A REVIEW ON AUGMENTATION OF HEAT TRANSFER FROM HEXAGONAL PERFORATED FINS IN STAGGERED ARRANGEMENT

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Abstract- This paper provides information on augmentation of heat transfer over a surface equipped with Hexagonal drilled pin fins in alternate arrangement in a rectangular path. Fin dimensions are 100 mm in height and 25 mm of each edge. Channel had cross-section area about 250-100mm². The experiment covered the following range: Reynolds no. 13,500-42,000, (C/H) clearance ratio is about 0, 0.33 and 1, (Sy/D) the inter-fin spacing ratio is about 1.208, 1.524, 1.944 and 3.417. Sy that is stream wise distance varies and Sx that is span wise distant is constant. Friction factor and Nusselt no. are Key parameter which relates with efficiency improvement and heat transfer rate. The friction factor, enhancement efficiency and heat transfer correlated in equation with each other. Alternate arrangement and holes enhance the heat transfer rate. Clearance ratio and inter-fin gap ratio and comparatively lower Reynolds no. give higher thermal attainment.

Keywords- heat transfer enhancement; drilled pin fins; performance analysis; Alternate arrangement.

INTRODUCTION

There are many conditions where heat is transferred between a fluid and a surface. In such conditions the heat flow depends on three factors namely 1) area of the surface 2) temperature difference 3) the convective heat transfer coefficient. The base surface area is limited by the design of the system. The temperature difference depends upon the process and connate be changed. The only choice appears to be convection heat transfer coefficient and this also cannot be increased beyond some limit any such increment will be at the expenses of power of fans and pumps. Thus the possible option is to increase base area by the so called extended surfaces or fins. The fins extended surfaces or fins and provided additional convection area for heat conduction into the fin at the base. Fins are thus used whenever the available surfaces area is found insufficient to dissipate amount of heat with that temperature void and coefficient. In the case of fins the direction of heat transfer by convection is perpendicular to the direction of conduction flow. Various types of heat exchanger fins, ranging from relatively simple shapes, such as rectangular, square, cylindrical, annular, tapered or pin fins to a combination of different geometries, have been used. These fins may protrude from either a rectangular or cylindrical base. One of the commonly used heat exchanger fin is the pin fin. A pin fin is a cylindrical, square or other shape element.
attach to perpendicular to a wall with the transfer fluid passing is cross flow over the element. Pin fins having a height to diameter ratio, H/D, Between0.5 and 4 are accepted as short fins, whereas long pin fins have a pin height-to- diameter ratio, H/D more than 4. Thus the various important parameters in the analysis of fins are,1) heat transfer coefficient 2) length of the fin 3) cross-sectional area of the fin 4) thermal conductivity of fin 5) efficiency and effectiveness of the fin. The use of extended surface is of practical importance for numerous applications such as cooling the air cooled engine cylinder head, Economizer for steam power plants, Radiators of automobiles, small capacity compressors, transformers, electronic equipment.

In this experiment analysis we are using the same parameter and setup as that of the work done on the cylindrical pin fins but here the aim only aim is to prove that the hexagonal cross section pin fins are having influencing effectiveness and efficiency on the cylindrical pin fins

HEXAGONAL FIN

G.J. Vanfossen and B.A Brigham

This paper describes us about Analysis of heat transfer by short pin-fins in staggered arrangements. According to results, more heat transferred in longer fin having (H/D=4) but shorter pin-fins having (H/D=1/2 and 2) less heat transfer as compare to the above ratio and slightly exceeds that with only four rows when array-averaged heat transfer with eight rows of pin-fins. The another point in as result is the average heat transfer coefficient on the pin surface is around 35% more than that on the end walls is established.

