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Cooling Performance Analysis of Heat Sink

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ABSTRACT

Today scenario is to use handy electronic devices if motivates the study of cooling devices for controlling temperature and extracting heat which will increase the reliability of components. The continuing increase of power densities in electronics packages and the simultaneous drive to reduce the size and weight of electronic products have led to an increased importance on thermal management issues in this industry. Plate fin heat sinks are commonly used devices for enhancing heat transfer in electronics components. The choice of an optimal heat sink depends on a number of geometric parameters such as fin height, fin length, fin thickness, number of fins, base plate thickness, space between fins, fin shape or profile, material etc. Given a set of design constraints, one needs to determine the maximum possible performance of a heat sink within the constraints. Optimizing the above parameters to achieve low thermal resistance and low pressure drop is very difficult. In order to select the optimal geometric parameters of a heat sink for a more design tools to predict heat sink performance. Therefore in this research work, to select an optimal heat sink design, preliminary studies on the fluid flow and heat transfer characteristics of a parallel plate heat sink have been carried through CFD modelling and simulations. The simulation is carried out with a commercial package provided by Fluent Inc. The geometric parameters considered in this study are fin height, fin thickness, base height and fin count. Experimental validation of simulation results also has been performed. In this present study, for the 100W heat input the heat sink of the size width at 0.5m, length at 1m is used. For parametric study concludes that for minimum thermal resistance the geometric parameters.

Keywords : parallel plate heat sink, thermal resistance, pressure drop, cfd

I. INTRODUCTION

With the novel development in manufacturing techniques and electronic technology, electronic appliances and devices of even micro size are 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 [2]. It motivates the researcher to develop a efficient heat sink which will gives the reliable operation of the electronic devices. 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.

In this present work CFD (Icepak) has been used to study the effect of various parameters like number of fins, height of fin, fin thickness, base height on cooling performance of heat sink for heat load 100W.

II. HEAT SINK MODEL

A typical computational model of the parallel plate heat sink created in ansys icepack is shown in fig.1.

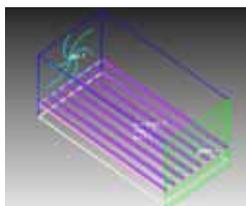


Figure.1 Computational Model

Table 1 – Model Specification

Heat Input	100W
Fin Width	0.5 m
Fin Length	1 m
Cabinet Size	1m × 0.5m × 0.5m
Fan flow rate	12 cfm
Fluid	Air(ambient temp)
Heat sink material	Aluminum

CFD SIMULATIONS

The simulation are carried out using fluent software with air flow at 12 CFM and a heat input of 100 W at the heat sink base. The range of geometric parameters of the chosen heat sink for the present study is given in Table 2. Considering the various geometric variables present, 324 models are created in icepack and simulation are carried out using Fluent to determine the output parameters like base temperature, pressure drop.

Table 2 – Range of geometric parameters used for simulation

Parameter	Minimum value	Maximum value	Increment value
Fin overall height	0.02 m	0.06 m	0.01
Fin base height	0.004 m	0.012 m	0.004
Fin thickness	0.008 m	0.016 m	0.004
Fin count	4	8	2

III. HEAT SINK ANALYSIS

From the parametric study the optimize geometric parameter are found as shown in table 3.

Table 3 Simulation result for minimum thermal resistance, at fin count 8

Sr. no	Thermal Resistance	Pressure Drop	Tmax	Fin Thickness	Fin Base H	Fin Overall H
1	0.08205	1.529	28.2	0.008	0.008	0.06

The Pressure Contours and Temperature Contours are show in Fig. (2, 3)

