VALIDATION OF SINGLE CUT PLATE-FIN OF COMPUTER CHASSIS BY VARYING GEOMETRY AND USING METALLURGICAL COMPOUND OF CARBON

Christian Walsh Benjamin[1], Darshan N Gajdhar[2], Krunal A Shah[3]

[1]PG Student, Department of Mechanical Engineering, D.J.M.I.T, GTU
[2]Assistant Professor, Department of Mechanical Engineering, D.J.M.I.T, GTU
[3]Assistant Professor, Department of Mechanical Engineering, H.G.C.E, GTU

Abstract- *Experimental and numerical performance of variety of heat sink with different base plat like, aluminum, copper and carbon carbon composite are used for increasing heat dissipation rate in CPU have been undertake in this project.in this research work the parameter of heat sink Geometry like, fin pitch, fin thickness, base plate thickness is varying and base plate materials change for improving the thermal performance of single cut plate-fin heat sink. Experimental Performance of heat sink also compared with commercially available ANSYS CFD. In this research the model of heat sink and heat sink geometry will be developed by ANSYS Fluent software generally the heat sink and other fin geometry is created by preprocessing Software gambit and steady state simulation is carried out by ANSYS fluent CFD software. First, we taking some individual heat sink and base plate of heat sink bottom to top we placing a Thermocouple at different different position and we measuring an existing temperature of heat Sink and after we putting this data in ANSYS software for validation this data is validated so we Varying heat sink geometry and also changing base plate materials of heat sink.*

***Keywords*: Single cut plate-fin, Base Plate, Forced Cooling of Electronics Devices, Thermal resistance, Computational Fluid Dynamics.**

1. INTRODUCTION: -

The performance levels of electronic systems such as computers are increasing day by day, while keeping the temperatures of heat sources under control has been a challenge. All electronic equipment's depend on the flow and control of electrical current to perform a variety of functions. Whenever electrical current flows through a resistive element, heat is generated. The heat dissipation is one of the most critical aspects to be considered in order to maintain the continuous operation. The electronic industry requires increased forced-air cooling limits to cool heat sources of CPUs adequately. Improving the air -cooled heat sink thermal performance is one of the critical areas for increasing the overall air-cooling limit. The purpose of the present work is twofold. First, obtain experimental data for the thermal characteristics of some individual heat sinks to enable a generalized comparison of the differences between the heat sinks. Second, develop computational models for the heat sinks with the simplest geometries and compare the results with the experimental results to verify the fidelity of the models.

2. LITERATURE REVIEW: -

Zhao and Avedisian (1997) have presented an experimental study of heat transfer from an array of copper plate fins supported by a copper heat pipe and cooled by forced air flow. The results are compared to an identical array of copper fins, but supported by a solid copper rod. The primary variable is the height of the fin stack, while the fin pitch, air flow rate, surface area and fin shape is fixed. The results show that for some conditions, fins of fixed pitch supported by a heat pipe dissipate higher heat transfer rates for the same surface temperature than fin arrays supported by a solid rod.

Marongiu et al. (1998) have discussed the investigation of micro heat pipes and other high thermal conductivity materials that has been incorporated into Multi-Chip Modules (MCM). The parameters that affect the heat dissipation capabilities such as fin material, fin height, heat pipe configuration and pumping power have been changed and analyzed using Icepack.

Wang and Vafai (2000) presented that the temperature along the heat pipe wall surfaces is quite uniform. The results also indicate that the porous wick of the evaporator section creates the main thermal resistance resulting in the largest temperature drop, which consequently affects the performance of the heat pipe.

Miller et al.(2007) have described the design of a high performance single phase liquid cooling system which has been used to cool single or multiple heat sources within the computer system. The liquid cooling system consists of copper cold plates, heat exchanger, centrifugal pump, flexible tubing and a coolant has been integrated for long operating life.

