; for ex. it includes mechanical aids and the use of a magnetic field to disturb the light seeded particles in a flowing streams, etc.

3.2 Passive Method

The Passive heat transfer augmentation methods do not need any external power inputs. In the convective heat transfe rmethods one of the way to enhance heat transfer rate is to increases the effective surface areas and residence time of the heat transfer fluids. By Using this techniques cause the swirl in the bulk of the fluid and disturbs the actual boundary layers which increases effective surface areas, residence time and simultaneously heat transfer coefficient increases in an existing system. This methods are generally used as Inserts, Extended surfaces, Surface Modification, Use of Additives.

3.3 Compound Method

When any two or more techniques i.e. passive and active may be used simultaneously to enhance the heat transfer of any device, which is greater than that of produced by any of those techniques separately, the term known as Compound enhancement technique.

3.1 Active Method

There are some limitations of passive methodology so we use active method from last few year. Active method are those, which are require external power supply to maintain the enhancement of mechanisms. The examples of active method for heat transfer are:(1)Jet (2) Spray (3) Mechanical aid:(4)Surface Vibration (5)Fluid vibration.

3.1.1 Jets

It forces a single phase fluid normaly or obliquely toward the surface. Single and multiple jets may be used, and boiling is possible with liquids. Another method used as active method for enhancement of heat transfer is use of jet in between fluid flow. It used principles that increases in projection of fluid at high velocity increases heat transfer coefficient. it automatically increases heat enhancement. Jet having property to give high heat transfer at stagnation point. Jets are uses in many industrial applications thermal control of high flux devices such as electronics, X-rays, optics, gas turbines, cooling of internal combustion engines. this technique uses multiple impingement jets to heat and cool the surface uniformly and widely. In the following sentence, the main mechanisms of flow and heat transfer enhancement are described for both single and multiple jets. Jets are well known to gives a high heat transfed coefficient near the stagnation region where the jet impinges on the target plate. According to jet used it has following types which are discussed below (L . Lal , 2013).

3.1.2. Spray

A spray consisted of liquid droplets generated by air by a pressure-assisted atomiser. 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. Spray usesd droplets in air which contain moistured, which will then spread over heated surface thus heat transfer occurs. By evaporation, convection and secondary nucleation heat transfer is more even at low temperatured. The heat transfer behavior (heat flux versus wall temperature) using spray cooling presents the following specification: For low wall temperature, the heating plate temp is reduced or cool by a single-phase regime. Because of the flow is rapidly expelled from the heating surface, in that temperature range, the liquid does not have time to warm up enough to attain the boiling condition at the heating wall (Prof. Min Zeng , 2005).

Convection heat transfered is increased because droplets acts on the liquid film this mixing the fluid better. Below the saturation temperature, the curve slope may increased due to the evaporation of the thin liquid film form on the heating surface When liquid near the heating wall becomes superheated, heat transfer may be increased by secondary nucleation or boiling which increase the heat transfer coefficient, the evaporation rate and the turbulence When the motions of flow increases farther, the surface start to dry. The vapor generated by phase changes are quickly removed Because the critical heat flux is higher for spray cooling than for pool boiling Spray cooling is very difficult because it depends on many parameters. For ex. nozzles-to-heating surface distance, incident angle, droplet size, air pressure, droplets velocity droplets density, surface roughness and orientation, non-condensable gases, air pressure, etc (Prof. Min Zeng , 2005).

3.1.3 Mechanical aids

Equipments are with rotating heat exchanger tube is found in commercial practice .They involve gripping the fluid by mechanical means or spin the surface. Mechanical surface Scrapers, can be applied to tube flow of gases, viscous liquids in the chemical process industry (Prof. Min Zeng , 2005).

3.1.4 Surface vibration

Surface vibration may be at lower or higher frequency has been used firstly to rise or increase single-phase heat transfer. To vibrate a surfaces and spray few droplet onto a heated surface to promote" spray cooling", a piezoelectric devices are used. There are three main heat transfer enhancements technque involved Cyclic movements of a solid walsl are considered here acoustics waves formed by high frequency oscillations of a membrane; synthetic jet where the flow is imposed by the motion of a diaphragm bounding a void; dynamic deformity of a solid at high amplitude. high amplitudes vibratory motions are through solutions using the deformation of a wall to increase shift, one is particularly studied. It consists of evaluating the impacts on an oscillation of a movable blade constituting piezoelectric. Such a piezoelectrics fan coulds be reduce which is consistent with the objective of compactnesss (Prof. Min Zeng , 2005). The oscillation of the blade cause motion in the surrounding fluid. Piezoelectric fans are uses to imposed motion on a fluid local in a global stagnant fluid area, increas heat transfers in a hot spot, and so reducing local temperature. Other studied about heat transfers enhancements using wall morphing have been conducted. For ex., using a plate oscillating in a channels are enhances natural and forced convections. In the same ways, a vibrations can be impose direct on the wall of a channel. repeated moving a wall strongly enhances heat transfer, either with or without boiling of the moving fluid (Prof. Min Zeng 2005).