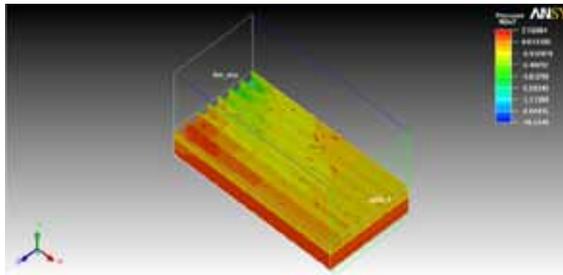


Figure.2 Pressure Contours For Optimize Heat Sink

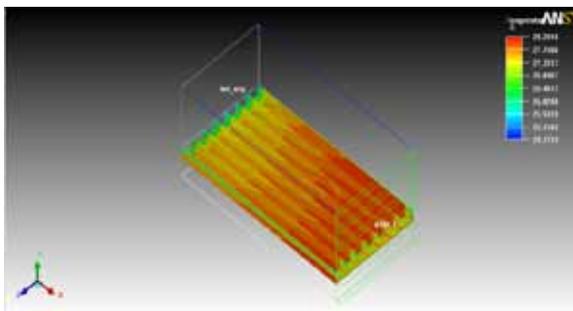


Figure.3 Temperature Contours For Optimize Heat Sink

IV. Results and Discussions

Effect of fin thickness on the thermal resistance and the pressure drop is shown in fig (4, 5) show that as the fin thickness increase the thermal resistance also increases on of decrease in pressure drop for minimum thermal resistance we should select the minimum fin thickness.

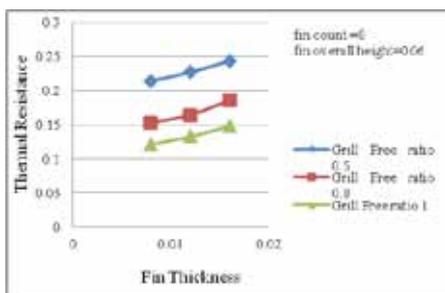


Figure 4 Graphical representation of Effect of Fin Thickness on Thermal Resistance

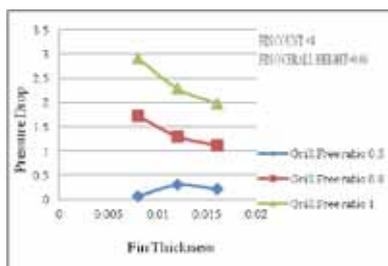


Figure 5 Graphical representation Effect of Fin Thickness on

Pressure Drop

Also the effect of fin base height, fin count, fin overall height, is shown in fig (6, 7, 8) the thermal resistance is proportional varies with fin base height, fin thickness, but it is inversely proportional to fin count and fin overall height, So that with minimum base height and fin thickness and maximum possible no of fins and overall height we can enhance the cooling performance.

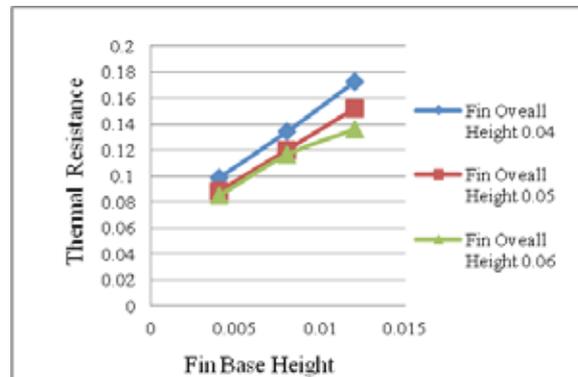


Figure 6 Graphical representation Effect of fin Base Height on Thermal

Resistance

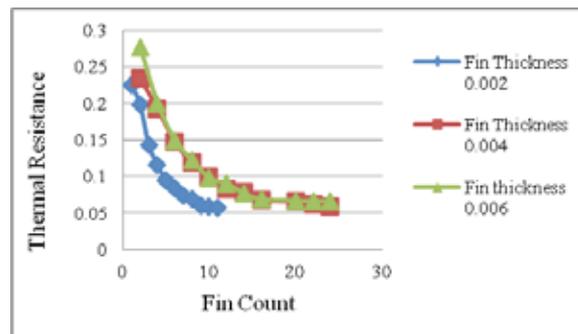


Figure 7 Graphical representation Effect of Fin Count on Thermal Resistance

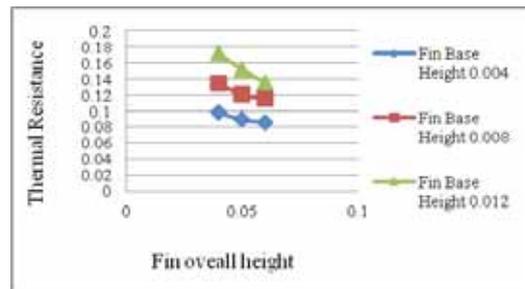


Figure 8 Graphical representation Effect of Fin Overall Height on Thermal Resistance

V. CONCLUSIONS

In the present work we conclude that,

- The cooling performance of a heat dissipating component with Extruded heat sinks is simulated with the Ansys Ice-pack.
- The number of fins, fin thickness, Base height and the overall height were investigated for enhancing the heat dissipation rate from component.

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