Imperial Journal of Interdisciplinary Research (IJIR)
Vol-2, Issue-6, 2016
ISSN: 2454-1362, http://www.onlinejournal.in

Experimental Analysis of Natural Convection Heat Transfer from Notched Fin

Mr. Ram Bakale[1], Mr. Kaushik Baheti[2], Mr. Chandrakant Dokade[3] & Mr. Pandhurang Galande[4]
[1,2,3,4] Department of Mechanical Engineering, Sinhgad College of Engineering, Pune, India.

Abstract: *An experiment to investigate the heat transfer coefficient of fin with different notch size for the given fin spacing using free convection heat transfer from horizontal fin array was carried out. Horizontal rectangular fin array with aluminium fin and aluminium fin block to hold the fins is constructed. Fins with different rectangular notch size are used. The objective of this experiment is to determine the optimum notch size to maximize heat transfer by natural convection at different heat inputs.*

1. Introduction

We use fins to cool the surface when available surface is found in adequate to dispatch the unwanted heat generated. Heat transfer through the body is directly linked with the surface area of the body. By adding fins we increase the surface area thus increasing the heat transfer from the body. Fins are extensively used in automobile engines, air craft engines, generators, motors, transformers, refrigerators. As fins provide effective cooling using air, it is a favourite option to cool electronic instruments like computer processors, microwaves etc., as water cooling can damage the device. Fins uses convective heat transfer method to dispatch the heat to air. Natural convection occurs if this motion and mixing is caused by density variations resulting from temperature differences within the fluid.

Square fins are the most popular fin type because of their low production costs and high effectiveness. Manufacturing fins protruding from their base is popular because they offer economical and trouble free solution to the problem. Since heat transfer by convection depends on fluid flow, so we change the fluid flow by providing a notch and finding its effect experimentally.

2. Review of literature

Experimental work on horizontal fin arrays was studied by various authors. Starner and McManus [1] was the first one on the topic of natural convection heat transfer from rectangular fin arrays on horizontal surfaces. The purposed of investigation was to experimentally determined average heat transfer coefficients for rectangular fin arrays of various dimension. Harahap and McManus [2] extended the work of Starner and McManus with object of more fully investigating the other objectives of their study were to investigate flow field. The other objectives of their study were to investigate flow field. Jones and Smith [3] undertook their investigation with prime objective of establishing the optimum spacing of fins for maximum transfer from given base surface. They experimentally determined averaged heat transfer coefficient for horizontal arrays over a wide range of spacing. Mannan [4] studied the effect all pertinent geometrical parameter of fin array on its performance. His work covered wide range of length: 127 mm to 508 mm, height: 254 mm to 1016 mm and spacing: 4.8mm to 28.6mm with temperature difference varying from 39 ^oC to 156 ^oC. Sane and Sukhatme [6] considered the situation of an isothermal rectangular fin array on a horizontal surface. Vinod Wankar, Dr. S.G.Taji [9] investigate flow pattern through rectangular fin under natural convection. Nusselt number for 10mm fin spacing was 58.35. The highest value of ha is 5.7929 W/m^2 K at the spacing of 12 mm. Maximum value of Nu for fin spacing 10mm was found 58.35.

3. Experimental Setup

We use 4 types of fins, without notch, 10% notch, 20% notch, 30% notch. Dimensions of fins used for our experiment are as follows,

We used 9 simple rectangular fin with dimension 150 mm x 75 mm cut out of 1 mm thick aluminium sheet. We keep the area of fins constant as the notched area is compunsated.

