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Experimental Investigation of Heat Transfer Performance of Rectangular and Triangular Fin Heat Sink

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Abstract: *Heat dissipation is a drastic issue to tackle due to continued integration, miniaturization, compacting and lightning of equipment. Heat dissipaters are not only chosen for their thermal performance; but also for other design parameters that includes weight, cost and reliability, depending on application. A heat sink is a device that is used to cool many various types of electronic devices by absorbing and dissipating the heat device produces through direct contact. Heat sink works the basis of transferring heat from a high temperature source to a lower temperature source, where the lower temperature source has much greater heat capacity. The primary of this study is to experimentally obtain the performance of a triangular fin heat sink by conducting free convection test. In this geometry our main purpose is that for same mass of triangular fin having two more surfaces than rectangular fin that enhance the heat transfer rate.*

Keywords: Heat sink, Fin, Convection, Heat transfer etc.

I. Introduction

Heat transfer is vital parameter for the proper & efficient working of the all the mechanical as well as electronics components. Engines, condensers, transformers, etc. possesses great deal residual heat generated throughout the operating of those equipment's. This heat generated causes development of stresses within the parts & shortens the lifetime of the parts. Hence, there is need of increasing the rate of heat transfer from the main body to the atmosphere. The techniques used in the cooling of high power density electronic devices vary widely, depending on the application and the required cooling capacity. The heat generated by the electronic components has to pass through a complex network of thermal resistances to the environment. Passive cooling techniques found more efficient and economical for electronics component. Using fins is one of the most inexpensive and common ways to dissipate unwanted heat and it has been successfully used for many engineering.

There is problem related with rectangular fin is that, It consumes more material & it have only 4 sides are surrounded by atmospheric air for given mass. So our attempt to increase heat transfer rate by splitting this rectangular fin into two triangular fin.

II. Literature Review

Goshayeshi et. al. [1] according to them, the primary airflow pattern for the vertical/vertical con-figuration. Air enters nears the bot-tom of the fin channels and there will be some air flow from the fin tips. Air is heated within the fin channels and exit at the top. With this air flow path, the vertical/ configuration delivers the best performance for free or natural cooling. The final heat sink configuration to be discussed is the vertical baseplate/horizontal fin channel geometry. Vertical fin channels are better. However it should be mentioned that the vertical/ horizontal sink is certainly better than a flat wall. With a fin length of 25 mm the vertical/horizontal heat sink pro-vides roughly twice the wattage dissipated, an appreciable improvement. Also, the fins allow for an additional conduction where it is logical to use vertical/horizontal heat sinks.

Sreedev et.al. [2] The efficiency of many devices greatly depends upon their ability to dissipate heat from their surfaces. Fins are extended surfaces used for dissipating heat from the hot surfaces. A number of experiments have been done in the field of enhancing heat transfer rate from hot surfaces. In that study new mechanism in which heat transfer rate in rectangular array is enhanced by means of staggered perforations. Analysis of flow field and heat transfer has been carried out for two different orientations It is observed that flow path lines around solid and perforated fin are different. From the analysis it is also concluded that when perforations in staggered manner are introduced on fin surface, the turbulent effect of air passing through the holes gets increased. This in turn enhances the heat carrying capacity of the perforated fins

Mathias et.al. [3] The concern about thermal performance of microelectronics is on the increase due to recent over-heating induced failures which have led to product recalls. Removal of excess heat from microelectronic systems with the use of heat sinks could improve thermal efficiency of the system. That paper investigates the effect of change in heat sink geometry on thermal performance of aluminium and copper heat sinks in microelectronics. Numerical studies on thermal conduction through an electronic package comprising a heat sink, chip, and thermal interface material were carried out. The thickness of the heat sink base and the height of the heat sink fins were varied in the study. The minimum and maximum temperatures of aluminium and copper heat sinks in the two models were investigated using steady state thermal conduction analysis. Better heat dissipation occurred in thinner base thickness and extended fins height for both aluminium and copper heat sinks. Aluminium heat sink recorded the lowest minimum temperatures in both investigations and is recommended as optimal thermal management material for heat sink production.

Santosh Kansal et.al [4] The objective of that paper was to present a best possible Heat Sink for efficient cooling of electronic devices. That paper deals with the comparative study of heat sink having fins of various profiles namely rectangle, Trapezoidal, rectangle Interrupted, Square, circular inline and staggered, as heat sinks are the commonly used devices for enhancing heat transfer in electronic components. In this work, a new concept for cooling the electronic components using the Aluminium alloy heat sink is proposed.

