ISSN (O): 2393-8609

International Journal of Aerospace and Mechanical Engineering

Volume 5 – No.1, February 2018

EXPERIMENTAL AND CFD ANALYSIS OF HEAT SINK WITH AL-CU IN CPU COOLING

Srinivas. D[1]
Prof and Head
Dept of Mech Engg
Research scholar
Bangalore.

Dr. S. Ramamurthy[2]
Professor and Guide
CMET, Jain University
Bangalore

Dr M.A.Raheem[3]
Prof, mec dept & Principal
KCTEC, kalaburagi 3
Bangalore

ABSTRACT

A heat sink device for use with thermal load of 20W, temperature of the heat source rises by 100C dissipating heat into the atmosphere. Heat sink performance is measured in 0C /W.ie rating of 100C/20W,=0.50C/W. A cooling unit comprising a heat radiating plate and an electric fan device. The heat radiating copper base plate has thermal conductivity of 400W/mK and comprises a heat receiving portion of Aluminum fin with thermal conductivity of 205W/mk and a heat exchanging portion, (fan) which are arranged side by side. Tapered solid fin configuration is been considered for testing by experimental and CFD simulation methods. With base of 5mm & tip dimensions varying as 1.5mm, 2.00mm, 2.5mm

Keywords

Heat sink, IC's, cooling fan, fin configuration, heat dissipation rate, fidelity, Geometrics, CFD simulation

1. INTRODUCTION

With the rapid development of electronic technology, electronic appliances and devices now are always ever-present in our daily lives. However, as the component size shrinks the heat flux per unit area increases dramatically. The working temperature of the electronic components may exceed the desired temperature level. Thus, promoting the heat transfer rate and maintaining the die at the desired operating temperature have played an important role in insuring a reliable operation of electronic components. There are a number of methods in electronics cooling, such as jet impingement cooling and heat pipe. To design a practical heat sink, some criteria such as a large heat transfer rate, a low pressure drop, and a simpler structure should be considered. . Among various types of heat sinks, plate-fin and pin-fin heat sinks are widely used owing to their own advantages. The plate-fin heat sink has the advantages of a small pressure drop, a simple design and easy fabrication. The purpose of the present work is two-fold. First, obtain experimental data for the thermal characteristics of selected individual heat sinks to enable a generalized comparison of different heat sinks. Second, develop computational models for the heat sinks with the simplest geometries (dimensions) and compare the results with the experimental results to verify the fidelity-(accuracy) of the models.

2. OBJECTIVES

Heat sink dissipates heat in large and faster rate using less space. Heat transfer analysis of heat sink is greatly simplifies by introducing one-dimensional heat transfer along constant Uniform thickness, base plate material are optimized and to analyze the flow and heat transfer inside the complex. Heat sinks offer the same attributes as their single-phase counterparts while providing the following important added benefits: higher convective heat transfer coefficients, better temperature uniformity, and smaller Coolant flow rate.

3. EXPERIMENTAL SETUP AND PROCEDURE

This test setup is not the whole computer chassis system, but a smaller domain in order to simplify the experiments. An experimental setup is arranged with an electrical heater of size 50 x 40mm as a heat sources to imitate a processor and it is supplied by direct current power supply. A heater strip was mounted on a piece of circuit board which was, in turn mounted on a piece of insulation. Silicon compound and Araldite were used to fix aluminum tapered fins (04) to the copper base plate of base thickness 2.5mm and tip thickness1.5mm. The heat sink rejects the heat into air which is enhanced by placing the blower.

The area covered by the resistance coils (on the heat strip) is less than the area of the base of the heat sink, so that the bottom surface of the heat sink completely covers the active heater section. This ensures that the entire power output of the heater is dissipated through the heat sink. Ten (10) J – type thermocouples are used for temperature measurement. To measure the maximum temperature of the heat sink, 02 thermocouples were mounted through 1mm deep holes at the base plate of the heat sink.. The thermocouple is positioned 10mm from the leading edge of the heat sink. Each fin has two (02) thermocouples at 10mm from base at ends. Therefore 02thermocouples x04 fins is 08 thermocouples. Total 10thermocouples fixed.

Fig 1 shows the schematic representation of the arrangement for the experimentation. Since the test setup is an open domain, the atmospheric temperature is the temperature of the air blown to the heat sink. The atmospheric air is passed around the heat sink which is heated then is exhausted by blower and also the pressure drop has been noted. In this setup other heat sources are not considered for simplifying the experiments. In this experimental setup the desired volume flow rate of the air

ISSN (O): 2393-8609
International Journal of Aerospace and Mechanical Engineering
Volume 5 – No.1, February 2018

was generated by a suction type blower in steadily of CPU fan. The steady state was assumed that the change in maximum temperature of the heat sink was smaller than ± 10C for a period of 3 min.