Jang et al. (2003) have experimentally investigated the heat transfer enhancement of a micro channel heat sink subject to an impinging jet. In order to evaluate the cooling Performance of the micro channel heat sink subject to an impinging jet, temperature distributions are measured by using a micro thermal sensor array manufactured through simple and convenient micro fabrication processes.

Yongmann et al. (2002) has presented the unsteady heat transfer caused by a confined impinging jet using direct numerical simulation (DNS). The time-dependent compressible Navier Stokes equations are solved using high-order numerical schemes together with high-fidelity numerical boundary conditions.

3. METHODOLOGY:-

The simple three dimensional model based computation will be taken place showing the significant effect of several parameters and their variation combinations. After performing simple calculation, the modelling has been created on the Creo software and then after the analysis work has been performed on the ANSYS version.

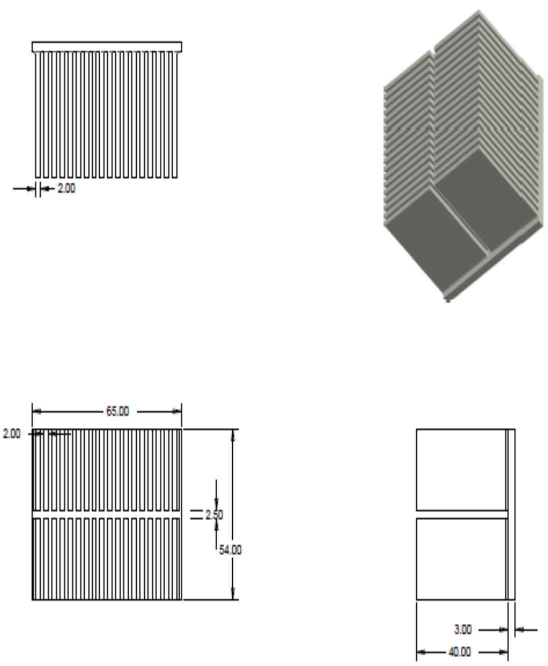

Figure1:-Modelling of heat sink and geometry

4. EXPERIMETAL SETUP

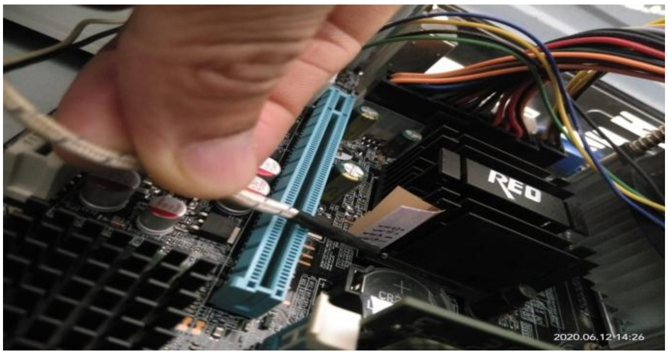

Figure 2:- Measuring Point

In this project we note done for whole computer chassis system but in this project, we developed critical components, in this project power supply is connected with voltage regulator and also given to temperature scanner we distributed through a DC voltage regulator form the constant voltage regulator when air is flowing passed a heat sink so heat sink will be heated and flow of heat is exhausted by a blower.

OBSERVATION TABLE

Sr No.	Temperature (^{0}C)	Base bottom to top measuring portion
1.	65	3mm
2.	62	6mm
3.	59	8mm
4.	58	10mm
5.	54	12mm

PRODUCT SPECIFICATIONS		
OBJECT NAME	**MATERIALS**	**HEAT DISSIPIATION RATE IN WATTS**
CPU	Silicon	100
CPU HEAT SINK	Al-Cu	-
COMPACT DISK(CD)	Al	15
DIGITAL VERSATILE DISK (DVD)	Al	15
HARD DISK DRIVE (HDD)	Al	20
POWER SUPPLY	Pores	75

4.1THERMAL RESISTANCE OF HEAT SINK

The maximum base temperature of the heat sink and minimum top surface temperature are used to calculate the thermal resistance of the heat sink.

