Performance Analysis of Heat Sink

[1]Muthusamy K, [2]Prem Kumar S, [3]Madhu A K, [4]Srinivasagam Ramesh, [5]Muthiah A

*[1]Assistant Professor, [2]PG Student, [3]Assistant Professor, [4]Associate Professor, [5]Professor
Department of Mechanical Engineering,
P.S.R.Engineering College, Sivakasi,

***Abstract*: All electronics devices dissipate heat to a large extent. Sufficient cooling is required to maintain their transistors; an electronic device is used in several applications. We have considered the transistor in the electrical contractor application. Our aim is to design a heat sink which could efficiently remove the heat dissipated by the transistor. In this project different materials heat sink for same base area and same heat input is considered and performance of the heat sink is analysis. The experimental analysis for aluminum and copper fins.**

***Keywords*: Flexural Strength, Shear Strength, ANSYS Software.**

I. INTRODUCTION

The operation of many engineering systems results in the generation of heat. This unwanted by-product can cause serious overheating problems and sometimes leads to failure of the system. The heat generated within a system must be dissipated to its surrounding in order to maintain the system at its recommended working temperature and functioning effectively and reliably. This is especially important in modern electronic systems, in which the packaging density of circuits can be high. In order to overcome this problem, thermal systems with effective emitters as fins are desirable. In electronic systems, a heat sink is a passive heat exchanger component that cools a device by dissipating heat into the surrounding air. A heat sink is designed to increase the surface area in contact with the cooling medium surrounding it, such as the air. Approach air velocity, choice of material, fin (or other protrusion) design and surface treatment are some of the factors which affect the thermal performance of a heat sink. Heat sink attachment methods and thermal interface materials affect the temperature. Thermal adhesive or thermal grease fills the air gap between the heat sink and device to improve its thermal performance. Theoretical, experimental and numerical methods can be used to determine a heat sink's thermal performance. A heat sink transfer thermal energy from a higher temperature to a lower temperature fluid medium. The fluid medium is frequently air, but can also be water or in the case of heat exchangers, refrigerants and oil. If the fluid medium is water, the 'heat sink' is frequently called a cold plate. In thermodynamics a heat sink is a heat reservoir that can absorb an arbitrary amount of heat without significantly changing temperature higher than the surrounding to transfer heat by conviction, radiation, and conduction. To understand the principle of a heat sink, consider Fourier's law of heat conduction. Joseph Fourier was a French mathematician who made important contributions to the analytical treatment of heat conduction. Fourier's; law of heat conduction, simplified to a one-dimensional form in the x-direction, shows that when there is a temperature gradient in a body, heat will be transferred from the higher temperature region to lower temperature region. The rate at which het is transferred by conduction, is proportional to the product of the temperature gradient and the cross-sectional area through which heat is transferred.

II. LITERATURE REVIEW

Welling and Wooldridge[1965] performed another experimental study to compare actual rectangular fin experiments with those of vertical plate, enclosed duct and parallel plate data from previous studies. During the tests, guard heater plate was utilized to minimize the heat losses from the sides and rear of the set-up. Data obtained from experiments showed that with closely spaced fins, the heat transfer coefficients were smaller compared to wider fin spacing's because of boundary layer inference, which prevents air inflow. It was observed that the heat transfer coefficients of finned arrays were smaller than those of vertical plate and greater than either those of enclosed ducts or those of parallel plates. For a given base-to-ambient temperature difference, and optimum H/s (fin height to fin spacing) ratio at which heat transfer coefficient is maximum was determined from the considered fin configurations.

