
ABSTRACT

Heat transfer enhancement is a major concern of the researchers as it has wide area of application in many fields. Heat transfer of the processes can be increased by increasing fluid movement or increasing surface area of the heat transfer surface. Fluid movement can be increased by using pulsations, electrohydrodynamics, inserts, magnetohydrodynamics etc. While heat transfer area can be increased by using extended surfaces of different shapes, dimples etc. The comparison in between performance of circular annular fins and elliptical annular fins shows that elliptical cross sectional annular fins transfer more heat and has high heat transfer coefficient in each case. It is observed that the maximum increase in heat transfer coefficient in elliptical fin is 60% than heat transfer coefficient of the circular fins. The average of increase in heat transfer coefficient of elliptical fins in all the cases studied in this work is 19.92%.

KEYWORDS: Heat Transfer Enhancement, Extended surfaces, Annular Fins.

INTRODUCTION

The heat exchangers with the finned system used in automobiles and electronic kits are designed according to the availability of space in the device containing them, with progressively less weight, compact size and cost. When the space is restricted in one direction and there is enough space in perpendicular direction the elliptical fin with circular tube heat exchanger, in such cases annular fins can be used.

In many commercial and industrial processes heat transfer has vital importance. As many industries like are using heat transfer processes in different forms, study of heat transfer is very much essential. The heat transfer is used in many applications hence improvement in heat transfer will have great effect on efficiency of systems using heat transfer.

Nowdays many researchers are working on the heat transfer enhancement processes as it is main requirement of industry. Heat transfer enhancement is the process to increase the amount of heat transfer done by equipment by using fins, flow pulsation, using inserts, using nanofluids etc. The objectives of heat transfer enhancement are higher thermal performance, reduced size of heat transfer equipment, increased heat transfer rate at same area (size) etc. For last a century, efforts have been made to produce more efficient heat exchanging devices by employing different methods of heat transfer enhancement. Research on this study of enhanced heat transfer has gained serious attention of different researchers during recent years, however, due to increased demands by industry for heat exchange equipment that have low cost of production and low cost of operation than conventional heat exchange devices. Savings in materials and energy required also provide strong motivation for the development of improved methods of enhancement. While designing cooling systems for automobiles and spacecraft, it is imperative that the heat exchangers are especially compact and lightweight. And enhancement devices are necessary for the high heat duty exchangers found in power plants (i. e. air-cooled condensers, nuclear fuel rods).

Use of annular fins is one of the passive method in which extended surfaces in the form of annular fins are used in order to enhance heat transfer. Using annular fins in shape of ellipse and circle gives positive results for heat transfer enhancement.

ANNULAR FINS:

Annular fins are installed generally around the pipes. Annular fins are generally classified as circular, elliptical and diamond shaped annular fins. Annular fins are used extensively in heat exchange devices to increase the heat transfer rate from a heat source for a given temperature difference or to decrease the temperature difference between the heat source and the heat sink for a given heat flow rate. Interest in the use of fins is found in many fields of thermal engineering, such as air conditioning, heat-exchangers and microelectronics where, using extended surfaces, thermal analysts have succeeded in designing more compact and efficient heat transfer systems.

In thermal engineering, an annular fin is a specific type of fin used in heat transfer that varies, radially, in cross-sectional area. Adding an annular fin to an object increases the amount of surface area in contact with the surrounding fluid, which increases the convective heat transfer between the object and surrounding fluid. Because surface area increases as length from the object increases, an annular fin transfers more heat than a similar pin fin at any given length. Annular fins are often used to increase the heat exchange in liquid-gas heat exchanger systems. Fig.1 shows the experimental setup used in this study. This figure shows the different components of the experimental setup like, control panel, manometer, orifice, blower, dimmerstat, heater test section etc. This is setup is used to analyze the heat transferred from the different profiles of fins.



Fig. 1 Experimental Setup

In this, a electric motor driven blower is used to circulate the air over the fins, it is suction type of blower which suck the air in duct where fins are installed. This air will remove heat from the fins and that heat will be carried out with air. An orifice is installed in path of air to measure discharge of the air using manometer difference. An induction heater is installed to provide heat to the fins whose input will be controlled by dimmerstat installed on control panel. All indicators for voltage, current, temperature and manometer heads are installed on the control panel.

The experimental study is carried out and readings of manometer head and different temperatures are recorded in this study.