Rth=Tb, avg-Ttsavg/Q

1. Thermal resistance of heat sink on 3mm position of thermocouple on bottom to top measuring temperature when 65°C is base temperature of heat sink and 32°C atmospheric temperature.

Rth= 65-32/100

Rth=0.33K/W

2. Thermal resistance of heat sink on 6mm position of thermocouple on bottom to top measuring temperature when 62°C is base temperature of heat sink and 32°C atmospheric temperature.

Rth= 62-32/100

Rth=0.3K/W

3. Thermal resistance of heat sink on 8mm position of thermocouple on bottom to top measuring temperature when 59°C is base temperature of heat sink and 32°C atmospheric temperature.

Rth= 59-32/100

Rth=0.27K/W

4. Thermal resistance of heat sink on 10mm position of thermocouple on bottom to top measuring temperature when 58°C is base temperature of heat sink and 32°C atmospheric temperature.

Rth= 58-32/100

Rth=0.26K/W

5. Thermal resistance of heat sink on 12mm position of thermocouple on bottom to top measuring temperature when 54°C is base temperature of heat sink and 32°C atmospheric temperature

Rth= 54-32/100

Rth=0.22K/W.

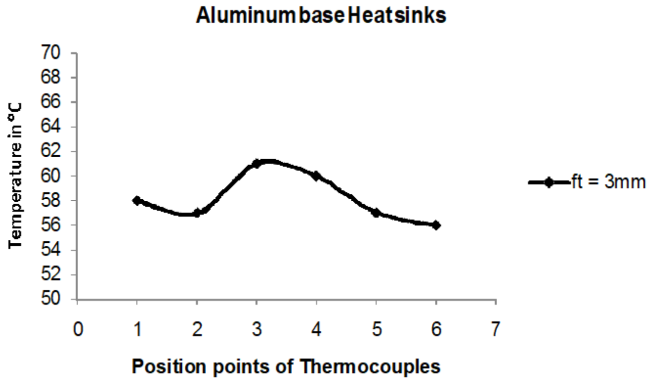

Figure 3:- Temperature distribution at base of heat sink

At base of heat sink we measure the temperature of heat sink with help of thermocouple at point 3 we get maximum temperature 62^{0}C so we can say that middle portion of heat sink is high.

4.2 BOUNDARY CONDITIONS:-

Since Navier-Stokes equations are solved inside the domain, the boundary conditions for velocity and temperature fields are needed.

4.3 HYDRODYNAMIC BOUNDARY CONDITIONS:-

1. At the inner walls in the domain no-slip boundary condition is applied.

u = 0, v =0, w = 0.

2. At inlet

p = pin , v =0 , w =0.

3. At outlet

p = pout , u =0 , v = 0 .

4.4 THERMAL BOUNDARY CONDITION:-

The CPU chip is represented as a 30mm-by-30mm square area at the bottom of the heat sink. A uniform heat flux is given over the chip area which is calculated based on the total heat dissipation value.

1. At inlet

T = Tin

2. At outlet

dT/dZ=0

4.5 MESHING OF THE MODEL:-

Meshing in CFD analysis is start with Preparing the Model. Convert solid assembly prepared as mention in figure in to part. And create the model that only has wet surfaces. Logic behind is to decrease the computational power use for the analysis.

