Analysis of Heat Transfer through Circular Pipe using Internal Threads of varying Pitch

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Abstract- *Heat dissipation from many cutting edge applications have raised very quickly due rapid advancement in almost all technological sectors such as microelectronics, aviation, military application, fission and fussion reactors etc. To ensure effective and efficient performance of aforesaid technologies it is important dissipate high generated. In present paper, effect of the internal threads of different pitch (4 mm and 6 mm) fabricated inside circular aluminum tube. Thermal and hydraulic performance of modified surface has been tested under various operating condition (heat flux 20W to 100W, mass flux 0.005Kg/s to 0.008Kg/s). From the experimentation it is observed that threaded surface shows better heat transfer performance (Nusselt number, Reynolds number) as compared to plain tube that can be attributed to the formation of turbulent due to presence of threaded surface. Further, it is observed that tube with 4 mm pitch shows good heat transfer characteristics due increase in Reynolds number.*

Keywords- Heat transfer rate, Internal threads, Heat transfer coefficient, Forced convection, Turbulent Flow

I. INTRODUCTION

Extensive research effort has been focused on reducing the consumption of nonrenewable energy. . Enhancing the proficiency of the widespread procedure of warmth is one such zone which to pulls in part of suggestion. Improving the productivity of warmth move is helpful in assortment of commonsense applications, for example, large scale and small scale heat exchangers, gas turbine interior aerofoil cooling, fuel components of atomic power plants, capable semiconductor gadgets, electronic cooling, ignition chambers liners, biomedical gadgets and so forth conservative warmth exchangers and gas turbine aerofoil cooling are two applications which have been the subject of concentrate for various analysts over the ongoing years.

Air-side protection from warm move in warm exchangers involves between 70-80% of the aggregate obstruction and consequently any change in the productivity of a minimum warmth exchangers is centered around enlarging the air side convective warmth exchange.

1.1 Heat Transfer Augmentation Techniques

Heat transfer augmentation is of special interest in channel flow where the rate of heat transfer between fluid & channel wall deteriorates as boundary layers grows on channel walls & flow tends to become fully developed augmentation techniques can be classified as active & passive methods.

1.1.1 Passive Techniques:

In these cases, external power is used to facilitate the desired flow modification and the improvement in the rate of heat transfer. Augmentation of heat transfer by this method can be achieved by

(i) Mechanical Aids: Such instruments blend the liquid by mechanical means or by pivoting the surface. These incorporate pivoting tube warm exchangers and rejected surface warmth and mass exchangers.

(ii) Surface vibration: They have been connected in single stage streams to acquire higher warmth exchange coefficient.

(iii) Fluid vibration: These are basically utilized as a part of single stage streams and are thought to be maybe the most functional kind of vibration improvement procedure.

(iv)Electrostatic fields: It can be as electric or attractive fields or a mix of the two from dc or air conditioning sources, which can be connected in warm trade frameworks including dielectric liquids. Contingent upon the application, it can likewise deliver more noteworthy mass blending and actuate constrained convection or electromagnetic pumping to upgrade warm exchange.

(v) Injection: Such a strategy is utilized as a part of single stage stream and relates to the technique for infusing the same or an alternate liquid into the primary mass liquid either through a permeable warmth exchange interface or upstream of the warmth exchange area.

(vi)Suction: It includes either vapor evacuation through a permeable warmed surface in nucleate or film bubbling, or liquid withdrawal through a permeable warmed surface in single-stage stream.

(vii) Jet impingement: It includes the heading of warming or cooling liquid oppositely or diagonally to the warmth exchange surface.

To produce the turbulent flow through the pipe for good heat transfer characteristics one of the method used is to use a pipe with internal threads. Shrirao[1] studied heat transfer and friction factor characteristics of horizontal circular pipe using internal threads of pitch 100mm, 120mm and 160mm with air as the working fluid. The transitional flow regime is selected for this study with the Reynolds number range 7,000 to 14,000.

1.1.2 Active Techniques:

(i) Treated Surfaces: Such surfaces have a fine scale modification to their complete or covering which might be nonstop or spasmodic. They are basically utilized for bubbling and gathering obligations.

(ii) Rough surfaces: These are the surface alterations that advance turbulence in the stream field in the divider district, principally in single stage streams, without increment in warm exchange surface zone.

(iii) Extended surfaces: They give compelling warmth exchange development. The more up to date advancements have prompted changed finned surfaces that likewise have a tendency to enhance the warmth exchange coefficients by aggravating the stream field notwithstanding expanding the surface territory.

(iv)Displaced upgrade gadgets: These are the supplements that are utilized basically in bound constrained convection, and they enhance vitality transport in a roundabout way at the warmth trade surface by dislodging the liquid from the warmed or cooled surface of the pipe with mass liquid from the center stream.

(v) Swirl stream gadgets: They deliver and superimpose whirl stream or optional distribution on the pivotal stream in a channel. These incorporate helical strip or cored screw compose tube embeds, turned tapes. They can be utilized for single stage and two-stage streams.

(vi)Coiled tubes: These prompt moderately more smaller warmth exchangers. It produces auxiliary streams and vortices which advance higher warmth move coefficients in single stage streams and in addition in many districts of bubbling.

Kundan More[2] concentrated the impact of warmth exchange, warm improvement factor and grating element in a smooth copper tube and distinctive test copper tube having inward strings of pitch 3.5 mm, with water as working liquid media. Asma Qureshi[3] considered the examination of warmth exchange and trial examination of warmth exchange upgrade through roundabout conduit of carbon steel utilizing inner strings of pitch 5 mm and 10 mm with air as working liquid. Shubham Dambiwal [4]contemplated on exploratory examination of warmth exchange and grinding factor normal for level round channel utilizing inward strings of pitch 10 mm, 12 mm and 16 mm with air as a working liquid.