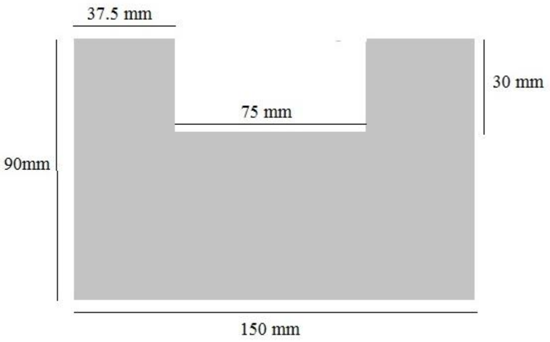

Figure 1 Dimensions of 10% notched fins

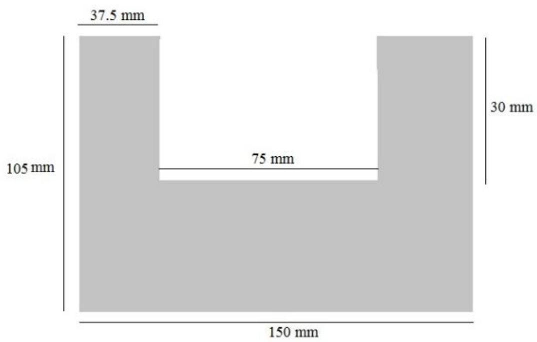

Figure 2 Dimensions of 20% notched fin

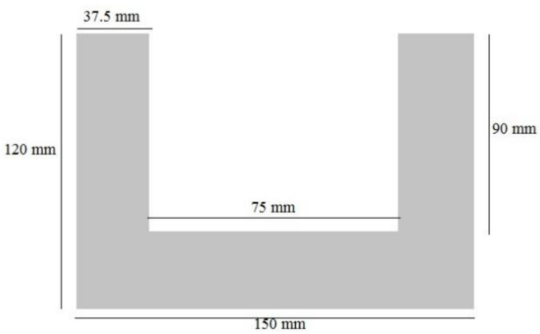

Figure 3 Dimensions of 30% notched fin

An aluminium block with dimensions 100 x 170 x 40 mm is used to hold the 9 fins 10 mm apart. A hole for cartridge heater is provided to heat the base plate. We have used 100 W cartridge type heater. We use cement to insulate the base pate to avoid unwanted heat losses. K- Type thermocouple wires are used to measure the temperature of the fins. Cartridge heater is connected through wattmeter and dimmer stat to mains. Dimmer stat is used to give desired input to the heater. We had selected a room with no fans windows or any other ventilation to avoid forced convection.

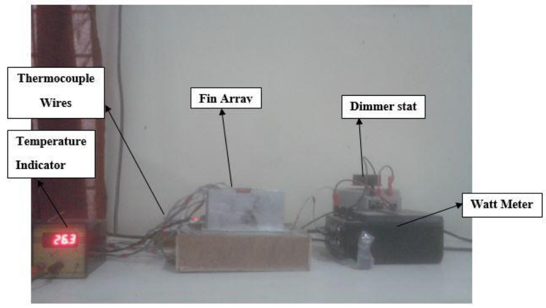

Figure 4 Experimental setup

Figure 5 Fin array.

4. Experimental Procedure

a) Connect the dimmer stat, wattmeter to the heater.
b) Connect the probes of digital temperature indicator at different locations on the base plate and on the fins as per requirement.
c) Wait until the temperature indicated by digital temperature indicator becomes steady. It took us 3- 4 hours to reach steady state.
d) Once the steady state is reached, note down the temperatures at required locations

Now conduct the same procedure for different set of fins at different voltages. In our case we had conducted experiment for 40 W, 70 W and 90 W and un-notched, 10%, 20%, 30% notched fin.

5. Sample Reading

For 20% notch

Wattage 70W

Ambient temperature = 30^{o}C

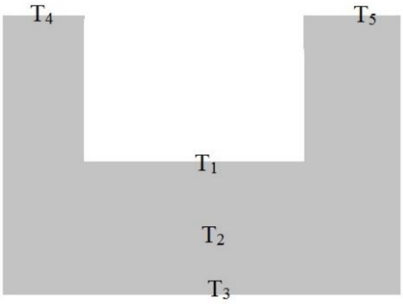

Figure 6 Temperature Labelling

Table 1 Temperature Readings

Fin No.	T_1	T_4	T_5	T_{tip} $(T_1+T_4+T_5)/3$	T_2 T_{middle}	T_3 T_{base}
1	55	53	55	55.33	58	72
3	61	55	58	58	63	75
5	67	55	57	59.66	69	76
7	66	52	56	58	67	78
9	59	51	55	55	61	74
Avg				56.99	63.6	75

Then, we find value of heat transfer coefficient using formula

$h = Q / (A \times \Delta T)$

6. Results and Conclusion

Results were obtained and presented in the form of various heat transfer parameters. It is concluded that, the values of average heat transfer coefficient 'h' increases as the notch size increases. It may be because of fresh air circulation occurs as notch is provided. But after specific size of notch, the heat transfer coefficient will decrease as conduction will out power convection. As heat transfer coefficient is increased more effective cooling occurs.

