Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 4, April-2017

EXPERIMENTAL ANALYSIS OF NATURAL CONVECTION HEAT TRANSFER FROM NOTCHED FIN

Bakale Aadesh[1], Kokane Piyush[2] Kokane Lakhan[3] Bakale Parag[4]
Prof.R.S.Shinde[5]
1(Student, Department of Mechanical Engineering SNDCOE YEOLA, Maharashtra, India)
2(Asso.Professor Department of Mechanical Engineering SNDCOE YEOLA, Maharashtra, India,)

Abstract

Cooling of a body is always been a challenge as unwanted heat generated can hinder the working of system. Implementing proper cooling technique dispatch the heat. This cooling method should by cheap, effective and feasible. Using of extended surfaces, fins, is most commonly used method to dispatch waste heat. Our project 'Experimental Analysis of Natural Convection Heat Transfer from Notched Fin' deals with increasing the efficiency of fins by providing the notch.The various types of fins used are longitudinal fins, radial fins, pin fins etc. Here we manufactured fins with notch to increase heat transfer coefficient for rectangular fins. We also experimentally prove that how heat transfer coefficient increases with increase in notch up to optimum notch size. For this we keep the area of fins constant i.e. we compensate area by adding the area of material that we have removed for notch. 9 fin array is arranged using a metal block that also holds the heating element. Experimental analysis is done for un-notched fins, 10% notched, 20% notched and 30% notched at 3 different input power supply. Temperatures and heat transfer results obtained from the experiment are as expected and hence heat transfer coefficient is maximum for 30% among 4 types of fins we test.

Keyword- FINS

I.INTRODUCTION

When available surface is found inadequate to transfer required quantityof heat with available temperature gradient, fins are used. Rate of heatdissipation from a fin configuration by convection heat transfer depends on theheat transfer coefficient and the surface area of the fins. The surface area of thefins can also be increased by adding more fins to the base material in order toincrease the total heat transfer from the fins. But the number of the fins shouldbe optimized because it should be noted that adding more fins also decreases thedistance between the adjacent fins. Using fins is one of the cheapest and easiestways to dissipate unwanted heat and it has been commonly used for manyengineering applications successfully. Fins are used to enhance convective heattransfer in a wide range of engineering applications, and offer a practical meansfor achieving a large total heat transfer surface area without the use of anexcessive amount of primary surface area. Fins are commonly applied for heatmanagement in electrical appliances such as computer power supplies orsubstation transformers. Other applications include Internal Combustion enginecooling, such as fins in a car radiator. It is important to predict the temperaturedistribution within the fin in order to choose the configuration that offers
maximum effectiveness. Natural convection heat transfer is often increased byprovision of Square fins on horizontal or vertical surfaces in many electronicapplications, motors and transformers. The current trend in the electronicindustry is miniaturization, making the overheating problem more acute due tothe reduction in surface area available for heat dissipation.

Square fins are the most popular fin type because of their low productioncosts and high effectiveness. Configuration of all fins protruding from theirbases is popular because they offer economical and trouble free solution to theproblem. Natural convection heat transfer is augmented by provision of squarefins on horizontal or vertical surfaces in many electrical and electronicappliances. Because of reduction in surface area available for heat dissipationand low heat transfer coefficient optimization of fin geometry becomes veryimportant in natural convection heat transfer. Now a days in electronicindustriesmicrominiaturization of electronic packages are in trend. The thermaldesign problem is recognized as one of the factors limiting achievement ofhigher packaging densities.

II Background

Fins are extensively used to remove the heat from the automobile engines, air craft engines, cooling of generators, motors, transformers, refrigerators, cooling of computer processors and other electronics devices. The failure rate of electronic equipment increase exponentially with the temperature. Also the high thermal stresses in the solder joints of the electronic components mounted on circuit board resulting from temperature variation are major causes of failure. Therefore thermal control of the circuit board has become an important factor in the design and operation of the electronic equipment. The current trend in electronic industry is microminiaturization of the electronic equipment. The thermal design problem is recognized as one of the limiting factor for achieving the higher packaging density. Natural convection cooling with the help of the finned surfaces often offers an economical and trouble free solution in many situations. Fin array on horizontal and vertical surface are used in variety of engineering applications to dissipate heat to surrounding. The only controlling variables in the hands of the designer are orientation and geometry of the fins to maximize the heat transfer. For effective dissipation of heat, plain horizontal surfaces facing upward are preferred since they provide relatively higher surfaces heat transfer coefficients than other orientations. Since the heat transfer coefficients are strongly depends upon the mechanism of the fluid flow, a thorough understanding of the resulting of the fluid flow patterns from the fin array is also of much use of the designer. The problem of the natural convection heat transfer from a rectangular fin array on a horizontal base surface has been investigated experimentally.

