COMPUTER AIDED DESIGN AND ANALYSIS OF HEAT SINKS WITH SQUARE, CIRCULAR AND RECTANGULAR FINS OF DIFFERENT SIZES USING SIMSCALE

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Abstract- Heat sinks are widely used in electronic devices to cool the motherboards in CPU and many electronic devices. Heat sinks with variety of cross sections by varying their size of cross section and keeping height as same are designed using FUSION 360 and analysed with real time parameters like heat input and convective environment as input using SIMSCALE. Finally the best among all types is determined.

Keywords—Heat sink, Design, Analysis

I. INTRODUCTION

A heat sink is a component that increases the heat flow away from a hot device. It accomplishes this task by increasing the device's working surface area and the amount of low-temperature fluid that moves across its enlarged surface area. Based on each device's configuration, we find a multitude of heat sink aesthetics, design, and ultimate capabilities. A heat sink works by moving heat away from a critical component. Nearly all heat sinks accomplish this task in four basic steps

1. The source generates heat.
2. Heat transfers away from the source
3. Heat distributes throughout the heat sink
4. Heat moves away from the heat sink

Electronic circuit boards generate heat during processing data, that heat is absorbed by base of heat sink. Further that heat diffuse into whole heatsink by conduction. A fan is provided in a proper position to drag atmospheric air over all the surface of heat sink and to discharge outside of the device.

Fig 1.1 Heat Sinks placed on a motherboard.

II. MATERIALS & METHODOLOGY

1.A processor on the motherboard of dimensions 37.5mmx37.5mmx1mm generates heat at a rate of 80W. A heat sink is to be designed so that the component temperature maintains below 100°C where the ambient temperature is 30°C. A finned heat sink will be used. It is required to design a heat sink that fulfils these requirements. So, different designs are developed and evaluated for their performance. Later the designs are to be investigated by changing fin thickness as how that affects the performance of the heat sink. The designed models of rectangular along the length, square, circular and array of rectangular shape with height 60mm as fixed for all. Further size of the each fin is changed. CFD has been done on the models and the result has been studied. Enclosure of the models to be kept inside is of size 72mmx72mmx80mm. Mass flow rate of the fan has been kept constant at 0.0131 kg/s. Air at 30°C has been given as inlet and outlet is drawn from the opposite side. The orientation of air flow has been finalised as the linear direction has best results than sideway entry towards radial exit. Absolute power source is given as 80W at the bottom of the processor made of Silicon material. Thermal conductivity of Silicon is taken as 130W/m-K.

Table.1: heat sinks studied

Heat sinks	Thickness(mm)			
Rectangle	2x60	3x60	4x60	5x60
Square	2x2	3x3	4x4	5x5
Circular	Φ2	Φ3	Φ4	Φ5
Array of Rectangular	-----	2x3	2x4	2x5

A new model, Rectangular slotted throughout the length has been designed and analysed which resulted in higher efficiency than the pin fin type heat sinks. Higher heat of 400W has been given at the base of processor. The temperature was 37.05°C for 60mm height. Keeping the length and breadth constant, height has been reduced until its base temperature reaches 50°C i.e at 29mm height. According to the above performed analysis 2mm thickness fin has the better efficiency, so the thickness of the present fin has been taken as 2mm and end wall of the processor is taken as 1mm as the temperature at the ends is less than the the centre of the basement.

Noctua NF-A6x25 PWM fan dimensions and specifications has been used in this simulation which has a flow rate of 29 m^3/h at 3000rpm. The dimensions of the fan is 60x60x25mm.

2.The most commonly used material in making heatsinks for CPU is 6063-T5. The following table gives the properties of it.

Table.2:properties of Al 6063-T5

Property	**Aluminium 6063-T5**
Density	2.70 g/cc
Tensile Strength	186 MPa
Yield Strength	145 MPa
Modulus of Elasticity	68.9 GPa
Coefficient of Thermal Expansion @ 20.0 - 100 °C	21.8µm/m-°C
Thermal Conductivity	209 W/m-K

III. RESULTS AND TABLES

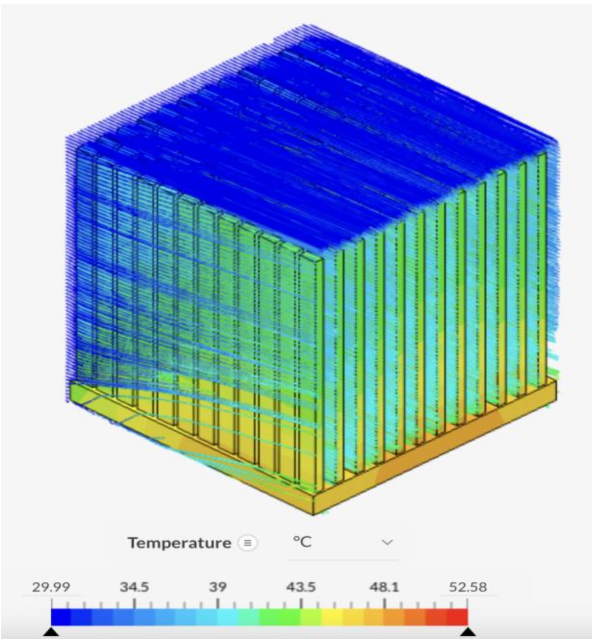

Fig.3.1 Temperature distribution in array of rectangular fins 2x4mm thickness at 80W.

