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Temperature Distribution Of A Heat Sink Used In Transformer

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Abstract:

This paper deals with the study of temperature distribution on a heat sink used in transformer. The modern laptop or transformer needs to be placed in a limited space. Extended surfaces of fins are used on electronic components raging from power supplies to transformers. The heat dissipation is important for normal functioning of the devices. The heat that is generated by the resistance encountered by electric current. Unless proper cooling arrangement is designed the operating temperature exceeds the permissible limit. For purpose of thickness, base height, fin pitch as 6.2 cm ,5cm,6mm and fin pitch of 8mm.The simulation is carried by using ANSYS Software for a heat generation of 78125 W/m^3 at the bottom of the fin at a temperature of 333 K.The modeling and the analysis were carried using the ANSYS APDL software. The convection is applied on all the surfaces of the fin at a temperature of 293 K.The contour plot ,Temperature gradient and temperature heat flux are obtained.

Keywords: Heat sink, Heat transfer coefficient, Temperature

1. Introduction:

Heat sinks are the most common thermal management hardware used in electronics. They improve the thermal control of electronic components, assemblies and modules by enhancing their surface area through the use of pin fins. Applications utilizing pin fin heat sinks for cooling of electronics have increased significantly during the last few decades due to an increase in heat flux densities and product miniaturization. Today's cutting edge electronic circuits dissipate substantially heavier loads of heat than ever before. At the same time, the premium associated with miniaturized applications has never been greater and space allocated for cooling purposes is on the decline. These factors have forced design engineers to seek more efficient heat sink technologies. One of the more powerful cooling technologies.

2. Objective of Work:

1. To simulate the heat sink for 78125 W/m^3 of heat generation.
2. To predict the temperature distribution.
3. To predict the temperature gradient vector.
4. To predict the temperature flux vector.
5. Comparative study of temperature distribution for 8mm and 6mm pitch

3. Literature Survey

According to the Kelvin Planck and Clausius statement of second law of thermodynamics heat always flow from a region of higher potential to the lower potential. This study involves the prediction of heat flow and temperature distribution on the fin used in the transformer optimum value of the pitch of the fin , in order to dissipate maximum heat to the sink. The modes of heat transfer involves conduction where heat flow within the material or same medium and convection where the heat flows from one medium to that of the other. Free convection takes place naturally and the forced convection occurs with the aid of external means. As experimented by Nagarani [1], an extended surface or a fin is provided to facilitate the heat transfer. There are various types of extended surfaces like infinitely long, short type, insulated type, connected fins etc.

This work was structured as a sequence of fundamental problems built on simple models that capture the most basic characteristics of the temperature distribution in a structure [2]. Heat transfer coefficient value is fixed to 15

The fin is modeled and analyses using the ANSYS APDL and the results and compared. Finite element approach provides the solution at every node of consideration [3]. This paper deals with the comparative Study of heat sinkhaving fins of various profiles [4].This work analysis the rectangular heat sink of variable pin pitch using Ansys Work Bench[5].

4. METHODOLOGY

In the present study the governing equations of heat transfer between the elements are applied. Below equation (1) represents the heat transfer which takes place during conduction derived by the Fourier, and equation (2) represents the heat transfer during conduction which is by Newton's law of cooling [5]. The heat transfer from different heat sources that is different temperature [6] points is represented using equation (3). Temperature at any point in the element is determined by the equation (4).

Fourier's Law of conduction

$$Q^{\cdot} = -KA \frac{dT}{dx} \tag{1}$$

Newton's Law of cooling

$$Q^{\cdot} = hAs\,(Ts - Ta) \tag{2}$$

Heat transfer from different temperature sources

$$Q = \sqrt{h\,p\,k\,A_{cs}}\,(\theta_1 + \theta_2)\left(\frac{\cosh(ml) - 1}{\sinh\,(ml)}\right) \tag{3}$$

Temperature at any point in the element

$$\theta = \left(\frac{\theta_1 \sinh(m(l-x)) + \theta_2 \sinh\,(mx)}{\sinh\,(ml)}\right) \tag{4}$$

Fin Factor

$$m = \sqrt{\frac{hp}{KA_{cs}}} \tag{5}$$

5. MODELLING AND ANALYIS:

The finite element analysis was based on the following common assumptions:

a) Steady-state heat flow,
b) The materials are homogeneous and isotropic,
c) There is a heat generation at the bottom of the fin,
d) The convection heat transfer co-efficient is same all over the surface,
e) The temperature of the surrounding fluid is uniform,
f) The thermal conductivity of the material is constant.

