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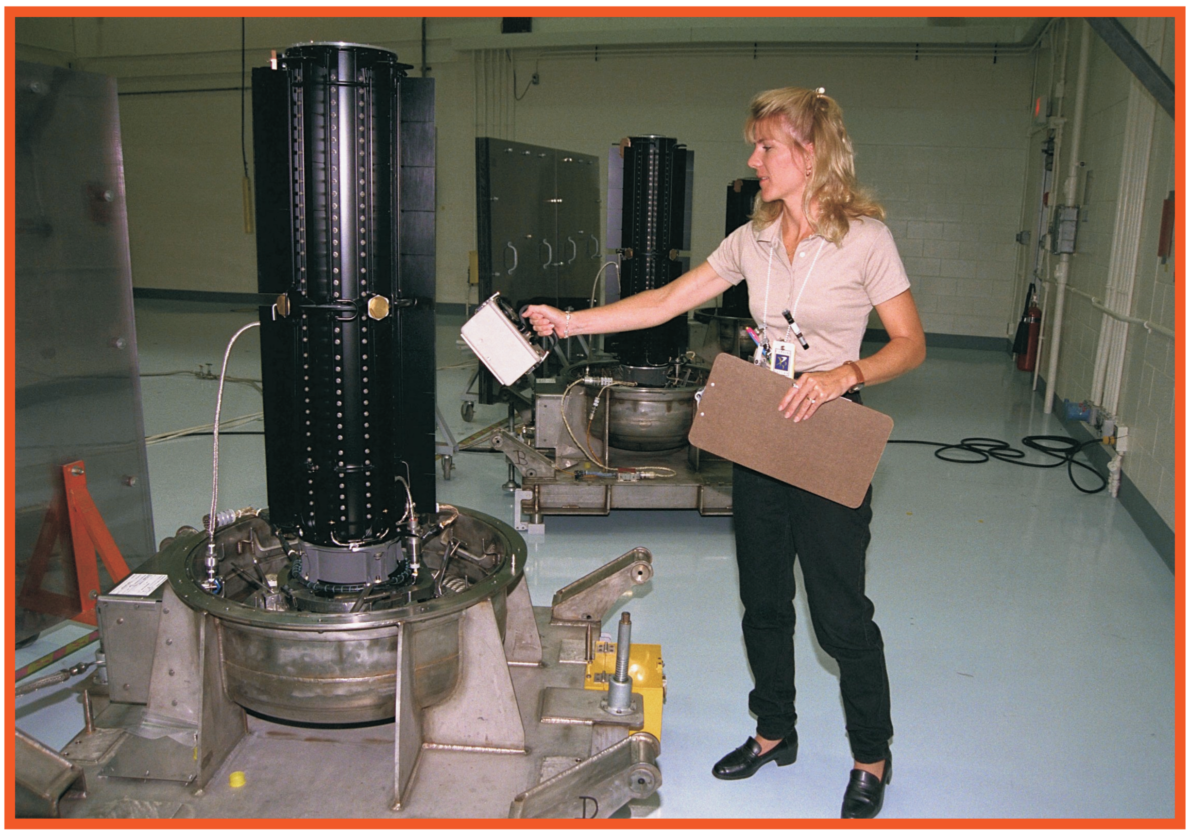
INCREASING RELIABILITY OF PROCESSOR BY OPTIMUM UTILIZATION OF THERMIONIC SINK



Abstract:-

The heat pipe is widely used because of its amazing heat transfer rate. Since last decade heat pipes became more popular because of its wide applications in cooling systems. Manufacturers like Asia Vital Components now have their own heat pipe manufacturing facilities, and heat pipe manufacturing is no longer reserved to a few specialized companies The thermal resistance of materials is of great interest to electronic engineers, because most electrical components generate heat and need to be cooled. Some electronic components malfunction when they overheat, while others are permanently damaged.

The project aims at thermal heat sink of Computer Processing Unit (CPU) which is particularly useful in energy-conservation equipment where it is desired to recover heat from hot gases for air-preheater or supplemental heating applications. In some cases the heat-pipe can take the place of more costly combinations of pumps, piping and dual heat-exchange configurations, further in this regard, design and theory is vital. In many cases, engineers follow a thermal analysis with a stress analysis to calculate thermal stresses (that is, stresses caused by thermal expansions or contractions).

Keywords:

Air Preheater, Thermal Contractions, Stresses, Dual Heat Exchange Configurations, Cpu.

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1.0 INTRODUCTION :-

The heat pipe operating principle is that a liquid is heated to its boiling point, vaporizes and gives of useful heat, condenses and returns to the heat source. The heat pipe is a closed and operates in vacuum. The boiling point of a liquid is a function of the pressure surrounding it .Because of the strong vacuum (about 10^{-3} microns of Hg), the working fluid is virtually in a state of liquid – vapor equilibrium. Consequently, a slight increase in temperature will cause it to boil and vaporize.

This uses the same principle as a passive heat sink cooler, with the only difference being that a fan is directed to blow over or through the heat sink. This results in more air being blown through the heat sink, increasing the rate at which the heat sink can exchange heat with the ambient air. Active heat sinks are the primary method of cooling a modern day processor or graphics card. The buildup of dust is greatly increased with active heat sink cooling as the fan is continually taking in the dust present in the surrounding air. As a result, dust removal procedures need to be exercised much more frequently than with passive heat sink methods.

