Thermal Analysis of Cooling Fin for Electronics Circuit

Rajesh Pant, Jasmeet Kalra, Pankaj Negi, Rajesh P Verma

Abstract: ***In this paper we have used second law of thermodynamics. Fourier law and Newton's law of cooling, fin equations is used to solve a variety of steady heat conduction problem. The Problem is solved computationally using ANSYS Software. Analytical results were obtained for cooling fin. Convection is found to be along with all the boundaries of the assembly except the lower most, which is fixed to the steel block. The film coefficient is taken to be 50 W/m²K and the Bulk (ambient) Temperature is taken as 293 K. The block will be containing a copper/aluminium heating element that releases heat, totaling to 27.2 W. The other boundaries of the steel block are insulated to prevent the loss of heat energy. Due to temperature difference heat will flow from higher temperature to lower temperature. Fins were used to increase heat transfer rate. Result obtain were nodal temperature distribution and maximum value temperature in the component. we will also see how temperature varies with different thermal conductivity of material. With the help of MATLAB graph has been plotted to make it more understandable.***

Keywords: - fin (extended surface), ANSYS software, MATLAB software, convection, conductivity of material

I. INTRODUCTION

In the recent few years electronic has developed to revolve all around of our daily life. At the same time with increasing number of its application, requirement of higher reliability has been a mandate .The failure of a device used in our daily life can be compromised but devices supporting vital system of emergency services like healthcare, defense equipment's could lead not only interuption of that service but could lead to fatality.

Recognizing the importance of the problem much focus has been given to the enhancement of the reliability level as well as to the improvement and enhancement of the electrical performance of the electronic devices.

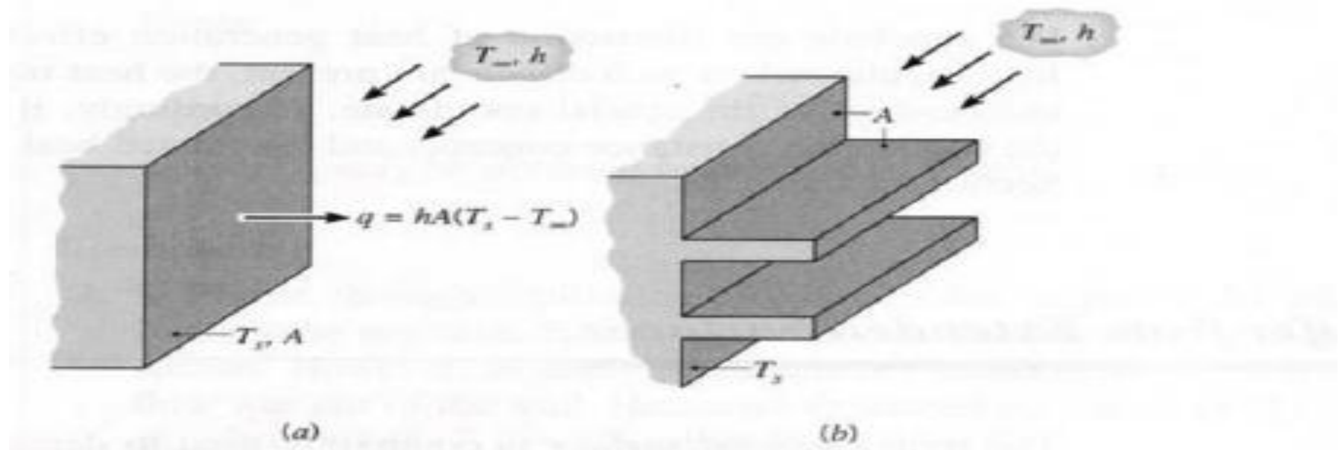

Fig 1: Fins of an electronic device

Objective: - Thermal analysis of cooling fin in electronics. Heat is generated in all the electronic components due to movement of electrons within, and if the generated heat is not dissipated quickly heat will start accumulating within the device and which in turn will hinder the performance of the device. To dissipate this accumulated heat fins are used, they provide an extra surface area for the dissipation of the heat and thus helping in quick removal of the heat via natural convection.

- To determine the nodal temperature distribution.
- To determine the maximum value of temperature in the component.
- Using different material of fin and different thermal conductivity of material (like aluminum and copper), how fin efficiency and effectiveness changes with thermal conductivity.

Physical Problem: -The size of components and the device has to be considered during the fin design. Due to small size of the components the fins have to be designed with proper shape and size.

- **Problem Description**: -
- Assuming the electronic circuit is made up of copper with thermal conductivity of 386 W/m K. Also, it generates heat at the rate of 10e6 W.

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Rajesh Pant, Department of Mechanical Engineering, Graphic Era Hill University, Dehradun 248002, India
Jasmeet Kalra, Department of Mechanical Engineering, Graphic Era Deemed to be University, Dehradun 248002, India
Pankaj Negi, Department of Mechanical Engineering, Graphic Era Hill University, Dehradun 248002, India
Rajesh P Verma, Department of Mechanical Engineering, Graphic Era Hill University, Dehradun 248002, India

- Thermal conductivity of steel enclosure - 20 W/m K.
- Thermal conductivity of aluminum fins - 180 W/m K.

