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REVIEW ON ENHANCEMENT OF HEAT EXCHANGER BY USING CONICAL INSERT

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Abstract *- The heat exchanger is an important device in almost all of the mechanical industries it is key element. Thus many researchers in this area are working to improve the performance of the heat exchangers in terms of heat transfer rate. This paper is a review of passive augmentation techniques used in heat exchangers. The thermal performance behavior of tube in tube heat exchanger it is studied for wire coil inserts, twisted tape inserts and their combination. The research was done for constant/periodically varying wire coil pitch ratio. Some of them have varied 3 coil pitch ratios.*

The conical ring were also been tested. These inserts are tested individually and in combine form and results were compared. The Reynolds number is selected for allowing the inserts to be tested for different flow conditions from laminar, transient and turbulent. The new improved performance was found in the increasing order for inserts like wire coil, twisted tapes and conical inserts. Also some of researchers have developed correlations for these inserts for nusselt number as a function of Reynolds number.

Key Words: *Heat transfer enhancement, Passive technique, wire coil, Heat exchanger, Conical insert.*

1. INTRODUCTION

Heat exchangers are widely used in the fields of refrigeration, air conditioning, water cooler, space heating, automobile, radiator and chemical engineering. Fin-tube heat exchanger with two rows of round tubes is commonly used in refrigeration and air-conditioning systems. Heat exchanger devices such as plate type, plate fin type operate on the principle of temperature difference between two mediums and can find efficient sensible heat transfer from one fluid to another. With the development of design of heat exchanger and making some changes without affecting the cost, the heat transfer enhancement can be achieved.

These techniques are also known as Heat transfer Enhancement or Improvement. Augmentation techniques increase convective heat transfer rate by reducing the thermal resistance in a heat exchanger. Use of Heat transfer enhancement techniques lead to increase in heat transfer coefficient but increase in pressure drop with increase in cost. So, while designing a heat exchanger using any of these techniques, synthesis of heat transfer rate &pressure drop has to be done. Together from this, issues like long term performance & detailed economic synthesis of heat exchanger has to be studied. To achieve more heat transfer rate in an existing or new heat exchanger while taking care of the increased pumping power, several techniques have been done in recent years and are discussed. Inserts like Conical tube a type of passive heat transfer augmentation techniques have shown significantly good results.

1.1 HEAT TRANSFER ENHANCEMENT

Heat transfer enhancement is the process of modifying a heat transfer surface or the cross section flow to either increase the heat transfer coefficient between fluid and surface to effectively maintain higher heat loads with a smaller temperature difference. I have treated some practical examples of heat transfer enhancement like fins, surface roughness, conical inserts and coiled tube, which are generally referred to as passive techniques. Heat transfer enhancement may also be achieved by surface, fluid vibration, electrostatic fields. These methods are often referred to as active techniques because they required the application of external power. Active techniques have received attention in the research literature their some practical applications are very limited. In this section some specific example of passive techniques. Increases in heat transfer due to surface treatment increased turbulence, increased surface area, and improved mixing or flow swirl. These effects generally result in increase in pressure drop along with the more increase in heat transfer. However, with performance evaluation and optimization, significant heat transfer improvement relative to a untreated heat transfer surface of the same nominal heat transfer area is achieved for a variety of applications. The increasing in attractiveness of different heat transfer enhancement techniques are benefits of industrial importance because due to heat exchanger offer the opportunity.

1) To reduce the heat transfer surface area required for a given application.
2) Reduces the heat exchanger size and cost.
3) Increase the heat rate of the exchanger.
4) Permit closer approach temperature.

All of these can be concern from the expression for heat rate for a heat exchanger. Q=UA LMTD any enhancement technique which increases the heat transfer coefficient also increases conductance U. One can reduce the heat transfer area A, increase the heat rate or decrease the temperature difference. LMTD, for fixed Q and LMTD, Fixed A and LMTD, or fixed Q and A. Enhancement can also be used to prevent the overheating of heat transfer surface with a fixed heat generation rate. In practical application a complete synthesis is required to determine the economic benefits. Such synthesis must include to possible increased cost because of the enhancement, increased heat exchanger heat transfer performance, the effect on operating costs.

Another in some few industrial applications there is possibility of increased fouling of the heat exchanger surface caused by the enhancement. Accelerating fouling can decrease in the heat transfer coefficient. Sustainable energy utilization and the need for conservation the benefits of using enhancement techniques in most heat exchanger system cannot be over studied.

2. LITERATURE REVIEW

Ya-Ling Heetal. [1]: This paper investigated the heat transfer enhancement and pressure loss penalty for fin-and-tube heat exchangers with rectangular winglet pairs (RWPs) were numerically investigated in a relatively low Reynolds number flow. The purpose of this study was to explore the fundamental mechanism between the local flow structure and the heat transfer augmentation.

S Naga sarada, A.V Sita Rama Raju [2]: This paper shows the result obtained from experimental investigations of augmentation of turbulent flow heat transfer in a horizontal tube by means of varying width conical ring inserts with air as a working fluid.

S. Liu , M. Sakr [3]: This paper shows that conical ring inserts platform better in laminar flow than turbulent flow. In this paper other several passive techniques of enhancement of heat transfer such as ribs, conical nozzle & conical rings.

Subhankar Saha, Sujoy Kumar Saha. [4]: This paper presented experimental friction factor & nusselt number data for laminar flow viscous oil through a circular duct having integral helical rib roughness fitted with helical screw tape inserts.

V. Vivek , L. viveknath& N. Vinayagam [5]: In this hydraulic experimental facility is provided for measurement of pressure drop & heat transfer coefficient in water flowing through a cylindrical annulus with single & double start helical tapes.