Table 2 Heat transfer coefficient

Fin / Input	40 W	70 W	90 W
Un notched	8.305	8.725	8.55
10%	9.004	9.388	8.997
20%	9.365	9.718	9.252
30%	9.849	9.895	9.708

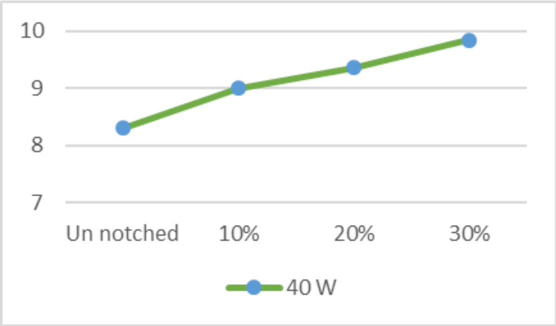

Figure 7 'h' for 40W input.

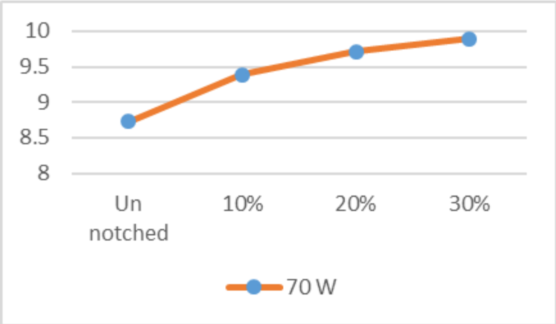

Figure 8 'h' for 70W input.

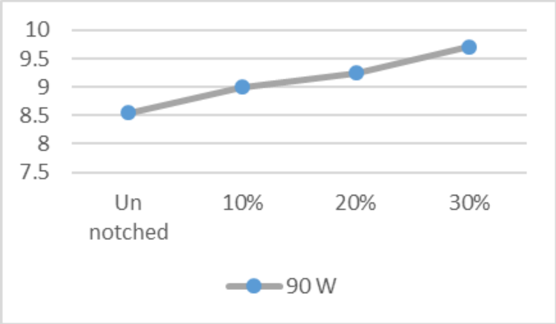

Figure 9 'h' for 90W input.

Thus from above shown graphs and readings it is concluded that heat transfer coefficient for fin array can be improved by providing notch.

References

[1] Starner, K. E., and McManus, H. N., 1963, "An Experimental Investigation of Free Convection Heat Transfer From Rectangular Fin Arrays," Trans. ASME, Ser. C: J. Heat Transfer, 85, pp. 273–278.

[2] Harahap, F., and McManus, H. N., 1967, "Natural Convection Heat Transfer From Horizontal Rectangular Fin Arrays," Trans. ASME, Ser. C: J. Heat Transfer, 89, pp. 32–38.

[3] Jones C D, Smith L F (1970): "Optimum Arrangement of Rectangular Fins On Horizontal Surface for Free Convection Heat Transfer", Trans. ASME Paper No. 69-HT-44, pp 6-10.

[4] Mannan, K. D., 1970, "An Experimental Investigation of Rectangular Fins on Horizontal Surface," Ph.D. thesis, Ohio State University, Columbus, OH.

[5] S. D. Suryawanshi1 and N. K. Sane Natural Convection Heat Transfer From Horizontal Rectangular Inverted Notched Fin Arrays Transactions of the ASME AUGUST 2009 E 082501-6 / Vol. 131

[6] Sane, N. K., and Sukhatme, S. P., 1974, "Natural Convection Heat Transfer From Short Horizontal Rectangular Fin Arrays," Fifth International Heat Transfer Conference, Tokyo, Sept.

[7] Sane, N. K., Kittur, M. B., and Magdum, J. D., 1995, "Natural Convection Heat Transfer From Horizontal Rectangular Fin Arrays With a Rectangular Notch at the Center," Seventh ISHMT Conference, Suratkal.

[8] Sane N.K., Sane S.S., and Parishwad G.V., January 2006, Natural Convention Heat Transfer Enhancement in Horizontal Rectangular Fin Array with Inverted Notch, 18th National & 7th ISHMTASME Heat and mass Transfer Conference IIT, Guwahati, 312-317.

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