International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

A Review on Experimental Study of Heat Transfer from Plate Fin in Mixed Convection Mode

Pravin Kamble[1], S.N Doijode[2], Geeta Lathkar[3]

[1]PG Student S.T.B.C.O.E,Tuljapur, Maharashtra, India

[2]Professor, Mechanical Engineering Department, S.T.B.C.O.E,Tuljapur, Maharashtra, India

[3]MGM, College of Engineering, Nanded

Abstract: ***The work summarized in this paper presents an experimental study of heat transfer from plate fin in mixed convection mode enhancement by the use of pin fins is presented. After a brief review of the basic methods used to enhance the heat transfer by simultaneous increase of heat transfer surface area as well as the heat transfer coefficient, a simple experimental method to assess the heat transfer enhancement is presented. The method is demonstrated on plate fins as elements for the heat transfer enhancement, but it can in principle be applied also to other fin forms. That is varying various parameters (height, spacing). The order of the magnitude of heat transfer enhancement obtained experimentally, it was found that by a direct comparison of Nu and Re no conclusion regarding the relative performances could be made. This is because the dimensionless variables are introduced for the scaling of heat transfer and pressure drop results from laboratory to large scale but not for the performance comparison. Therefore a literature survey of the performance comparison methods used in the past was also performed. Experiments will carried out on mixed convection heat transfer from plate fin heat sinks subject to the influence of its geometry and heat flux. A total of 40 fins were bolted into the upper surface of the base plate. The area of the base plate is 120mm by 120mm. The base plate and the fins were made of aluminum. For all tested plate fin heat sinks, however, the heat transfer performance for heat sinks with plate fins was better than that of solid pins.***

Keywords*:* Mixed convection, plate fin, and heater

1. Introduction

Extended or finned surface are widely used in electronic cooling system by using theory of free & force convection [01] the plate fin is widely used in variety of industrial applications, particularly in the heating, air-conditioning and refrigeration, HVAC industries. There are different types of plate-fin geometry, the most common being the plain fin. These fins act as a sink, absorbing the heat out of the hot element with the help of conductive heat transfer. Heat transfer from a finned (plate) heat sink depends on many parameters; temperature difference between the heat sink and the fluid, shape and size of the fins, number of fins, and the type of flow and the fluid, thermal conductivity and spacing between the fins.

There are many methods in electronics cooling, such as jet impingement cooling heat pipe, Conventional electronics cooling normally used impinging jet with heat sink showing superiority in terms of unit price, weight and reliability. This is easily done using by plate fin.

The operating capability and consumption power of electronic components have been increasing owing to the rapid development of the semiconductor technology. To remove heat efficiently from the high density electronic components becomes a crucial issue. Various cooling techniques, e.g. phase-change cooling, thermoelectric cooling, liquid cooling and impinging jet cooling, have been established to solve the problem. But plate pin mounted on surface with certain height and spacing between them acts effectively increase rate of heat transfer.

2. Literature Review

Sandip S. kale & V.W. Bhatkar[2] were studied in his research paper that, 'when number of plate fin are arranged parallel and attached to hot element, in the form of tube or some other shape .The fin acts as heat porosity equipped on horizontal flat surface in horizontal rectangular duct. The data used in performance analyses were obtained experimentally by varying PPI, different material inputs and fluids. With the change in metal foam material having different thermal conductivity leads to predict heat transfer behavior in the rectangular channel for various industrial applications. These results when relates with the previous investigation of different sink which heat transfer rate and also various performance parameter such as fin pitch, fin length, fin thickness, longitudal pitch, transverse pitch &friction factor pressure drop.

ShrikantVasantraoBhunte[3] studied that to investigate the heat transfer enhancement in rectangular fin arrays defined parameters of the fin, then it yield that PPI is the optimized parameter. Experimental Investigation of Natural Convection from Heated Triangular Fin Array within a Rectangular Enclosure was cleared idea by Gaurav Kuma & Kamal Raj Sharma[4] . about Natural convection heat transfer from triangular fins within an air filled and vertically oriented rectangular enclosure has been studied experimentally. The system performance (Nu number and fin effectiveness) as the functions of fin height, fin spacing and Rayleigh number have been reported

Murtadha Ahmed and Abdul Jabbar[5] has proved that At the same heat input rate, the temperature difference between the base plate and Surrounding air was found to be less for hollow/perforated pin fin heat sink than that for solid pin one. The heat transfer coefficient for solid pin fin is greater than from perforated pin fin. Changzheng Sun &Hakan F. Oztop[6] has studied that in his paper .The fin reduces the fluid velocity nearby causing the weakened heat convection. Thus, the local Nu in this area is smaller than that without fin.Rama Subba Reddy Gorla A.Y. Bakier[7]carried out an experiment Thermal analysis of natural convection and radiation in porous fins & concluded that The ratio of heat transfer rate for porous fin to solid fin is compared for both the cases of with radiation and without radiation. It is found from this analysis that radiates and convicts transfers more heat than that dissipates heat by convection only.