M.M. K Bhutiya , A.S. M Sayenetc [6] : This paper based on an experimental study on to investigate the air flow friction & heat transfer characteristics in a circular tube fitted with double counter conical ring inserts of different twist ratio for turbulent regime. The use of double counter conical ring inserts provided significant augmentation of heat transfer by causing a high pressure drop increase.

3. CLASSIFICATION OF AUGMENTATION TECHNIQUES

It is broadly classified into three different categories.
1. Passive Techniques
2. Active Techniques
3. Compound Techniques.

3.1. Passive Techniques

These techniques do not require any direct input of external power; rather than use it from the system itself which leads to an increase in the fluid pressure drop. They use surface or geometrical modifications to the flow channel by inserts or additional devices. Heat transfer augmentation techniques can be achieved by using;

1. Treated Surfaces
2. Rough surfaces
3. Extended surfaces
4. Displaced enhancement devices
5. Swirl flow devices
6. Coiled tubes
7. Surface tension devices
8. Additives for liquids
9. Additives for gases

3.2. Active Techniques

In this technique, an external power is used to facilitate the desired flow modification and improvement in the heat transfer rate. The augmentation of heat transfer by this method can be achieved by following:

1. Suctions
2. Surface vibrations
3. Fluid vibrations
4. Electrostatic fields
5. Injections
6. Mechanical Aids

3.3. Compound Techniques

When any two or more of these techniques are used simultaneously to obtain enhancement in heat transfer that is greater. It is termed as compound enhancement. This technique involves complex design and limited applications.

4. PROPOSED EXPERIMENTAL SETUP

4.1. Introduction

Convective heat transfer through pipe is studied by inserting surfaces roughness parameter such as conical rings, internal fins etc. It is seen from literature review that conical ring is of prime importance which affects the heat transfer through wall of pipe for carrying out the experimental work on the conical rings and proposed experimental setup used is as shown in below.

4.2. Tube in Tube Heat Exchanger

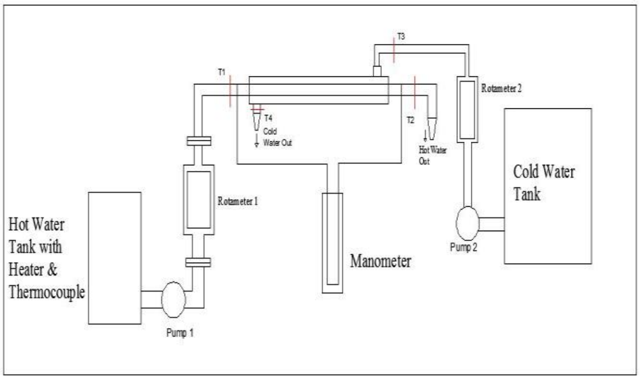
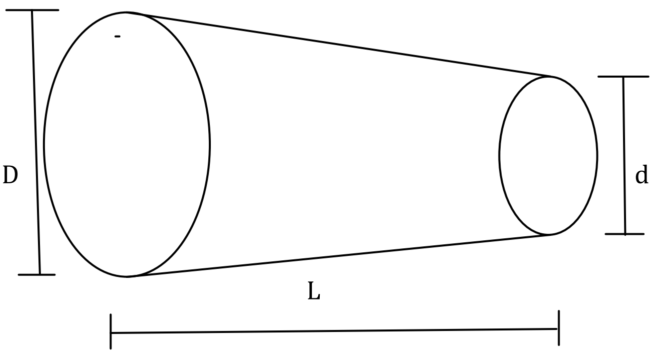


Fig 4.2 Proposed Experimental setup

4.3. Working

When the pump 1 starts, it will suck the hot water from the tank. Then it will flows through pipe. The rotameter-1 is connected in pipe measuring the flow of hot water. This water passes through inlet of heat exchanger having temp (T1) & exit at outlet temp (T2). Manometer measure the pressure drop across the inlet & outlet of heat exchanger. Similarly, at that same time Pump 2 also starts. The cold water flows from rotameter2 through pipe and cold water enters into the heat exchanger. It will help to increase the heat transfer capacity of heat exchanger.

4.4. Details of conical inserts



Nomenclature

D= Major diameter (outer)
d= Minor diameter (inner)
L= Length of conical inserts

4.5. Displaced Enhancement Devices

Several types of inserts which are classified as displaced enhancement devices including static mixer elements, metallic mesh, wire matrix inserts, rings or round balls. Rings and round balls have efficient heat transfer improvements, but the friction factors are high. Most of the devices are effective only in laminar flows. Spiral brush inserts in short channels with turbulent flows have high heat transfer coefficient can be improved as much as 8.5 times of smooth tube.

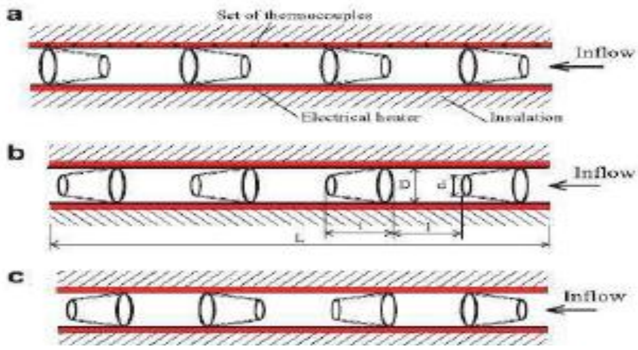


Fig 4.5 Conical Ring inserts in circular tube

a:- Diverging Ring
b:- Converging Ring,
c:- Converging and Diverging Rings

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