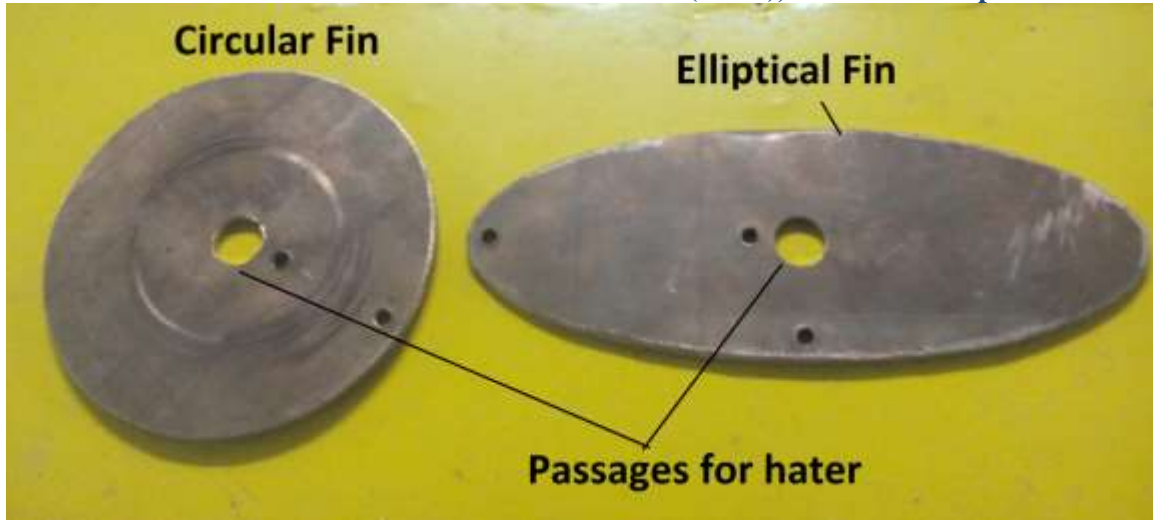
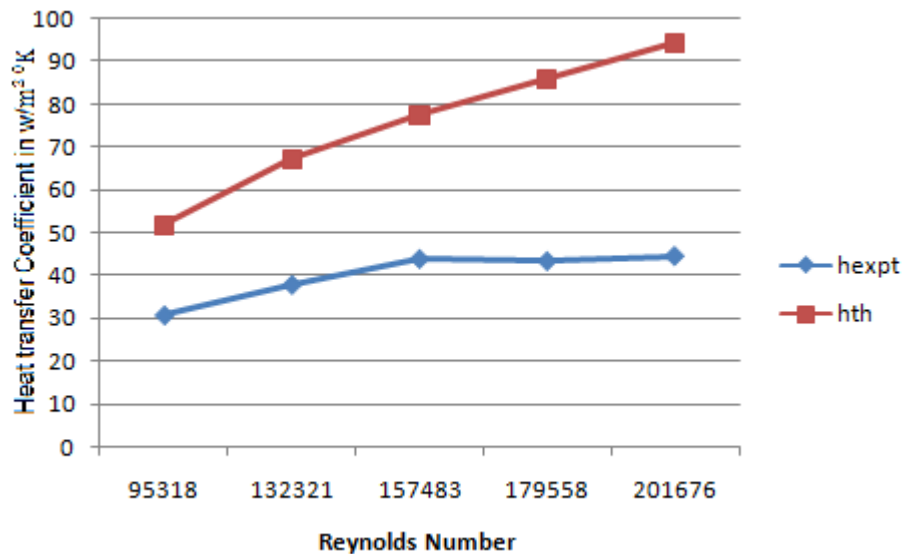


Fig. 2 Circular and Elliptical Fins

Fig. 2 shows the profiles of annular fins used in this study. Fig. shows the circular profiled and elliptical profiled annular fins of copper metal installed into air duct. The squared hole at the centre of the fin is provided for installed induction heater. The stack of 4 fins of same dimensions is attached on the heater and installed inside an air duct for testing.

RESULTS AND DISCUSSION

Heat Transfer coefficient Vs Reynolds Number:

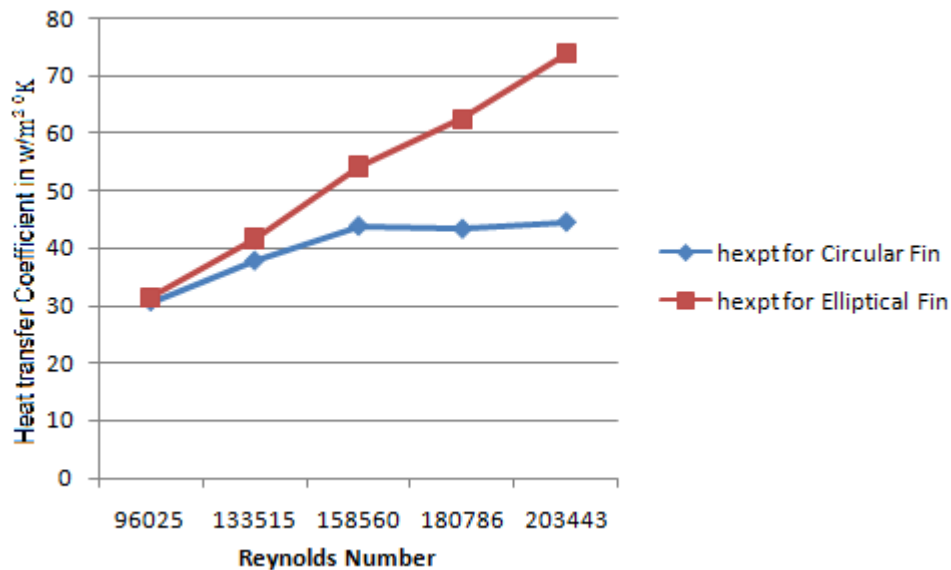


Graph No 1. Heat Transfer coefficient Vs Reynolds Number

From graph 1, it can be observed that heat transfer coefficient of the system increases with increase in Reynolds number. It can be observed from the graph that when Reynolds number is increases from 95318 to 201676, the experimental heat transfer coefficient in increases by 45.18% from 30.65 w/m² °K to 44.5 w/m² °K. And theoretical values increases by 82% from 51.82 w/m² °K to 94.37 w/m² °K. Increase in Reynolds number shows that the velocity of air steam is increased which result into the more amount of heat transferred this more amount of heat transfer is a result of increased heat transfer coefficient. This graph also gives comparison in between the values of

heat transfer coefficient by theoretical study and experimental study. The theoretical values are the maximum values of heat transfer coefficient and experimental values are actual values of heat transfer coefficient obtained by experimental study in which heat is lost by environmental losses. From this graph it is seen that theoretical values are 40 to 52% higher than experimental values.

For $V=60$, $I=0.17$



Graph No.2 Heat Transfer coefficient Vs Reynolds Number

Graph 2 shows the effect of elliptical and circular profile of annular fins on heat transfer coefficient of fins with respect to increasing Reynolds number. It can be clearly observed from this graph that the heat transfer coefficient of the elliptical shaped annular fins is higher than the heat transfer coefficient of circular fins. As elliptical fin and circular fins has same area the heat transfer enhancement observed in elliptical fins is due to the fact that in elliptical fins more length of annular fins is exposed to the air stream which will enhance the heat transfer from the fin. Circular fin has same area but perpendicular length covered by the fin against air stream is less which reduces total heat transfer from the fin. The elliptical fins also have the advantage that its surface area can be increased in one direction when space is restricted in perpendicular direction which is not possible in circular fin.

From the graph it can be observed that the at 96025 Reynolds number the heat transfer coefficient of the elliptical fin is $31.38 \text{ w/m}^2\text{°K}$ which is 2.5 % higher than the heat transfer coefficient of circular fin which is $30.64 \text{ w/m}^2\text{°K}$. When Reynolds number increases to 203443 heat transfer coefficient of circular fin will be $44.49 \text{ w/m}^2\text{°K}$ which is lesser than elliptical fin $73.82 \text{ w/m}^2\text{°K}$.

CONCLUSION

This study of heat transfer from annular fins of circular and elliptical cross section has been done in this work. In this dissertation work the heat transfer enhancement with annular fins of circular and elliptical cross section has been experimentally investigated and results of these investigations are compared with each other. The conclusions drawn from this experimental investigation are listed below;

- From this study it can be concluded that with increase in Reynolds number heat transfer coefficient of fins also increases. At a same input of the heat transfer coefficient of fins found to be increased when discharge of the air is increased. It is observed that in circular shaped annular fins maximum increase observed in heat transfer coefficient with increase in Reynolds number in 45% and in elliptical shaped annular fins it is 135%.

- It is also observed that with increases in Reynolds number Nusselt number of the process also gets increased. The maximum Nusselt number in circular fins is 352 and in elliptical fin it is 386.
- As the objective of this study is to analyze effect of geometry (cross section) of the annular fins on the heat transfer. The experimental investigations conducted on annular fins of circular and elliptical cross section and results are compared to each other. It shows that elliptical cross sectional annular fins transfer more heat and has high heat transfer coefficient in each case. It is observed that the maximum increase in heat transfer coefficient in elliptical fin is 60% than heat transfer coefficient of the circular fins.

The average of increase in heat transfer coefficient of elliptical fins in all the cases studied in this work is 19.92%. So, it can be concluded that the shape of geometry of the annular fin does affect the heat transfer characteristics of fins. And it can be also concluded that the elliptical shape of the fin is more effective to transfer heat than circular shaped annular fins.

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