An acoustic wave reduces cavitation's phenomena which in turn enhanceses heat transfer through a mixing effect. In the boiling structures, acoustics waves are increasing both heat transfer and critical heat flux. Increasing the amplitude at lower frequency sets the fluid in motion and thus enhances the convective effect (Prof. Min Zeng ,2005).

3.1.5 Fluid vibration

It is more experimental type of vibration enhancement because of the masses of most heat exchangers. The vibrations are spread from pulsations of about 1 Hz to ultrasound. Single phase of fluids are of primary task. They are of the applied in many variant ways to dielectric fluids. Generally speaking, electrostatic fields can be directed to the cause greater mixing of fluid in the vicinity of the heat transfer of surface (Prof. Min Zeng, 2005), The control of fluid motion in the vicinage of the wall are essential to increase heat transfer rate. Active techniques are act on the fluid in touch with the wall. The most efficient methods of the heat transfer enhancement are those generating a rebirth of the fluid in the immediate vicinage of the wall. A possible technique are the use of movable walls at the location where the taking out of heat takes place. But wall deformation does not without its disadvantages (Prof. Min Zeng, 2005).

3.2 Passive Study Methods To Be

1. Using Treated Surfaces
2. Using Inserts
3. Using Extended Surfaces

3.2.1 Treated Surfaces

It consists of a variety of structured surface (continuous or discontinuous integral surface roughness or alterations) and coatings. The roughness create by this treatment do not causes any significant effect in the single phase heat transfer. These are applicable in cases of two phases heat transfer only.

Boiling:

Some of the treated surfaces are as follows:

- Machined or grooved surfaces
- Formed or modified low-fin surfaces
- Multilayered surfaces
- Coated surfaces

Boiling are a convective heat transfer process in which the liquid changes its phase into vapour at the liquid vapour interface. Such the are process occurs when the heat is transferred from the solid surface to liquid in contact and surface temperature is maintained at a temperature higher than the saturation temperature of liquid.
Boiling process are used in boilers for steam formation, heat absorption in evaporators in refrigeration system, dehydration and drying of foods, distillation of liquids.
In enhanced boiling treated surfaces provide a large number of stable vapors traps or nucleation sites on the surface for bubble formation. In case of highly wetting fluids are like refrigerants, organic liquids, cryogens and alkali liquid metals the normal cavities present on the heated surfaces tend to experience sub-cooled liquid flooding. For high surface tension fluids are coatings of non-wetting material on either the heated surface or its pits and cavities were found to be effective in nucleate boiling. Stainless steel surfaces along with Teflon can be spread to creates spots of the no-wetting materials on the heated surface these are results in three to four times high heat transfer coefficients.

Condensing:

Condensation are a process in which the vapour changes into a liquid at its saturation temperature corresponding to its vapour pressure. Such a process occurs when vapour comes in contact with solid surface which is at a temperature lower than the are saturation temperature of vapour.

There must two types of condensation depending upon condition of surface. 1. Film wise Condensations 2. Dropwise Condensations

In case of the film condensation, the film formed on surface offers thermal resistance of heat transfer. Due to the low thermal conductivity of film the rate of heat transfer from vapour to surface are reduced.

In case of dropwise condensation, the vapour condenses in the form of droplets which grows in the size and finally they roll of the surface under the influence of gravity. Thus, there is no such thermal resistance due to the film in case of drop condensation and the vapour directly comes in contact with the surface.

In condensation of vapours, treated surfaces promote drop wise condensation which are ideal for preventing surface wetting and break up the condensate film into droplets. This process provides better drainage and more effective vapours removal at cold heat transfer interface. These are the techniques of increases heat transfer by a factor of 10 to 100 in drop wise condensation when it was compared with that in film wise condensation as proposed by Bergles. Non-wetting inorganic compound are or a noble metals or an organic polymer can be used effectively for coating the heat transfer surfaces. Among these are, organic coatings have been used considerably in steam systems.