3. System Development

A total of 40 fins are used in this experimental investigation. Ten fins are arranged on metallic blocks, blocks have to made ten equivalent slot is vertical. The fins are bolted into the upper surface of the base plate, the dimensions of the base plate is120mm × 120mm. Thermal paste was used to minimize the thermal contact resistance between the pin fins and the base plate; the pin fins were fixed at equal spacing, The base plate was made of the same material as the were made of aluminum because high thermal conductivity, low radiative emissivity and good contact between them will assure Like this other three set are made for experimental study , no. of set are four each set contain ten plate Fin with first having height H_1 & spacing between two plate pin (fin pitch) S_1 prepare next set for corresponding H& S

3.1 Procedure

1) Make different plate fin array by varying parameter (spacing, height & flow rate).
2) Place plate pin array in design ducts & heat base blocks by using 50W heater.
3) As per observation table taking the reading of all parameters.
4) We will calculate total heat

$Q_T = Q_{con} + Q_{conv} + Q_{rad}$

Also

We calculate the dimensional less parameter like Re ,Pr, Gr and convective heat transfer coefficient .

5) We will prove that mixed convection present in the system.

$\frac{Gr}{Re2} \cong 1$

6) Repeat experiment for various plate fin array.

3.2 Theory of mixed convection

Convection is a process involving the mass movement of fluids. When temperature difference produces a density difference which result in mass movement, the process is called free or natural convection .when the mass motion of the fluids is caused by external device like a pump, compressor, blower or fan, process is called forced convection. By Newton law of cooling heat transfer rate (Q) by convection is given by

$Q_u = h\, A_s\, (T_s - T_f)$

Where,

h= convective heat transfer coefficients .

A_s= projected surface area.

T_s= temperature of hot surface.

T_f=temperature of surrounding fluids

We know that,

Q= VI

V= voltage meter reading

I= current in amp

As

$Q_u = Q_{useful} - Q_{loss}$

3.3 Dimension Less Numbers

1. Reynolds number (Re)

It is defined as the ratio of the inertia force to the viscous.

$$Re = \frac{inertia\ force}{Viscous\ force} = \frac{UL}{v}$$

Reynolds number signifies the relative's predominance of the inertia to viscous forces occurring in flow systems.

Reynolds numbers is taken as an important criterion of kinematics and dynamics similarities in forced convection heat transfer.

2. Prandtl number (pr)

It is the Ratio of kinematics viscosity to thermal diffusivity.

$$Pr = \frac{v}{\alpha}$$

Prandtl numbers provides a measure of the relative effectiveness of the momentum & energy transport by diffusion.

3. Nusselt number (Nu):

It is the ratio of heat flow rate by convection process under a unit temperature gradient to the heat flow rate by conduction process under a unit temperature gradient through a stationary thickness of L meters.

$$Nu = \frac{hL}{k}$$

The Nusselt number is a convenient measure of the convective heat transfer coefficient .for a given value of the Nusselt number, the convective heat transfer coefficient is directly proportional to thermal conductivity of the fluid and inversely proportional to the significant length parameter.

4. Applications

1. In process industries especially in thermal
2. Heating and cooling in evaporator
3. Thermal power plant
4. In chemical process industries
5. A.C. equipment's
6. Refrigerator
7. Space vehicle
8. Sugar factories.

References

[1] V.S Daund,A.A Waluni "Review of natural convective heat transfer from Rectangular Vertical Plate fin", International Journal of Advanced Technology in Engineering and science.volumeno.02 issue no.07(2014.

[2] Sandip S. Kale, V.W.Bhatkar, M.M Dange "Performance Evaluation of Plate-Fin-And Tube Heat Exchanger with Wavy Fins".Int. Journal of Engineering Research and

Applications ISSN: 2248-9622, Vol. 4, Issue 9 (Version 6), September 2014, pp.154-158 .

[3] ShrikantVasantrao Bhunte1, Sanjay Kumbhare "Investigation of Optimum Porous Pin Fin Parameter for Forced Convective Heat Transfer through Rectangular Channel Part-I"International Journal of Emerging Technology and Advanced Engineering .Volume 4, Issue 8, August 2014

[4] Gaurav Kumar, Kamal Raj Sharma, Ankur Dwivedi "Experimental Investigation of Natural Convection from Heated Triangular Fin Array within a Rectangular Enclosure". International Review of Applied Engineering Research. ISSN 2248-9967 Volume 4, Number 3 (2014), pp. 203-210

[5] Murtadha Ahmed and Abdul Jabbar N. Khalifa "Natural Convection Heat Transfer from a Heat Sink with Fins of Different Configuration."

[6] Changzheng Sun Bo Yu Hakan F. Oztop "Control of mixed convection in lid-driven enclosures using conductive triangular fins". Science Direct International Journal of heat and mass transfer.54 (2011)

[7] Rama Subba Reddy, Gorla.A.Y "Thermal analysis of natural convection and radiation in porous fins".Science Direct. International Journal of heat and mass transfer.38 (2011).

[8] R.J Goldstein,W.E Ibele Heat transfer-review of 2005 literature. Science direct .international journal of heat and mass Transfer 53 (2010)