Review on a Heat Transfer from Annular Fins of Circular and Elliptical Cross Section

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Abstract— Heat transfer enhancement is now a major focus of researcher in heat transfer field. Use of annular fins is the field which has good potential to increase the heat transfer rate. In past few decades research on heat transfer enhancement using fins is continuously increasing, fine with many shapes, size and grooves are analyzed for heat transfer enhancement. Out of which annular fins with circular and elliptical cross section can be prove efficient method. The aim of this paper is to provide a review on heat transfer enhancement with application of annular fins with circular and elliptical cross section.

Key words: Heat transfer enhancement, Fins, Heat transfer characteristics, Annular fins

I. INTRODUCTION

Heat Exchangers are the essential components in many industries. Almost all industries are using various types of heat exchangers for different applications. Heat exchanging equipments are the essential part of process industries. It has been observed that to increase efficiency of these heat exchangers, many researchers are working in the field of active and passive techniques of heat transfer enhancement. In passive techniques fins, extended surfaces of various shapes and size are provided on the heat exchanging surface. In active techniques a external device is provided which enhance movement of fluid which subsequently increases the heat transfer. But in active techniques these externally provided devices requires external supply of energy. It is seen that major part energy consumption in process industry is done by forced convection equipments in heat exchangers. Hence to increase efficiency of heat exchangers active technique will not be suitable as it requires external energy for excitation.

In the other hand passive techniques does not require any external power source, i.e. these techniques increases heat transfer but does not consume more energy which subsequently results in a increase in efficiency and effectiveness of that heat exchanging device. Most commonly used passive technique is application of Fin. Fins are the extended surfaces on the heat transfer surfaces. Fins are installed on a heat exchanging surface which increases contact area of that surface with heat exchanging medium i.e. fluid.

In last few years researchers in the field of heat transfer are concentrating on the study of heat transfer through fins with different shapes and sizes.

II. ANNULAR FINS OF CIRCULAR AND ELLIPTICAL CROSS SECTION

In general, the enhancement of heat transfer from stream carrying tubes to the surrounding low temperature medium is attainable by attaching arrays of annular fins to external surface of the tubes. It is observed that many engineering problems there is a requirement of high performance heat exchanger with less size, compactable shape in less cost.

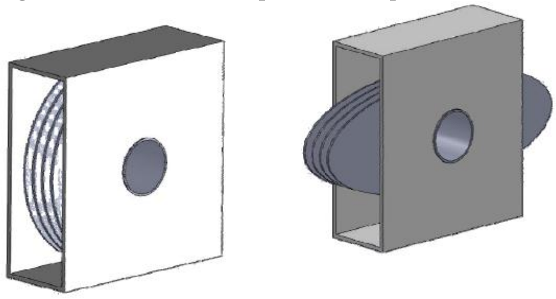

Fig. 1: Circular and Elliptical Fins

Extended surfaces (fins) are one of the heat exchanging devices that are employed in many engineering applications to increase heat transfer rates. The rate of heat transfer depends on the distance between two fins and the area of the fin. Radial or annular fins are one of the most popular types of fins for enhancing the heat transfer rate from the primary surface of cylindrical shape. In this paper review of the heat transfer rate and efficiency for circular and elliptical annular fins is made. From most of literatures it can be concluded that Elliptical fin efficiency is more than circular fin. If space restriction is there along one particular direction while the perpendicular direction is relatively unrestricted elliptical fins could be a good choice. Alternatively, given a fin profile, dimensions are obtained that satisfy the optimization conditions. The resulting fin profile achieved through the first criterion of the above two optimization techniques is always difficult to manufacture. Moreover, the fins with optimum profile are long and narrow; they need larger space and are weak near the tip.

III. LITERATURE REVIEW

Research work on the annular fins as well as different types of fine is reviewed and following observations are made:

Esmail et.al. [1] Investigated the performance of annular fins of different profiles subject to locally variable heat transfer coefficient. The performance of the fin expressed in terms of fin efficiency in the form of curves known as the fin-efficiency curves for different types of fins. These curves have been obtained based on constant convection heat transfer coefficient.

Chine et.al. [2] stated the two dimensional analyses for the efficiency of an elliptic fin under dry, partially wet and fully wet conditions of different range value for axis ratio, biot-number and air humidify.

Kundu et.al. [3] Reported that the performance of elliptic disc fin has been analyzed using a semi analytical technique .It has been shown that the efficiency of such fin can also be predicted very closely using sector method. Optimum elliptical fin dissipate heat at higher rate compared to annular fin when space restriction exists on both sides of the fin. Even when the restriction is on one side only, the performance of elliptical fin is comparable to that of eccentric annular fin for a wide parametric range.

Misandar et.al. [4] Reported that the effect of fin spacing on four rows annular finned tube bundles in staggered and inline arrangements are investigated by 3D numerical study. To investigate the velocity and temperature distribution between fins. The flow behavior of the developing boundary layer, the horse shoe vortex system, and thermal boundary layer developments in the annular finned tube banks will be visualized.

Kundu et.al. [5] in their paper compiled that obtaining two simple correlation equations which express the optimum heat transfer rate and optimum radii ratio of the fin as a function of the fin volume and Biot Number with uniform thickness.

Han-Taw et.al. [6] reported that the finite difference method in conjunction with the least-squares scheme and experimental measured temperatures is applied to predict the average heat transfer coefficient and fin efficiency on a vertical annular circular fin of finned-tube heat exchangers for various fin spacing inforced convection.

Prasanta et.al. [7] stated that reduce of fouling on the external surface of tubes is reason for selecting noncircular geometry .It is established by numerical modeling that elliptic tubes will have a reduced rate of fouling due to its lower frontal area and small wake region. Dutta proposed different non circular geometries of heat exchanger tubes where the force of gravity can be exploited to reduce the thickness of the condensate film. Due to higher thermal resistance in gas flow a specified heat transfer coefficient and given ambient temperature could be the appropriate condition for the other boundary.

Antonio et.al. [8] demonstrated that approximate analytic temperature profile and heat transfer rate are easily obtainable without restoring the exact analytic temperature distribution and heat transfer rate embodying modified Bessel function. He explained the salient feature in the quasi one-dimensional differential equation for annular fins of uniform thickness. It is demonstrated that approximate analytic temperature profiles and heat transfer rates of good quality are easily obtainable without resorting to the exact analytic temperature distribution and heat transfer rate embodying modified Bessel functions. For enhanced visualization, the computed temperature profiles, tip temperatures and fin efficiencies of approximate nature are graphed and tabulated for realistic combinations of the normalized radii ratio and the thermo-geometric fin parameter of interest in thermal engineering applications.

Ahmet et.al.[9] in their paper stated that the variable thickness annular fin mounted on a hot rotating rigid shaft is considered. Thickness of fin varies radially in a continuous variable non-liner elliptic form. The heat transfer and deformations in the fins subjected to both centrifugal force and radial temperature gradients.

IV. Conclusions

Many previous researchers investigated natural convection heat transfer from the extended surfaces.

- Few Researchers have discussed the optimization of rectangular profile circular fins with variable thermal conductivity and convective heat transfer coefficients.
- The nonlinear conducting, convecting and radiating heat transfer equation is solved by the differential transformation method.
- It is shown that considering the thermal conductivity and heat transfer coefficient are both constant for a given fin volume the optimum fin length is almost independent of the fin base temperature for pure convection. However for both convection- radiation and pure radiation.
- The length of the optimum fins for higher temperatures is shorter than the length of the fins with lower temperatures.

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