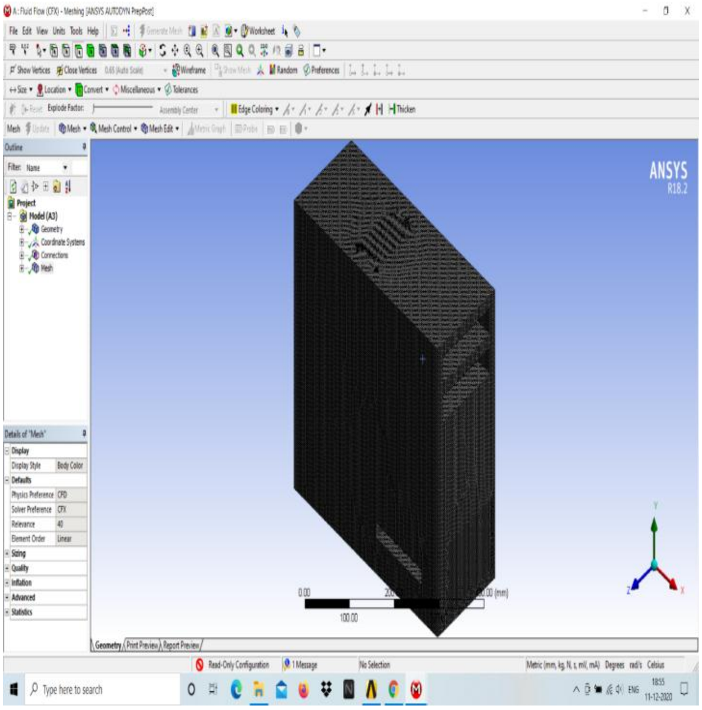

Figure 4:- Meshing of the CPU

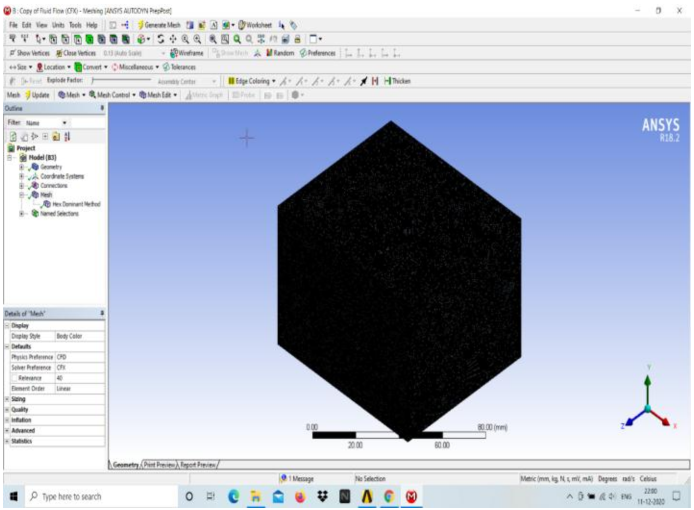

Figure 5:- Meshing of the Fin

4.6 VALIDATION:-

The heat sink is placed centre of the domain and the heat source is provided at centre of the heat sink by using heater. To reduce the heat loss, the bottom of the heater is insulated and the other components are not considered in this setup. The experiments are not conducted in fully controlled environments. In order to verify the present numerical study, the experimental results of the thermal difference of a heat sink, one of the experimental cases (Aluminium base plat heat sinks) have been compared to those obtained from CFD simulations.