- **Boundary conditions:**
  - **Film Coefficient - 50 W/m^{2}K**
  - **Temperature is 293 K**
  - **Heat generated in the rod - 27.2 W**
  - **Heat loss - 5.44 W**

Fig 2: Fin array on electronic device

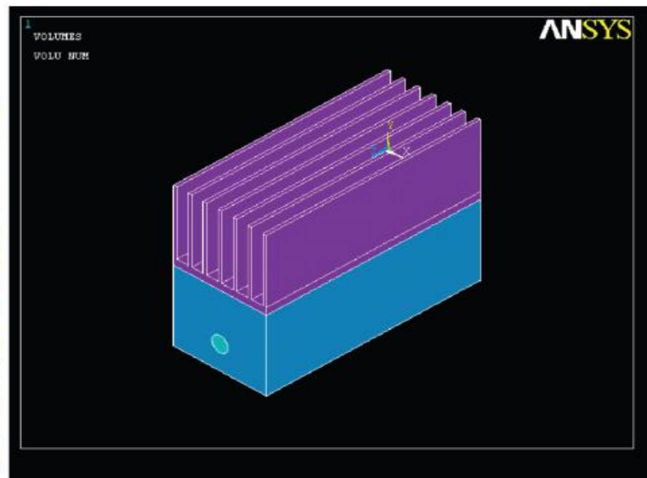


Fig 3: Modelling of the fin.

II. RESULT AND DISCUSSION

For case 1

In this project studied know about thermal analysis of cooling fin of aluminum material having conductivity (k=186w/m k) and temperature distribution. The above figure show temperatures at fin reaches at are near about 297.3k.

Table 1: result for aluminum fin array

Fin material	Fin effectiveness	Fin efficiency (%)
Aluminum	39.87	83

For case 2

Thermal analysis of cooling fin of aluminum material having conductivity(k=386w/m k) and temperature distribution. The above figure show temperatures at fin reaches at are near about 300k.

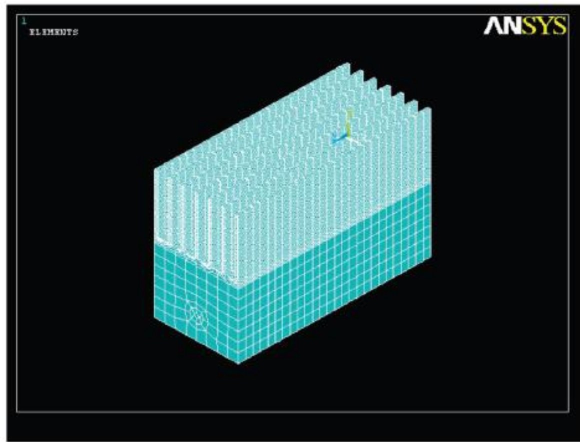
Table 2: result for copper fin array

Fin material	Fin effectiveness	Fin efficiency (%)
Copper	43.17	92

III. CONCLUSION

Fin is an extended area that is used to increase a heat transfer rate. Heat transfer will increase if we increase the fin length or we can use different shape of fin.Fin is one of the best methods to increase heat transfer. It is also one of the cheapest method available and also easy to manufacture.

Conductivity of a material plays a vital role in heat transfer applications. through above analysis we have come to know that conductivity of a material increases the fin efficiency and effectiveness. We did analysis on the copper and aluminum material and result came is that copper have better fin efficiency and fin effectiveness than aluminum, but copper is one the costly material, so it is less in use.



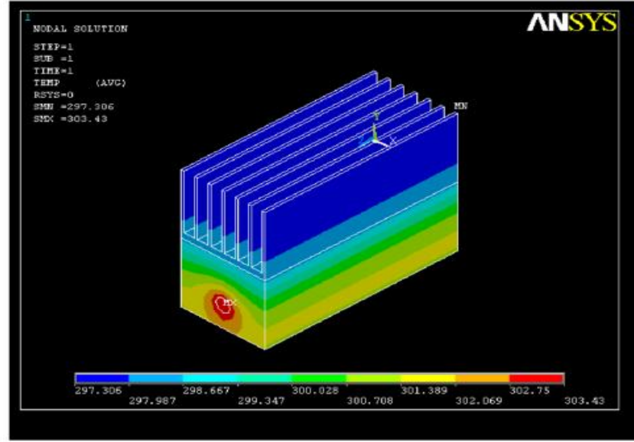


Fig 4: Meshing of the fin on ANSYS **Fig 5: CASE-I: Nodal temperature solutions for aluminum fin**

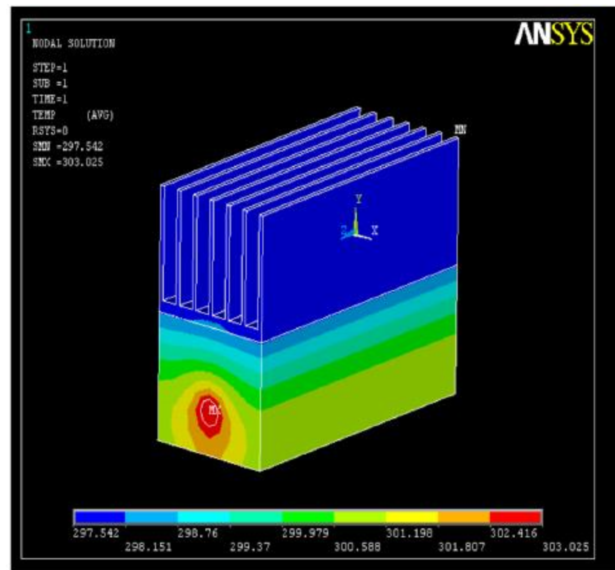


Fig 5: CASE-II: Nodal temperature solutions for copper fin

Future scope

If Future scope is concern, then we can use different fin array having different fin geometry and having different material conductivity. We can do transient thermal analysis. As we did steady state thermal analysis in present project. We can vary length of fin and can-do analysis on it.

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