Harahap and McManus [1967] observed the flow field of horizontally based rectangular fin arrays for natural convection heat transfer to determine average heat transfer coefficients. In the experimental unit, guard heaters and guard fins were located near the end fins to eliminate the end effects. To visualize the flow, field, schlieren-shadowgraph technique and smoke injection were used. Several types of chimney flow were observed. For equal fin spacing and fin height, two series to rectangular fin arrays differing in length was compared. The result of comparison indicated that the array having shorter fin length (by half) had higher average heat transfer coefficient because of its effective utilization caused by single chimney flow. This result revealed that single chimney flow pattern was favourable to high rates of heat transfer. Using the average heat transfer coefficient data, the following correlation were proposed in terms of $Gr_L.Pr$, s,n,h. **Jones and Smith [1970].** Determination of local heat transfer coefficients were achieved by measuring local temperature gradients with interferometer. Integrating the measured local heat transfer coefficients, the average heat transfer coefficient for the array was determined. Since the determined heat transfer coefficients were for convection only and were independent of the radiation, the interferometry technique was used directly. The result have shown that fin spacing's is primary geometric parameter that affects that heat transfer coefficient? They also compared the measured values with the limited comparable data in literature, and it was concluded that the agreement between them was satisfactory. **Hua-Shu Dou** and et.al,[2014]. This paper numerically investigates the thermal flow and heat transfer by natural convection in a cavity fixed with a fin array. The computational domain consists of both solid (copper) and fluid (air) areas. The finite volume method and the SIMPLE scheme are used to simulate the steady flow in the domain. Based on the numerical results, the energy gradient function of the energy gradient theory is calculated. It is observed from contours of the temperature and energy gradient function that the position where thermal instability takes place correlates well with the region of large values, which demonstrates that the energy gradient method reveals the physical mechanism of the flow instability. Furthermore, the effects of the fin height, the fin number, and the fin shape on the heat transfer rate are also investigated. It is found that the thermal performance of the fin array is determined by the combined effect of the fin space and fin height. It is also observed that the effect of fin shape on heat transfer is insignificant.

Yuncu and yildiz and et .al [2020], Natural convection heat transfer in annular fin-arrays mounted on a horizontal cylinder was experimentally investigated. An experimental set-up was constructed to investigate heat transfer characteristics of 18 sets of annular fin-arrays mounted on a horizontal cylinder of 24.9-mm diameter in atmospheric conditions. Keeping the fin thickness fixed at 1 mm, fin diameter is varied from 35 mm to 125 mm and fin spacing is varied from 3.6 mm to 31.7 mm. The base-to-ambient temperature difference was also varied with a calibrated wattmeter ranging from 25 W to 150 W. The results have shown that the convection heat transfer rate from the fin arrays depends on fin diameter, fin spacing and base-to-ambient temperature difference. In addition, for every fin diameter, for a given base-to-ambient temperature difference, there exists an optimum value for the fin spacing for which the heat transfer rate from the fin array is maximized. Experimental results show that, for practical engineering applications, the optimum fin spacing may be taken approximately as 8 mm. A scale analysis is also performed in order to estimate order-of-magnitude of optimum fin spacing at a given fin diameter and base-to-ambient temperature difference. The correlation obtained from scale analysis is the result of limited number of experiments. This
correlation may be generalized by applying the order-of-magnitude analysis developed in this work for wider range of experiments.

III PROBLEM DESCRIPTION

The objective of the present study is to design and analysis of fins and to find the best alternative material of fins. In the present study aluminum and copper fin have taken in place of currently using material like aluminum. In this analysis is done for aluminum fins and calculate the heat transfer rate.

IV EXPERIMENTAL WORK

4.1. Fabrication Set-up

The heat sink inserted into the pocket which was machined along the side of the UPS. The Heat sink was connected to the Field Effect Transistor to obtain the required voltage Input. The battery charged (Ac to Dc), Voltage input disconnected and start the power supply battery (Dc to Ac). The field effect transistor generates the heat to measure the temperature reading for every 60 seconds to temperature sensor and indicates the temperature in temperature indicator.