Anmol B. Dhumne and Hemant Farkade

This paper describe heat transfer analysis on cylindrical perforated fin in staggered arrangement, in this type of arrangement and shape have analysis heat transfer on cylindrical fin more heat transfer rate. In which the Reynolds no. taken as fixed range but it have to changing in shape of fin and give staggered arrangement it has same as the reference paper (1) change is only shape. In this paper they have analysis on both staggered and in line arrangement of fin the after the result obtain the cylindrical and also this solid and perforated pin fins. In staggered arrangement better heat exchange takes place as compare to cylindrical. The result obtained of compared to in line staggered arrangement and perforated with solid fins and also given to lower Reynolds no. are suggested for higher thermal performance. Progress efficiencies gradient related to the inter fin spacing ratio and clearance ratio.

Plans of Experimental

The all above references are used in this experiment and we arrange the hexagonal fins. In this experiment we have taken the hexagonal shape structure. Hexagonal with perforation as well as staggered arrangement is done. The improvement in the flow is brought about by the multi jet like flows through the perforations(7) and the staggered arrangement creates more turbulence due to all that molecule present in which collides with the fin gives the heat energy to the air molecule by force
convection. In this experiment same parameters are taken into consideration as in reference paper (4)(1) 

Like Reynolds no. 13500-42000. As the Reynolds no. increases the Nussult no. is also increases the base plate having hexagonal fins in staggered fashion are shown above in which base plate having square shape. The arrangement as per the inter fin distance is shown in above dig. Which is having the inter fin spacing i.e Sy/D = 1.208 and for this spacing the no. of fins on the base plate having each edge of length is 25mm is 25 in number.

PERFORMANCE

Input parameters

Area: it consist of square plate at the base having the dimension 250mm x 250mm, thickness is 6mm and fin is perpendicular set on the base plate of cylindrical square compound shape fin. Number of on base plate is 25,21,18 and 11 with its different in Sy/D ratio and different in lengths, corresponding to C/H (clearance ratio) values of 0, 0.333 and they have to give different in height i.e 100,75,50 (1)

Base plate temperature: The constant temp. about100 0C of base plate is maintain with the help of temperature
controller of RTD sensors. Switch on the heater, as soon as the base plate temperature reach to the temp. Reached to 100 OC, the temperature. Controller of RTD sensor comes in operation and it will cut off the power supply of heater.

Air velocity; The effect of air movement upon sensible heat loss from individual birds at ambient temperatures. The air velocity is about 2m/s to 5m/s.

Voltage, current and resistance: voltage, current, Resistance(R) input electrical system is

\[ Q_{elec} = I^2 \times R \] (4).

**Output parameters**

Temperature; the output and input temp. differences are affected the heat transfer coefficient.

Nussult no.: In heat transfer at a boundary within a fluid, Nussult no. is the ratio of convective to conductive heat transfer across the boundary. In this context, convection includes both advection and conduction. It’s a dimensionless no. (4)

Reynolds number: Reynolds no. can be defined for a no. of different situation where a fluid is in relative motion to a surface. These definitions generally include the fluid properties of density and viscosity, plus a velocity and characteristics length (10).

\[ Re = \frac{vL}{\nu} \]

**SET UP FACILITY**

The range of Reynolds no. used in this experiment 13500-42000, the average velocity (U) and hydraulic diameter of the stream over the examined portion (Dh) these two parameter are used to calculate the Reynolds no. the inlet and outlet temp. of the air stream will be measured RTD sensor which mounted on in wind tunnel. One RTD sensor for the outer surface temperature of the heating section and one of the ambient temperatures is employed the press. Drop across the test model is measured using two pressure transducers that can take measurements between 0 and 150 Kg/cm² which mounted in wind tunnel.

Tunnel made by wood having 20mm thickness, had an internal cross-section of area 250mm x 250mm and 100 mm the total height of tunnel the length channel is 1030mm. the air supplied into the tunnel over Fin with the of blower, which have adjustable speed i.e. 1, 2, 3, 4, 5, 6 m/s and range of rotation 0 to 16000 rpm and it is fitted at entry of tunnel i.e. at entrance point of tunnel grounded. It has both converging and diverging section at ends having the inclination of 300. A anemometer measured the average inlet velocity of the air flow moving to the examined section the anemometer is mounted at the inlet of the tunnel.