The temperatures are recorded and used to calculate the thermal resistance of the heat sink. The wind tunnel is an open circuit type consisting of a variable speed ½ horse power direct current motor powering a squirrel cage blower. Temperatures were measured with thermocouples and temperature data was collected at the locations upstream of the heat sink, and at the base of the heat sink

Geometric parameters of heat sink:

Fin Length, W_f(mm)	Fin Height, L_f (mm)	Fin Width b mm	Fin Number N	Top Fin Thickness, t_f (mm)	Fin –to-Fin distance ξ (mm)	Base thickness T_b mm	Base Fin Thickness mm
50	20	40	04	1.5	5	5	2.5

Schematic diagram of heat sink:

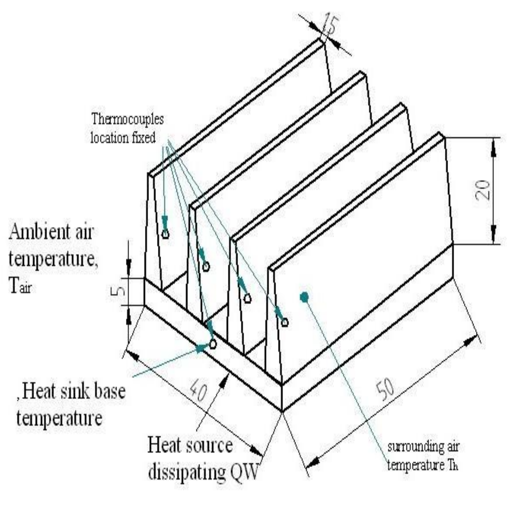

fig:1

4. CFD CALCULATIONS

4.1 Pre-processing

Pre-processing is the first step to achieve modeling goals and computational grid is created. In the second step numerical models and boundary conditions are set to start up the solver.

Solver is terminated, the results are examined which is the post-processing part.

The above three main steps constitutes CFD calculations.

4.2 Flow configuration:

The compressibility effects and turbulence inside the chassis are the parameters changing the governing equations to be solved.

i) Compressibility: The fluid in the domain is air. The compressibility effects are ignored due to the low speeds.

For a 90mm dia fan with 90CFM of air flow. Velocity of the incoming air and mach number are calculated as.

I] **velocity of the incoming air,**

$V_a = G/\pi r^2$ ------ m/sec. since G is fan flow rate,

= 90 CFM r is the fan dia =90mm

= 90x0.30483 x1/ π x (90/1000)2x6

= 1.67m/sec

2] **Mach number,**

$M_a = V_a /c$

= 1.67/300, c = speed of sound as 300 m/sec = 5.588 x 10^{-3}Although air is compressible fluid, incompressible flow assumptions is valid as long as the Mach number is smaller than 0.3. Hence we incompressible flow assumptions will be used for this study.

ii) Radiation

This is one of the important things to be considered when flow inside a computer chassis is to be solved. For a chassis inside which natural convection is the dominant heat transfer mode, radiation should be taken into account. In our case, the main heat transfer mode is forced convection.

Since only the radiative heat transfer between the imaginary surface bounding the heat sink and the surroundings is important, the heat sink is taken as a box with dimensions 50x55x40mm3.The heat sink dissipates 60 W of heat. It’s assumed that heat sink temperature is uniform and 50 ^{0}C and the surrounding temperature is 38 0C.assuming a view factor of 1 and surface emissivity of 0.97.the net radiative heat transfer accounted for is about 5% of the total heat transfer.

A= heat transfer area

= 0.05 x 0.04 + 4 x 0.055x0.05 = 0.013m^2

ISSN (O): 2393-8609

International Journal of Aerospace and Mechanical Engineering

Volume 5 – No.1, February 2018

Since. ε=0.97, F=1

Q= $\varepsilon\, \sigma$ FA $(T_h^4 - T_{surr}^4)$ --- watts

= $0.97 \times 5.67 \times 10^{-8} \times 1 \times 0.013 \times (323^4 - 311^4)$

Radiative heat transfer rate,

1.0936 W, which is negligible

iii) Turbulence

The flow inside the chassis is turbulent regardless the Reynolds number. The existence of several different components and several heat sources together with the vortices created by the fans make the flow regime turbulent inside the chassis.

5. Conclusion

The number of fins and their distribution, fin material and base plate thickness are to be investigated for enhancing the heat dissipation rate from CPU. Improvements on heat sink designs are possible by the use of CFD. It is possible to design a new heat sink with suitable base plate which has better thermal performance and uses less material using CFD simulations. The heat sink base thickness is also a parameter for increasing the performance of the heat sink. A finite volume method with an unstructured non-uniform grid system is employed for solving the model. The predicted results of CFD are to be validated by comparing with experimental data. The predicted results may be in reasonable agreement with the experiments.

6. References

1) S,Lee et al. 1995 IEEE.

2) Antohe et al., 1996.

3) Bastawros, A.F., Evans, A.G.1997.

4) Camidi and Mahajan, 2000. Sultan, 2000;

5) M.Shimada et al.: Furukawa Electric Review, 108 (2001) 23.

6) El-Sayed et al., 2002: M.Oomi et al.: Furukawa Review, 21 (2002) 69.

7) Kim et al., 2003;Rodgers and Eveloy (2003) Hsieh et al., 2004.

8) Dempsey et al. (2005), Emori et al.: OFC'99, PD19.

9) Bhattacharya, A., Mahajan, R.L.,2006. Transactions of the ASME: Journal of Electronics Packaging Yazawa et al.2006

10) Incropera, F.P., DeWit, D.P., 2007. fundamentals of heat and mass transfer, 6th edition, John Wiley& Sons.

11) Duan and Muzychka (2006, 2007). Banerjee et al., 2008,Geisler, 2009

12) Optimum heat sink Design and Selection at IJIAEM, 2013