Heat transfer inside flow passages can be enhanced by using passive surface modifications such as rib tabulators, protrusions, pin fins, and dimples. These heat transfer enhancement techniques have practical. Application for internal cooling of turbine air foils, combustion chamber liners and electronics cooling devices, biomedical devices and heat exchangers. The heat transfer can be increased by the following different Augmentation Techniques. They are broadly classified into three different categories:

Passive Cooling Techniques
Active Cooling Techniques
Compound Cooling Techniques

III OBJECTIVES

1. Designing the experimental setup from different literature reviews of others.
2. Manufacturing and fabrication of the fin array.
3. Conducting experiment to find the temperature distribution on the fin.
4. Achieving chimney flow for natural convection.

.

IV SCOPE OF PROJECT

The results obtained from the experiment on un-notched fin can be improved by providing a notch on the upper side of fin. This modified shape is also checked for different sizes of notch and find heat transfer coefficient for different input power. General purpose rectangular fins are experimented. Area is kept constant for the fin by compensating the notched area on either side of notch. Even though efficiency of fin increases, but it cannot be used commercially because machining and manufacturing cost for the fin increases. As the notch size increases the heat transfer coefficient increases upto specific limit. Then it starts to reduce after that value.

V LITERATURE SURVEY

'Experimental analysis of heat transfer and average heat transfer coefficient through finarray with or without notch using free convection.' [6]byS.R. Dixit, Dr. D.P. Mishra, Dr. T.C. Pandahave used copper base plate of dimensions 190 x 110 mm and thickness 1 mm, lengths of fins used is 127 mm and height 38 mm with thickness of 1 mm. 7 fins were brazed to base plate for experiment. Experiment was conducted for 4 values of heat inputs. They tested un-notched fins and 30% notched fins to find optimum spacing between them. From their experimental study it is found that the heat transfer rate in notchedfins is more than the un-notchedfins.

Natural convection heat transfer enhancement in horizontal rectangular fin arrays'[5]by Sane N.K., Sane S.S., and Pariswad G.V. They studied the aluminium fin array for heat transfer without notch and with notch. The parameters taken for their experimental purpose was fin as 150 mm and height as 75 mm. Number of fins were 9-15 and notched portion from 10% to 40%. The voltage applied is from 50 W to 200 W. From the experiments it has been observed that the total heat transfer coefficient increases as notch depth increases

'Experimental Investigation of Heat Transfer from Inverted Notch Fin Arrays (INFA) Under Natural and Forced Convections'. [1] By S. D. Wankhede, S. G. Taji, V. M. Suryawanshi.The objective of their work is to determine the heat transfer characteristics experimentally, and further to find out the enhancement in heat transfer in the case of notched fin arrays over normal fin arrays, and analysed the effect of different parameters like length, height, spacing of fins on heat transfer coefficient (h). Hereafter the inverted notched fin arrays are termed as INFAs and without inverted notched fin arrays are termed as normal arrays. It is concluded that, the values of average heat transfer coefficient ha increases as percentage of area removed increases near about 30 to 70% rise is achieved as compared to normal fin array. The value of hb increases as fin spacing decreases, reaches its maximum, giving optimum spacing and again decreases. For very less fin spacing the values of both ha and hb are significantly less. The value of Nua increases with increase in fin spacing. The value of Nub increases as fin spacing decreases; it reaches to its maximum and again decreases.