3.2.2 Inserts

Inserts requires additional arrangements to make to fluid flow which are enhance and augment the heat transfer.

The types of inserts are: twisted tape, wire coils, ribs, baffles, plates, helical screw insert, meshani inserts, convergent – divergent conical rings, conical rings etc. Tube insert devices including twisted tape, wire coil, extended surfaces and wire mesh insert is considered as the most important techniques of Passive methods; are in which, twisted tape and wire coil inserts are huge applied than others.

Twisted tapes is the metallic strips twisted using some of the suitable techniques are 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 the heat exchangers to enhance the heat transfer.

Wire coil are inserts have been utilized as one of the passive enhancements techniques and are wide utilized in heat transfer equipment.

We study in the following inserts - Twisted Tape, Wire Coils.

Twisted Tape

Twisted tapes is 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 suitables and wide use in heat exchangers to enhance the heat transfer.

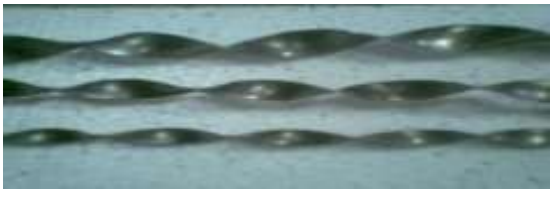

Fig 6.1 Twisted Tape

Twisted tape inserts increasees heat transfer rates with less friction factor. The use of twisted tapes in a tubes gives simple

passive technique for enhancing the convective heat transfer by making swirls into the heavy flow which disrupting the boundary layer at the tube surface due to rapidly changes are in the surface geometry. Which means to say that such type of tapes induces 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 are in geometry of twisted tape inserts. Simultaneously, the pressure drop are inside the tube will be increases when using twisted-tape as an insert. For this many researchers are has 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 are of twisted tapes inserts depends on the Pitch and Twist ratio.

Wire Coil

Wire coil inserts has been utilized as one of the passive enhancement techniques and are widely utilized in heat transfer equipments.

They show several advantages are in relation to other enhancement techniques:

1) It is Easy installation and removal.

2) It is Simple manufacturing process with low cost.

3) It will Preservation of original plain tube from mechanical strength.

4) It has Possibility of installation in an existing smooth tube heat exchanger (retrofit).

5) it has Fouling mitigation (in refineries, chemical industries and marine applications).

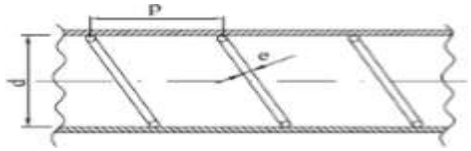

Fig.6.2 shows a fig. of a wire coil inserted in close contact with the inner tube wall, Helical Wire Coil Fitted Inside A Smooth Tube
where ,
p stands for helical pitch, e stands for the wire diameter ,d is the tube inner diameter.

3.2.3 Extended Surfaces

In many engineering applications are large quantities of heat have to be dissipated from small areas. Heat transfer by convection between a surfaceses and the fluids surroundings it can be increases by attaching to the surface thin strips of metals called fins. The fins increased the effective area of the surface thereby increasing the heat transfer by convection. The fins is also referred as "extended surfaces". Extended surfaces (fins) is one of the heat exchanging devices that are employed extensively to increase heat transfer rates. The rate of heat transfer depends upon the surface area of the fin. It increases the contact surface area, for ex. a heat sink with fins.

This can be obtained by regarding the fin as a metallic plate connected at its was base to a heated wall and transferring heat to a fluid by convection. The heat flow through the fin is by conduction. Thus the temperature distribution in a fin will depend upon the properties of the both the fin material and the surrounding fluid.

4. Conclusion

1) 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.

2) By using treated surfaces we enhance the heat transfer rate which are applicable for boiling and condensing.

3) The twisted tape inserts are most suitable and widely used in heat exchanger to enhance the heat transfer.

4) The heat transfer can also done by extended surfaces which conclude that copper has higher thermal conductivity than brass and aluminium.

5) Active method such as electromagnetic fields and surface vibration do require external power for operation.

6) Active technique are identified as a possibility for enhancement. The active technique depends on external power or activation, this are techniques have power cost .power cost must be considered and micro system designer have to carefully consider their implementation.

7) A important conclusion of single jet studies is that the heat transfer is very high near to the impact zone, but reduces rapidly away from it.

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