4.2 Experiential Procedure

UPS is connected to the power supply to charged ac to dc battery. Disconnect the power supply to start the inverter to power supply dc to ac. It consists of transistor which generates heat. A heat sink is connected to transistor to reduce heat. The temperature is measured in temperature sensor to indicate the temperature indicator after the steady state conditions. The observations are tabulated in the observation table.

4.3 Model

Fig 4.4. Model of Heat sink.

Heat sink UPS, market available is selected for the present investigation. The dimensions of the selected heat sink are found using Vernier calipers, screw gauge and are tabulated in the table 4.1. According to the dimensions the model of the heat sink is developed using PRO/E (cero-parametric). The modeled heat sink is shown in figure 4.1. It is imported in to design modeler of ANSYS work bench.

Table.4.5 Properties of aluminum:

S.NO	Property	Value in metric unit	
1	Density	7850	kg/m^3
2	Modulus of elasticity	$2 X10^{11}$	GPa
3	Tensile strength	$2.5 X10^{8}$	MPa
4	Elongation	12	%
5	Flexural strength	196	MPa
6	Thermal expansion (20 ºC)	$1.2 X10^{-5}$	$^{\circ}C^{-1}$
7	Thermal conductivity	151	W/(m K)
8	Melting point	585	ºC
9	Maximum work temperature	400	ºC
10	Electric resistivity	2.65	Ohm X m
11	Dielectric constant	0	-

Table.4.6 Properties of copper:

S.NO	Property	Value in metric unit	
1	Density	8300	kg/m^3
2	Modulus of elasticity	138	GPa
3	Tensile strength	$2.8 X10^{8}$	MPa
4	Elongation	31	%
5	Flexural strength	210	MPa
6	Thermal expansion (20 ºC)	$1.5 X10^{-5}$	$^{\circ}C^{-1}$
7	Thermal conductivity	398	W/(m K)
8	Melting point	1050	ºC
9	Maximum work temperature	900	ºC
10	Electric resistivity	0.0171	Ohm X m

Table 4.7 Chemical composition of chromium steel:

Fin length	Fin width	Fin thickness	No of Fin
23mm	10mm	1mm	13

V RESULT AND DISCUSSION

To calculate the heat transfer rate for aluminum fin. In future work of to calculate the heat transfer rate for copper fin. Then analysis by using ansys software to evaluate heat transfer rate for aluminum fin and copper fin. To fabricate of head sink in both materials. To take the mechanical and thermal test. To compare the analysis and laboratory results. By this result we conclude the best material.

VI CONCLUSION

In this study the steady state natural convection heat transfers from vertical rectangular fins protruding from a vertical base was investigated experimentally the effects of geometric parameters, fin height, fin length, fin spacing and the base to ambient – temperature difference on the heat transfer performance of fin arrays was discussed. A relation for the optimum fin spacing value that maximizes the heat transfer was obtained. The ups transistor was constructed and heat generation to perform the experiment of fin configurations. After the calibration of experimental ups transistor had been verified, experiments were conducted on five different fin temperatures in order to determine the heat transfer performances of the fin arrays. The results of the experiments were presented graphically and tabulated. From the ansys test the following conclusion were made:

REFERENCES:

[1] Welling J.R. and Wooldridge C.N., “Free Convection Heat Transfer Coefficient from Vertical Fins”, Journal of Heat Transfer, 439-444, (1965)

[2] Harahap F. and McManus H.N., “Natural Convection Heat Transfer from Horizontal Rectangular Fin Arrays”, Journal of Heat Transfer, 32-38, (1967).

[3] Jones C.D and Smith L.F., “Optimum Arrangement of Rectangular Fins of Horizontal Surfaces for Free Convection Heat Transfer”, Journal of Heat Transfer, -10, (1970).

[4] Hua-Shu Dou,1Gang Jiang,2and Lite Zhang “A Numerical Study of Natural Convection Heat Transfer in Fin Ribbed Radiator’ Hindawi Publishing Corporation Mathematical Problems in Engineering Volume 2015, Article ID 989260.