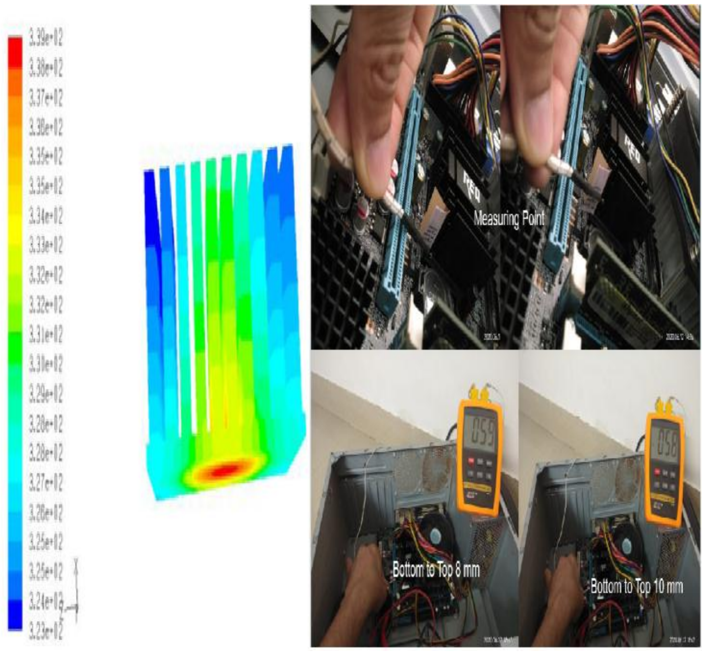

Figure.6:- Validation of Heat sink Ansys CFD

The experimental and simulation results of temperature difference are given in figure and are found good agreement in nature within acceptable limit of deviations. This demonstrates the exactness of CFD and Experimental methodologies. Here by test and CFD investigation result has 1% deviation which is low and insignificant, which contrast appeared in above in table. So, for the further investigation to enhance execution of the heatsink we can utilize CFD examination.

Original (Existing Case)	Experimental Results		CFD Analysis Results	
	Temp(°C)	Base Bottom to top measuring point	Temp(K)	Temp(⁰C)
1	65	3mm	337	64
2	62	6mm	335	62
3	59	8mm	333	60
4	58	10mm	332	59
5	54	12mm	330	57

Table :- Comparison Experimental and Simulation Results

5. RESULTS AND DISCUSSIONS:-

The analysis of heat sinks with Carbon Carbon Composite base of 2.5mm and 5mm thickness has been studied. The heat sink of three different fin thicknesses with variable fin pitch is simulated by keeping the entire computational domain.