The material property plays a very important role in determining the temperature distribution and the thermal stresses induced. The properties of the aluminum used in the present analysis are given K=180 W/m^2k

1. The representative models of the finned-tube considered in the present study are shown in Figure 1 and Figure 2
2. The boundary conditions applied to the finite element model is as follows.
3. A heat generation of 78125 W/m^3 at the bottom of the fin at a temperature of 333 K
4.. The fin surfaces subjected to fluid bulk temperature of 293 K and convective heat transfer coefficient of 50W/m K.

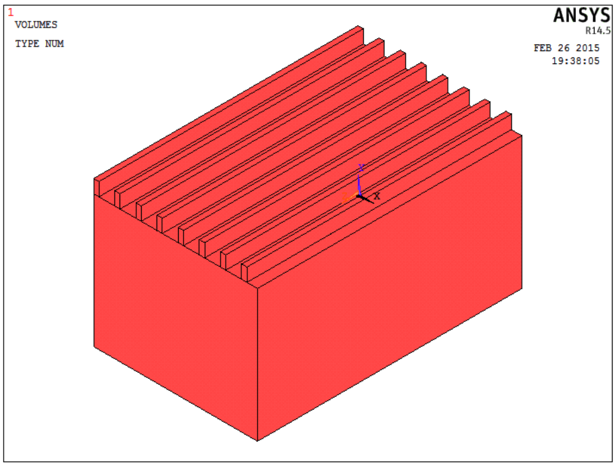
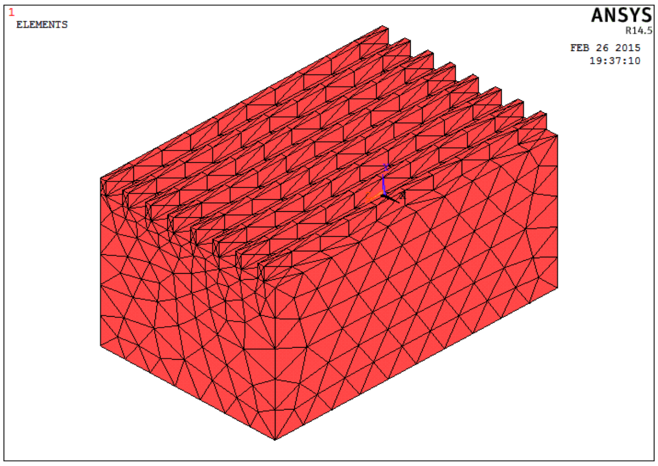


Figure 1.8 mm Pitch model



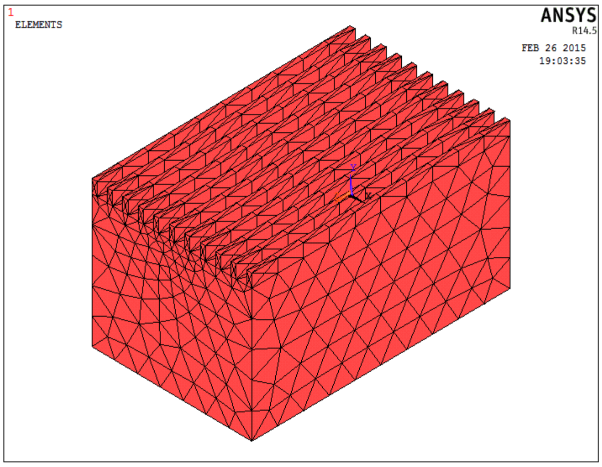


Figure 1. 6mm Pitch model

Table 1 Geometric Parameters:

Model	Fin Height	Fin Thickness	Base Height	Fin Pitch
1	5 mm	2mm	50 mm	8 mm
2	5 mm	2mm	50 mm	6 mm

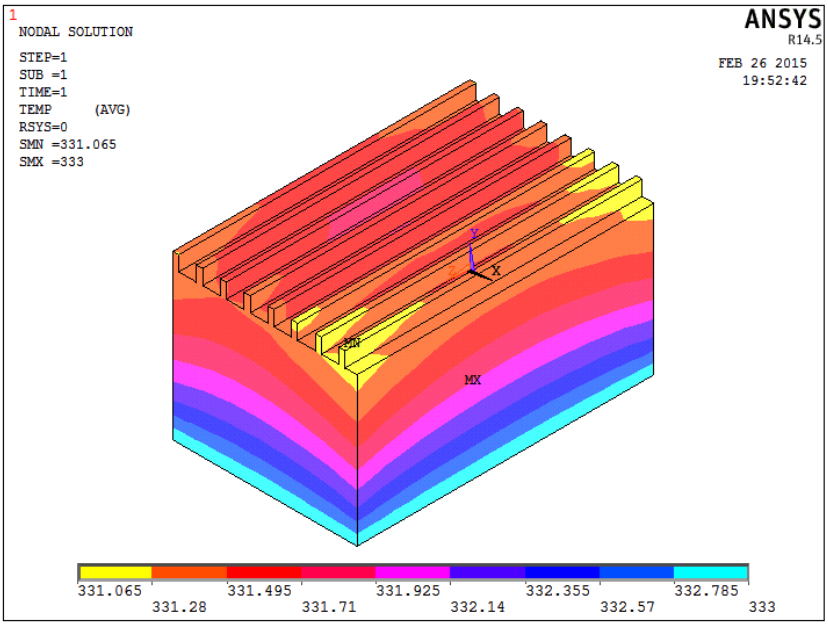
6. Result and Discussion

Table 2

Model	Fin Pitch	Maximum Temperature
1	8 mm	331.065
2	6 mm	330.584

6.1 Temperature distribution along the length of the fin with different Pitch

A thermal analysis was carried out with different fin pitch of 8mm and 6mm .The temperature contour are shown if figure 3 and figure 4. The above table indicates that the value of temperature distribution decreases as the fin pitch is reduced.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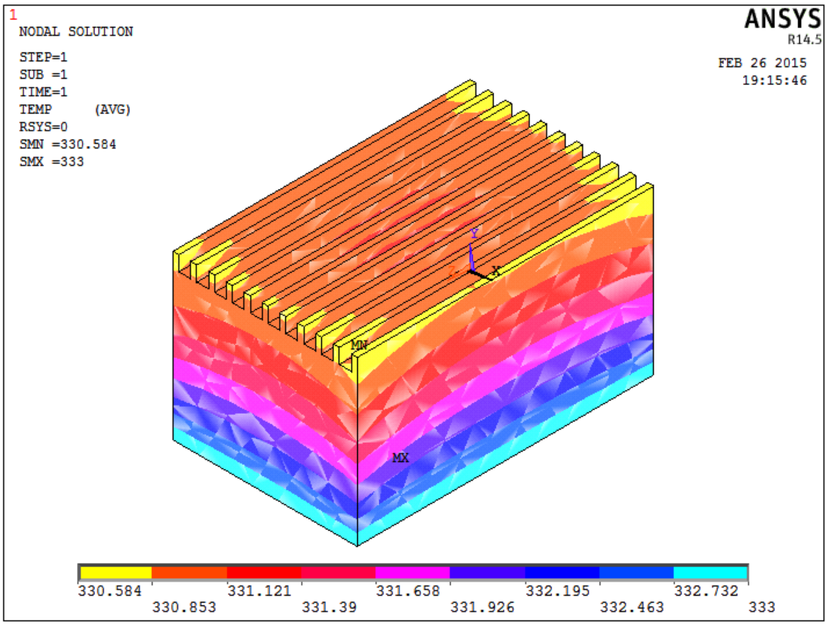