Sonawane et.al. [5]According to them, that was very important to enhance the heat transfer rate and ensure the better cooling of electronic devices. The fined surface is most commonly used to dissipate heat quickly to the surrounding flowing fluid. Experiment is carried out to investigate heat transfer rate in natural convection of parallel plate fin heat sink with circular pin fins placed between the plate fins. The firstly parallel plate heat sink consists of without perforated circular pin fin and its performance is compared with perforated circular pin fin. The height of circular pin fin is taken as 50 mm, 35 mm, 25 mm respectively for both cases. Further the number of perforation on pin fin increases and its effect on heat transfer rate is also examined. The result shows that, parallel plate fin heat sink with perforated circular pin fins gives more heat transfer than without perforated circular pin fins. In above three cases, it is observed that circular pin fin at 25 mm height shows better heat transfer than other two heights. The increase in number of perforation on each pin fin increases heat transfer rate.

AzeemAnzar et.al. [6] Integrated circuits operate best in a limited range of temperature hence their package must be designed in order to remove the excessive heat. As an alternative passive cooling technique means, phase change materials or phase change materials have been widely investigated for such transient cooling applications considering their advantages such as high specific heat, high latent heat of fusion, controllable temperature stability and small volume change during phase changes, etc. This types of PCM based cooling techniques have different application in various devices which are not be operated continuously over a long period of time, but in intermittently using devices like digital cameras, cellular phones, notebook etc.

Md. Abu JafarRasel et.al. [7] Heat transfer in a rectangular body embedded with circular fins cooled by forced convection was numerically investigated. The arrangement considered is vertical rectangular body with staggered arranged horizontal fins. Rectangular body is heated with a constant heat flux. Simulation software was implemented to observe different heat transfer characteristics in the rectangular body and fins separately. Pressure drop, temperature distribution and velocity profile across the fins was observed varying the fluid speed around the fins. This investigation provided a higher pressure loss as the fluid speed is higher. Heat transfer enhancement at fins was higher at lower fluid speed compared with higher fluid speed and heat transfer enhancement at base was higher at higher speed compared with lower fluid speed.

Rahul Gupta et.al. [8] In present work, a cylinder fin body is modeled with the help of Solid Works 2010 software and transient thermal analysis is done by using ANSYS 14.5. These fins are used for air cooling systems for two wheelers. In present study, Aluminum alloy and Magnesium alloy are used and compared with G. Babu and M. LavaKumar results. The various parameters (i.e., shape and geometry of the fin) are considered in the study, shape (Rectangular, Circular and Triangular), and thickness (3 mm) by changing the shape of the fin to triangular shaped, the weight of the fin body reduces thereby increasing the heat transfer rate and efficiency of the fin. The weight of the fin body is also reduced when Magnesium alloy is used. By using triangular fins the weight of the fin body reduces compare to existing engine cylinder fins.

III. Heat Transfer By Heat Sink

Convection is called natural (or free) convection if the fluid motion is caused by buoyancy forces that are induced by density differences due to the variation of temperature in the fluid.

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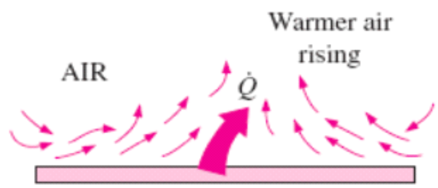

Figure 1: Natural Convection

For example, in the absence of a fan, heat transfer from the surface of the hot block will be by natural convection since any motion in the air in this case will be due to the rise of the warmer (and thus lighter) air near the surface and the fall of the cooler (and thus heavier) air to fill its place. Heat transfer between the block and the surrounding air will be by conduction if the temperature difference between the air and the block is not large enough to overcome the resistance of air to movement and thus to initiate natural convection currents.

A heat sink is a device that is used to cool many various types of electronic devices by absorbing and dissipating the heat devices produces through direct contact. Heat sinks are the most common hardware used for the heat dissipation. They are employed in microelectronic devices as well as in high power electrical components and are considered to be the simplest and the cheapest cooling solution. With constantly increasing demands for the heat dissipation the optimization of the heat sink design has become a key issue. A heat sink works on basis of transferring heat from a high temperature source to a lower temperature source, where the lower temperature source has a much greater heat capacity. In most cases, an improvement of the heat sink thermal performance has to be made with respect to the practical constrains like the available pressure drop, external dimensions, mass, volume or price. For many years the optimization was done basing on the analytical models or strongly simplified numerical models of the heat sinks. Comparative thermal tests have been carried out using aluminium heat sinks made with extruded fin, cross-cut rectangular pins, and elliptical shaped pins in low air flow environments. The performance of the elliptical pin heat sink was compared with those of extruded straight and crosscut fin heat sinks.