Holding the same design constraints a new design has been made to ensure maximum dissipation of heat with low material possible.

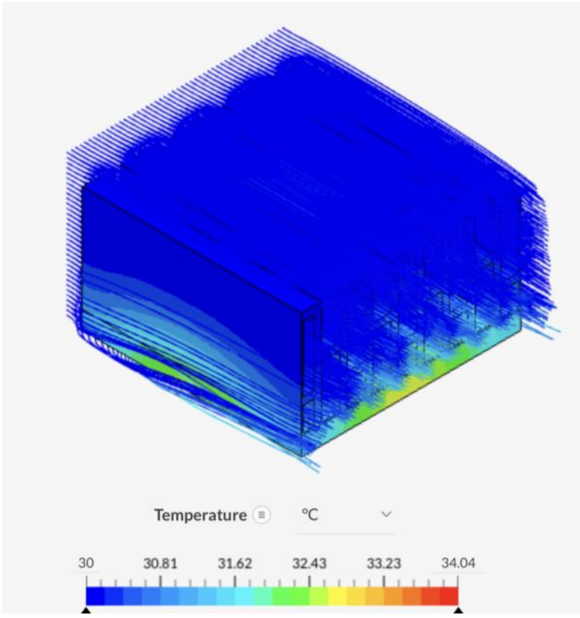

Fig.3.2 Temperature distribution in Slotted Rectangular fin 29mm height at 80W.

The efficiency of this fin was remarkable with an i5 or an i7 processor which has the peak TDP as 80W. In a Mac Pro Intel Xeon W processor generates 400 watts heat.

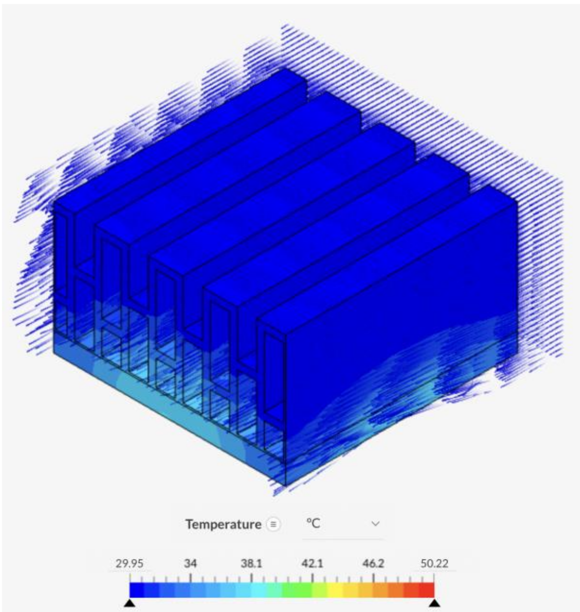

Fig.3.3 Temperature distribution in Slotted Rectangular fin 29mm height at 400W.

With the same dimensions and conditions a heat input of 400W is given at the base of the processor. Results in 50.22°C at the base of the processor.

Table 3.1: Motherboard temperatures with heat sink

Heat sinks	BASE OR MAXIMUM TEMPERATURE			
THICKNESS	2mm	3mm	4mm	5mm
Rectangle	74.32	86.86	81.89	84.06
Square	87.39	79.3	72.5	73.1
Circular	70.57	83.65	79.3	80.62
Array of Rectangular	-----	71.49	69.46	77.53

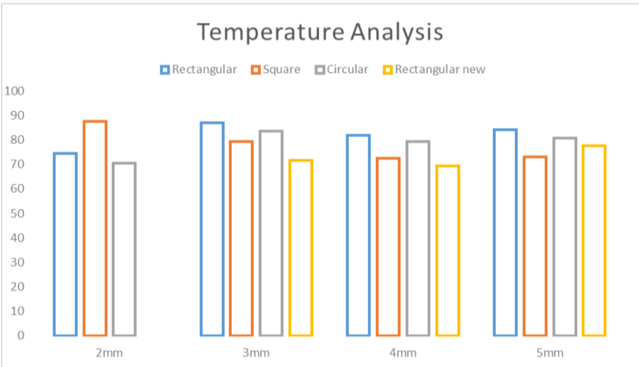

Fig.3.4 Maximum temperatures in different heat sinks.

4. CONCLUSIONS

Among all heat sinks, the best performer is decided based on the lowest temperature of heat sink under given conditions. The Slotted Rectangular design throughout the length has the least temperature at the base. In the simulation pin fin models of different cross sections were also created in the same virtual tool for evaluation. In this study it is clear that the rectangular slotted fin throughout the length performs better than the other heat sinks.

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