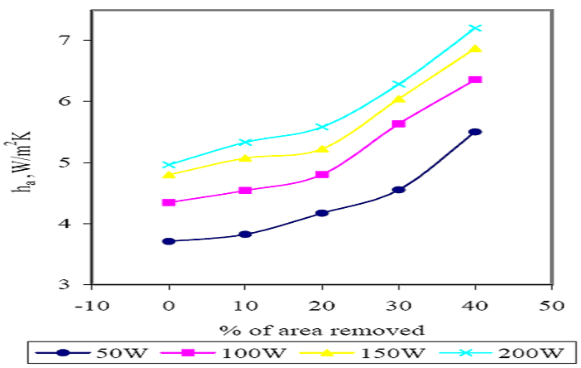

Figure1. Variation of h vs % area removed for 6mm fin spacing

VI. METHODOLOGY

To conduct the experiment for calculating heat transfer coefficient we first select the dimensions of the fins, number of fins to be used, material of fins, design of base block on geometric basis. We take help of previous researches to decide above mentioned parameters. Once decided we draw a creo model for better visualization of setup at that point. Then manufacturing and fabrication of model is to be started. Generally copper and aluminium are used as fin material. Both have good thermal conductivity. We select aluminium for our model as it is cheaper and easily machinable than copper. Thin sheets of aluminium of thickness 1 mm are selected to make fins. Thick aluminium block is machined to hold the heating element and fins. Proper insulation material is selected, in our case cement is used as insulatorto avoid unwanted heat convection**.**

VII EXPERIMENTATION

Setup of Fin Array

1. Take 9 fins of each type. i.e. un-notched, 10%, 20% and 30% notch.

2. Fit this 9 fins in 9 slots of the base block. There will be insertion fit between block and fin, as slot for fin on base plate is 1 mm and thickness of fin is also 1 mm.

3. Check for proper fitting as it may affect heat transfer between block and fins.

4. Insert cartridge heater in the hole drilled for it in base plate.

5. Surround the base and 4 sides of base block with cement so no neat transfer takes place through that sides. We use a wooden container to carry the cement and fin array.

Volume 4, Issue 4, April 2017, e-ISSN: 2393-9877, print-ISSN: 2394-2444

Procedure

1. Connect the dimmer stat to the cartridge heater.

2. Bring the knob of dimmer stat to zero

3. Connect the probes of digital temperature indicator at different locations on the base plate and on the fins as per requirement.

4. Switch on the mains supply.

5. Increase the wattage supplied to the heating element by rotating the knob slowly.
   Switch on the power supply of digital temperature also.

6. See the temperature of the base plate indicated by the digital temperature indicator by rotating the knob provided.

7. Increase or decrease the wattage supply provided to the heating element depending on the temperature required at the base plate.

8. Wait until the temperature indicated by digital temperature indicator becomes steady. If the temperature indicated is steady then it means that the experiment has reached steady state.

9. Once the steady state is reached, note down the temperatures at various locations on the base plate and also on fin tops.

Tabulate the temperatures so noted properly in the form of a table so that it becomes easy for further calculations

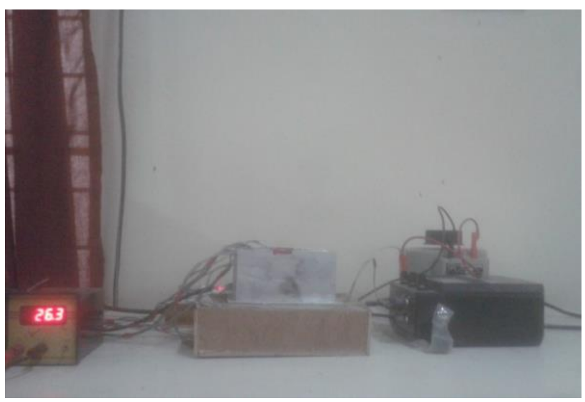

Figure2. .Experimental Setup

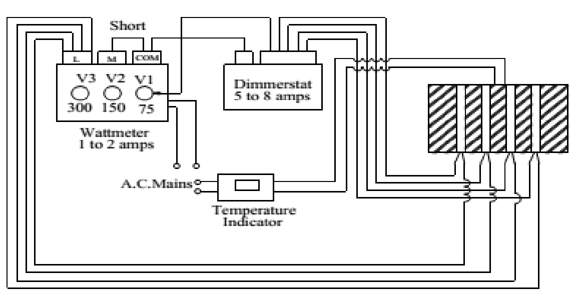

Figure 3. Block Diagram of Setup

VIII Calculations

Table 1: Results of calculations.