II. EXPERIMENTAL SET UP

The apparatus consists of a blower unit fitted with a circular duct, which is connected to the test section located in horizontal orientation. Nichrome plate heater encloses the test section to a length of 50 cm. Three thermocouples T2, T3,T4 and T5 are placed on the walls of the tube and two thermocouples are placed in the air stream, one at the entrance (T1) and the other at the exit (T6) of the test section to measure the temperature of flowing air as shown in Fig. 1.

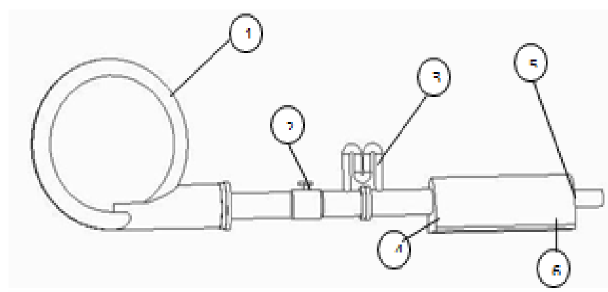

Fig. 1 Experimental setup

The duct system consists of a valve, which controls the air flow rate through it and an orifice meter to find the volume flow rate of air through the system. The diameter of the orifice is 14 mm and coefficient of discharge is 0.64. The two weight recordings of the hole meter are associated with a water U-tube manometer to demonstrate the weight contrast between them. Contribution to warmer is given through dimmer detail. The test container of 50 mm length is utilized for experimentation. Show unit comprises of voltmeter, ammeter and temperature marker.

III. DATA REDUCTION

The data reduction of the measured results is summarized in the following procedures:

The duct surface and in/out temperature:-

$T_S = (T2 + T3 + T4+T5)/4$ (Equation I)

T_b = (T1 + T6)/2 (Equation II)

Discharge of air:-

Q = Cd $*A_1 *A_2\sqrt{2gh_{air}})/\sqrt{(A_{12} - A_{22})}$ (Equation III)

Equivalent height of air column:-

$h_{air} = (\dot{\rho}_w *h_w) /\dot{\rho}_w$ - (Equation IV)

Velocity of air flow:-

V = (Q/A) - (Equation V)

Where A =convective heat transfer area (π*D*L)

Re = ($\dot{\rho}$ * V * D) /μ - (Equation VI)

Where D = inner diameter of duct and L= Length of duct

Experimental Nusselt number:-

Nu = h* (D/ K) (Equation XI)

Nusselt numbers calculated from the experimental data for plain tube were compared with the correlation recommended by Dittus-Boelter.

Theoretical Nusselt number:-

$Nu=0.023\ Re^{0.8}\ Pr^{0.4}$ (Equation XII)

IV. RESULT AND DISCUSSION

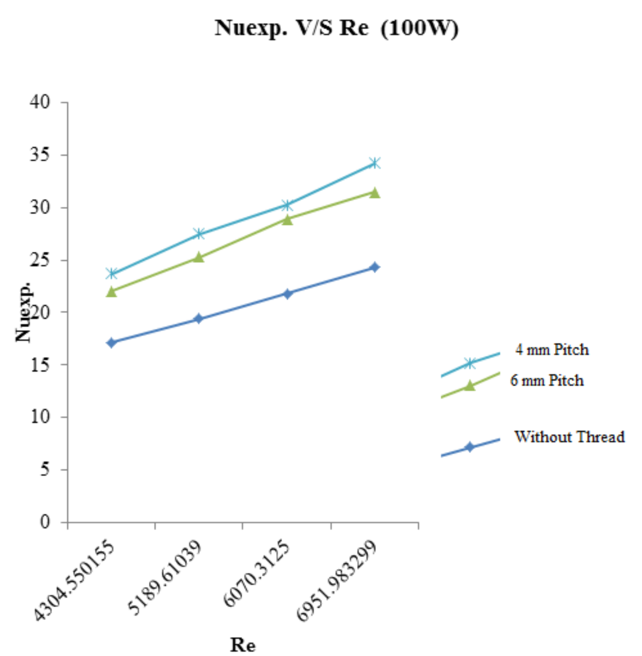

Fig.2 Nusselt Number Vs Reynolds Number

From Fig.2 it is observed that there is increase in Nusselt number as increase in Reynolds number .As Reynolds number increases the air flow will cause more turbulence due to which heat transfer rate will increase in heat transfer coefficient (h) and Nu=hDh/k i.e increase in heat transfer coefficient increases the Nusselt number.

V. CONCLUSIONS

Laminar flow shows less heat transfer through performance characteristics than that of through turbulent flow. To produce this turbulent flow various techniques and design strategies are used. Experimental investigations have been carried out to study the effects of the internal threads of different pitches (p= 4 mm & 6 mm) on the performance Circular duct of Aluminium. Heat transfer coefficient and friction factor are analysed with using passive heat transfer enhancement methods. From the graph plotted above following conclusions are made.

1) The heat transfer rate increases in duct with the internal threads as compared to without internal threads. The result shows that the heat transfer rate increases as the Reynolds number increases.

2) The performance of horizontal duct can be improved by the use of internal threads. The cost involved for making internal threads is minimal compared to energy efficiency improvement provided by this technique.

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