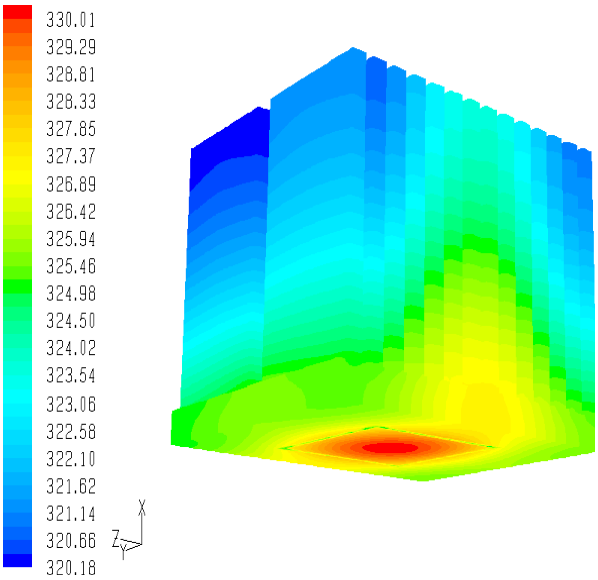

Figure (a):-ft=3mm

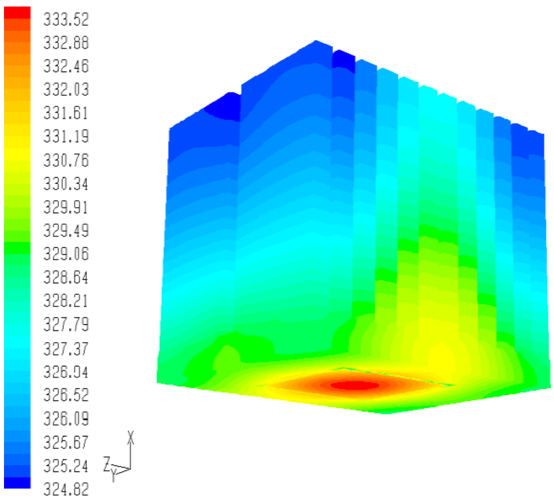

Figure (b):-ft=4mm

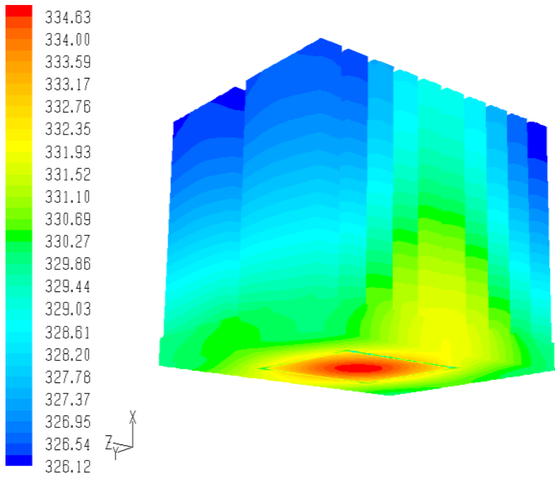

Figure (c):- ft=5mm

Figure 7:- Temperature distributions on 2.5mm carbon carbon composite base heat sink of different fin thickness with fp = 1.5mm

The chassis model with single plate cut-fin heat sink is analyzed by CFD simulations. The results have been obtained by varying the fin thickness and changing the base plate materials. The 3mm,4mm,5mm fin thickness is considered with base plate of carbon carbon composite single cut plate fin heatsink temperature distribution as shown fig.

As shown in figure the temperature distributions on 2.5mm carbon carbon composite base heat sink of various fin thickness with 1.5mm pitch. It is shows that the temperature difference is decreased from 9.83^{0}C to 8.51^{0}C by increasing the fin thickness. The base temperature of single cut plate fin is increased up to 4.6^{0}C by increasing the fin thickness. The base temperature is decreased by 0.6°C for varying the fin pitch from 2.5mm to 1.5mm for 3mm and 5mm fin thickness and there is insignificant change for 4mm fin thickness. Even though carbon carbon composite base plate has high thermal conductivity, the base temperature of single cut plate fin heat sink is increased when compared to 5mm copper base single cut plate fin heat sinks. It is decreased approx. 1°C compared to 2.5mm copper base plate and aluminium base plate single cut plate fin heat sinks. the temperature distributions on 5mm carbon carbon composite base single cut plate fin heat sink of various fin thickness with 1.5mm pitch. It is shows that the temperature difference is decreased from 8.3°C to 7.6°C by increasing the fin thickness.

6. CONCLUSION AND FUTURE SCOPE:-

In this study the colling of CPU is been investigated by computer chassis by different fin geometry and different base plate materials.at 100W heat load of CPU we use different base plate as a heat sink and checking experimental and numerical results, in this study we not developing all the components of CPU but we developing critical components in computer chassis

Therefore, modelling of them brings out additional computational complexity which is not worth modelling. On the other hand, difficulties occurred when modelling some critical components such as the processor single cut plate-fin heat sink, the chipset heat sink. Other than the geometrical complexity, there is a complexity related with the power ratings of some electronic components and the power supply. The exact operating power ratings of these components are impossible to determine, therefore reasonable values are assigned from literature review. The influence of the meshing resolution, choice, convergence criteria, and discretization schemes are investigated to find the best model with the least computational timing. The heat sink thermal resistance results are compared with the experimental results and found been a good agreement. While the comparison is qualitative, it has been observed that CFD simulation results are in good agreement with experimental results for the heat sinks. The system is developed for simulating the computer chassis.

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NOMENCLATURE :-

F_p= Fin Pitch

F_t= Fin Thickness

L= Heatsink Length

W=Heatsink Width

T_{bp}=Base Plate Thickness

Q= Power Generated From CPU(W)

$T_{b,avg}$=Average Base Temperature(K)

$T_{ts,avg}$= Average Top Surface Temperature(K)

R_{th}=Thermal Resistance