Q	Fin	T_{AVG}	T_0	ΔT	A_{FIN}	A	h
W		^0C	^0C	^0C	m^2	m^2	$W/^0C\ m^2$
40	Un-notched	52.53	29	23.53	0.189	0.204	8.305
	10 %	50.70	29	21.70	0.189	0.204	9.004
	20%	50.87	30	20.87	0.189	0.204	9.365
	30%	48.84	29	19.84	0.189	0.204	9.849
70	Un-notched	69.2	29	40.20	0.189	0.204	8.725
	10 %	66.43	30	36.43	0.189	0.204	9.388
	20%	65.19	30	35.19	0.189	0.204	9.718
	30%	64.56	30	34.56	0.189	0.204	9.895
90	Un-notched	81.40	30	51.40	0.189	0.204	8.555
	10 %	78.88	30	48.88	0.189	0.204	8.997
	20%	77.53	30	47.53	0.189	0.204	9.252
	30%	75.29	30	45.29	0.189	0.204	9.708

IX RESULTS AND DISCUSSION

For horizontal rectangular fin array a chimney flow pattern is developed due to density difference,which signifies natural convection heat transfer. In chimney flow the air passing over the middle point of tip, is already heated due to passage over fin surface.So the fin is notched and the area is compensated on sides

The broader flow pattern is observed because more air is coming in contact with fin surface, which ensures better heat transfer between fin surface and air. This results in better heat transfer thereby increasing the heat transfer coefficient.

The rate of increase of heat transfer coefficient between 20%-30% notch is less as compared to rate of increase of heat transfer coefficient up to 20% .So it can be seen that the heat transfer coefficient first increases with increase in notch size and after certain point it reduces due to reduction in conduction from base to fin.

CONCLUSION

Fin geometry and orientation plays a vital role in natural convection heat transfer. Our investigation deals with natural convection heat transfer on rectangular fin array. Here we have tried to optimize a rectangular fin array on the basis of cost and usefulness. In this experimental study, an attempt is made to improve the performance of horizontal rectangular fin array by removing the less effective portion of the fin flat in the form of a rectangular notch. It is observed that total heat flux as well as the heat transfer coefficient increase as the notch depth increases. As area removed from the fin is compensated at the air entry ends of the fin it provides chance to get greater amount of fresh cold air to come in contact with hot fin surfaces. As the air moves inwards along chimney profile, it gets heated and temperature difference between the fin and entering air decreases. When this area is removed and added at a place where it is more useful for heat transfer, the heat transfer increases and so does the convective heat transfer coefficient. This analysis reveals that the recommended single chimney flow pattern is maintained for the notched fin arrays. The performance of notched fin arrays is 13.5% superior to corresponding un-notched arrays, in terms of average heat transfer coefficient.

REFERENCES

[1] S.D. Wankhee, S. G. Taji and V. M. Suryawanshi, Experimental Investigation of heat transfer from inverted notch fin array (INFA) under Natural and Forced Convection.IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)ISSN(e) : 2278-1684

[2] S.S. Sane, N.K. Sane, G.V. Parishwad, 2008, Computational Analysis of Horizontal Rectangular Notched Fin Arrays Dissipating Heat by Natural Convection5th European Thermal-Sciences Conference, the Netherlands.

[3] Vinod M. Wankar, Dr. S.G. Taji InternationalJournal of Modern Engineering Research (IJMER)Vol.2, Issue.6, Nov-Dec. 2012 pp-4572-4576

[4] S.H.Barhatte, M.R.Chopade, V.N.Kapatkar,January-March 2011, Experimental & Computational Analysis & optimization forHeat Transfer through Fins with DifferentTypes of Notch

[5] Sane S.S., Paishwad G.V. and Sane N.KNatural convention heat transfer enhancement in horizontal rectangular fin array with inverted notch, 18th National & 7th ISHMT-ASME Heat and mass TransferConference at IIT, Guwahati, 312- 317, Jan 04-06, 2006

[6] S.R. Dixit, Dr. D.P. Mishra, Dr. T.C. Panda, Experimental analysis of heat transfer and average heat transfer coefficient through fin array with or without notch using free convection, International journal of Advanced Research, Vol. 1, Issue 2, May 2013, pp 11-2