**EXPERIMENTAL PROCEDURE**

1. First of all attached all the measuring instruments on their specific position
2. Put the aluminum base plate on heater
3. Move the heater unit and base plate upward with the help of screw jack.
4. The base plate touches the RTD sensor and checks the position of two other sensors.
5. Then switch on the main supply, the heater gets ON, as the temperature raised up to 1000 C, the controller of RTD sensors is get activated and it will cut off the power supply.

6. Next step is to start the blower and by using digital anemometer measured the velocity of the inlet air and maintain inlet air velocity constant as per specified with the help of blower regulator.

7. Now through tunnel air will flow over a heated Fin plate.

8. Measure the outgoing warm air with the help of RTD outlet temperature sensor.

9. As soon as the temperature of base plate decreases, due to forced convection, so that heater gets start to achieve constant temperature of 1000 C.

10. Apply the same procedure for velocity 3m/s, 4m/s, and 6m/s and take down the readings.

DATA PROCESSING

Heat transfer

\[
Q_{\text{conv}} = Q_{\text{elect.}} - Q_{\text{cond.}} - Q_{\text{rad.}}
\]

Where \( Q_{\text{conv}} \), \( Q_{\text{elect.}} \), \( Q_{\text{cond.}} \), \( Q_{\text{rad.}} \) indicates the heat transfer rate by convection, electrical, conduction, and radiation.

The electrical heat input is calculates from the electrical potential and current supplied to the surface. [1][4]

\[
Q_{\text{elect.}} = I^2 \times R
\]

Total area= project area+ total surface area contribution from the block s [2][4]

\[
A_s = W \times L + Np \times HD + Np (\pi D_d - 0.5 \pi d^2)
\]

Where \( W \& L \) are the width and length of the base plate, \( H \) is the height of the fin, \( Np \) is the no. Of pin fins and \( d \) is the diameter the perforated hole. The heat transfer rate by convection can be expressed as [9][10]

\[
Q_{\text{conv.}} = hA_vT_s - (T_{\text{out}} + T_{\text{in}}/2)
\]

Reynold no.[10]

\[
Re = \frac{D_h U}{v}
\]

Nusselt no. smooth surface without fin:[4][1]

\[
N_u = 0.077 Re^{0.716} Pr^{1/3}
\]

Nusselt no. [1][4]

\[
N_{u_p2} = 45.99 Re^{0.395} (1 + C/H) - 0.600 (S_Y/D) - 0.522 Pr^{1/2}
\]

Enhancement efficiency

The effectiveness of the heat transfer for a constant pumping power, it is useful to determine enhancement of heat transfer. The enhancement efficiency is the ratio of heat transfer coefficient with fins to without fins[4][1]

\[
\eta = \frac{h_a}{h_s} = 51.09 Re^{-0.358} (1 + C/H) 0.1028 (S_Y/D) 0.0812
\]

Friction factor

The pressure drop calculated by experiment this pressure drop is finding out in duct with nanometer or measured under the heated flow conditions. The experimental pressure drop will be converted to the friction factor 'F' using the experimental results. Friction factor was correlated as a function of the duct reynolds no, Re, and geometrical parameter the press. Drops in the tunnel without fins is so small that they could not be measured by the Manometer.[4]
F=2.4Re-0.0836(1+C/H)-0.0836 (Sy/D)-0.0814

CONCLUSION

In this experiment, we studied the hexagonal shape of fin. The hexagonal area is more than that of the other due to that the effect of various parameters. Here we are using staggered arrangement therefore turbulence will be more and the perforation will give the jet like flows of air which will be much helpful for the enhancement of the heat transfer as a result the hexagonal fins cover more flue gases therefore more heat transfer by convection will take place. And the dimensional factor which improves enhancement efficiency by heat exchange rate increases and friction characteristic will indicates the enhancement efficiency and the correlation have been obtained.

The inter-fin clearance ratio and distance ratio is fall because of friction factor increment. The projected area is helpful for calculating average Nusselt number and decreases the no. of fins on the base plate increases.

REFERENCES

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