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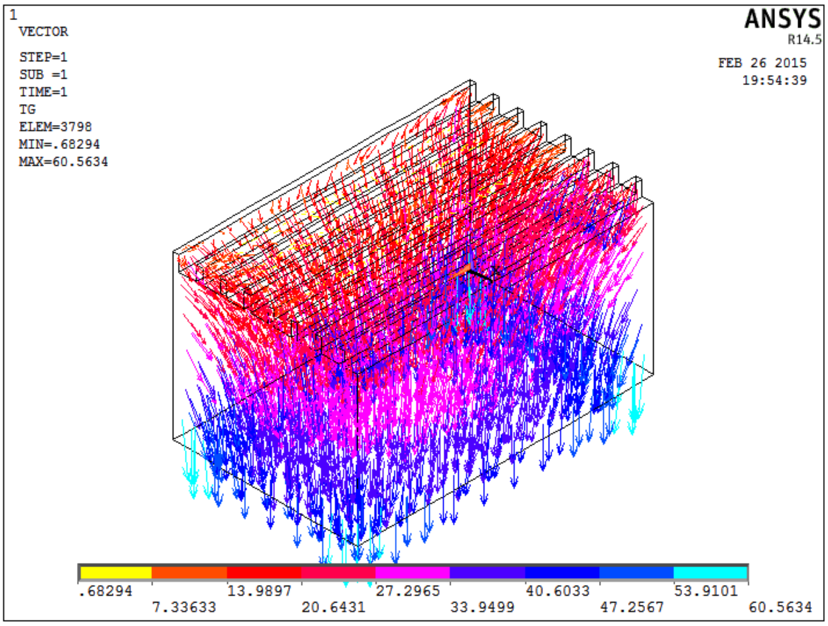

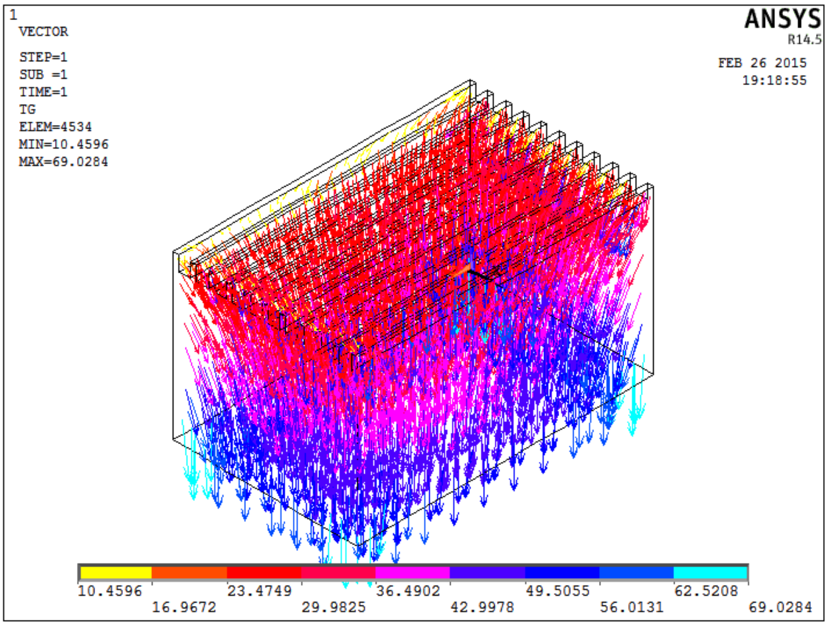

7. Conclusion

The current analysis has presented the study of the temperature distribution for the different pitch of the fin. It has been seen that the maximum temperature in the fin is reduced when the fin pitch is reduced .Also the vector plot of the heat gradient are plotted. The same analysis can be done by using computational fluid dynamics by passing air at particular speed so that the heat dissipation can be reduced to a considerable level.

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