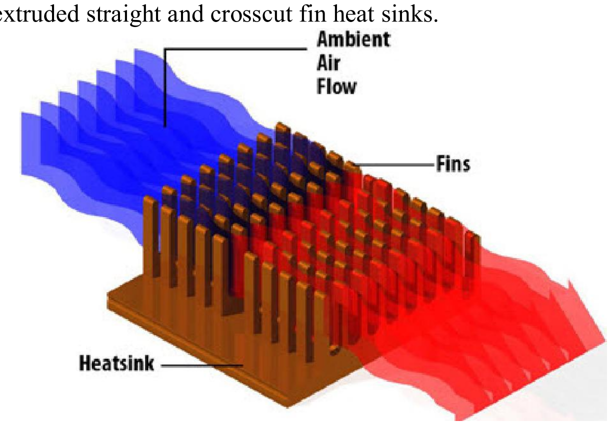

Figure 2: Principle of Heat sink

IV. Experimentation

A. Procedure

Figure 3 shows experimental layout and following steps are carried to perform experiment

1. Check all the connection of setup.
2. Put the dimmer stat reading on 0 volt
3. Switch on the main supply
4. Adjust the dimmer stat to obtain the required heat input (say 20w, 30w, 40w,50w etc.)
5. After steady state is reached (no temperature change for next 10 minute), which is confirmed from temperature reading- (T1 to T4)
6. Measure surface temperature at the various point i.e. T1 to T4.
7. Note the ambient temperature i.e. T5.
8. Repeat the experiment at different heat inputs.

Figure 3: Experimental layout

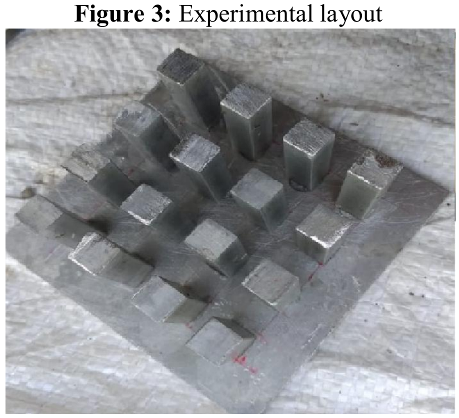

Figure 4: Rectangular Fin

Figure 5: Triangular Fin

Table 1: Observation Table for Rectangular fin

Sr. No.	V	I	T1	T2	T3	T4	T5
1	71	0.28	57.7	58.2	58.2	58.1	34
2	85	0.35	68.2	68.2	67.7.	67.8	34.2
3	100	0.4	79.8	79.9	79.8	80.4	33.5
4	111	0.45	84.2	84.4	84.2	84.1	34.1

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Table 2: Observation Table for Triangular Fin

Sr No.	V	I	T1	T2	T3	T4	T5
1	71	0.28	51.2	51.1	51.3	50.9	35.2
2	85	0.35	58.7	58.9	60.2	60.3	35.6
3	100	0.4	68.2	68.4.	68.3	68.9	36.1
4	111	0.45	71.8	71.9	72.3	72.2	36.6

B. Sample Calculation

Exposed fin area

Area for single rectangular fin = 4 x h x b

= 4 x 0.040 x 0.010

= 1.6 x 10^{-3} m^2

Total fin area for sample 1= (0.1 x 0.1) + No. of fin (1.6 x 10^{-3})

= 0.01 + 16(1.6 x 10^{-3})

= 0.0356 m^2

Area for single Triangular fin = (2 x h x b) + (h x diagonal)

= (2 x 0.040 x 0.010) + (0.04 x 0.014)

= 1.36 x 10^{-3} m^2

Total fin area for sample 2 = (0.1 x 0.1) + No. of fin (1.36 x 10^{-3})

= 0.05352 m^2

Qc = heater input=VI

Qc = havg A ΔT

Average heat transfer coefficient:

havg = Qc/(A ΔT)

ΔT= (Ts-T∞)

Ts= Average surface temperature

T∞= Ambient temperature

V. RESULT AND DISCUSSION

Table.3: Result Table

Sr No.	Q	ΔT for Rectangular Fin	ΔT for Triangular Fin	h for Rectangular Fin	h for Rectangular Fin
1	20	24	15.8	23.40	25.31
2	30	33.8	24.4	24.93	24.59
3	40	46.5	36.9	24.16	24.72
4	50	50	37.8	28.08	28.24

From above table we come to know that base plate temperature for triangular fin is less hence ΔT is lower for triangular fin. Heat transfer coe. is greater for triangular fin and goes on increasing as temperature increases.

VI. CONCLUSION

In that way we have studied triangular fin heat sink which having several advantages as compared to rectangular type heat sink. For triangular fin for same material mass of that of rectangular fin it covers two more surfaces. Hence thestudy about extended surfaces tells that as area increases heat transfer rate also increases. From the result we conclude that base plate temperature is less for triangular fin as compared to rectangular fin which is our aim. Also heat transfer coe. is higher for triangular fin.

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