2.0. HEAT SINK:

A heat sink (or heat sink) is an environment or object that absorbs and dissipates heat from another object using thermal contact (either direct or radiant). Heat sinks are used in a wide range of applications wherever efficient heat dissipation is required; major examples include refrigeration, heat engines and cooling electronic devices.

Heat sinks function by efficiently transferring thermal energy ("heat") from an object at high temperature to a second object at a lower temperature with a much greater heat capacity. This rapid transfer of thermal energy quickly brings the first object into thermal equilibrium with the second, lowering the temperature of the first object, fulfilling the heat sink's role as a cooling device. Efficient function of a heat sink relies on rapid transfer of thermal energy from the first object to the heat sink, and the heat sink to the second object.

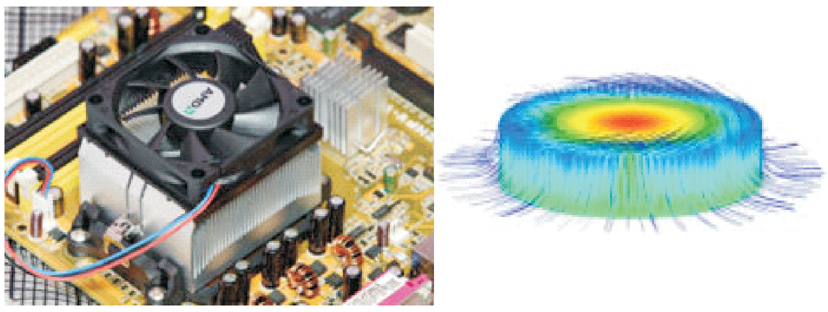


Fig: 2.1Radial Heat Sink with Thermal Profile and Swirling Forced Convection Flow

3.0 DATA CONSIDERED FOR THE ANALYSIS OF HEAT SINK:

1.The fins are made up of Aluminum.
2.Thermal conductivity of the aluminum is 160W/mK
3.Specific Heat of Aluminum is 963J/Kg.k.
4.Density of the Aluminum is 2770Kg/m^3.
5.The film Co-efficient is 20W/m^2K
6.Heat sink is assumed to be a thermal mass solid of Brick 8Node 70
7.Heat lost from the base is 5.44W
8.Heat flux is 1133.33W/m^2
9.The base of the heat sink is rectangular in section and base dimensions are 60mm x 80mm x 35mm.
10.For this experimental set up we required heat pipe which operated temperature range 40°C to 100°C and transmitted 100w power. For that we design heat pipe.

FLUID	**h (W/m^2K)**
Flowing gases	10 --- 280
Flowing liquids	170 --- 5700
Flowing liquid metals	5700 --- 284000
Gases(free convection)	5 ---- 28
Boiling liquids	1000 ---- 284000
Condensing vapors	2840 ---- 28400

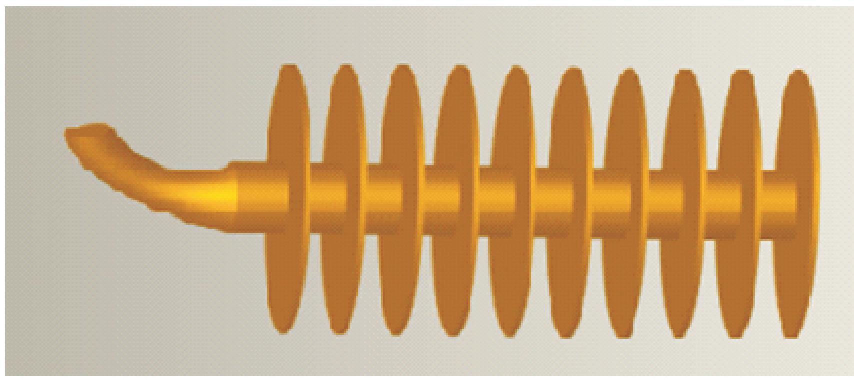
Table: 3.1 order of magnitude of heat transfer coefficient, h

3.1. DATA CONSIDERED FOR THE ANALYSIS OF HEAT PIPE:

1.The fins are made up of Copper.
2.Thermal conductivity of the copper is 393W/mK
3.Specific Heat of copper is 385.2J/Kg.k.
4.Density of the copper is 8900Kg/m^3.
5.The inside film Co-efficient is 5000W/m^2K
6.the outside film co-efficient is 10 W/m^2K
7.Heat pipe is assumed to be a thermal mass solid of Brick 8Node 70
8.Heat lost from the base is 5.44W
9.Heat flux is 1133.3W/m^2
10.The base of the heat pipe is circular and dimensions are Φ 75mm x105mm long

3.2DESIGN OF HEAT PIPE

11.Height of the pipe	:	105 mm
12.External diameter of the vertical pipe	:	19 mm
13.Internal diameter of the vertical pipe	:	17 mm
14.Thickness of the base plate	:	1.5 mm
15.Diameter of the base plate	:	75 mm



Design of a Heat pipe

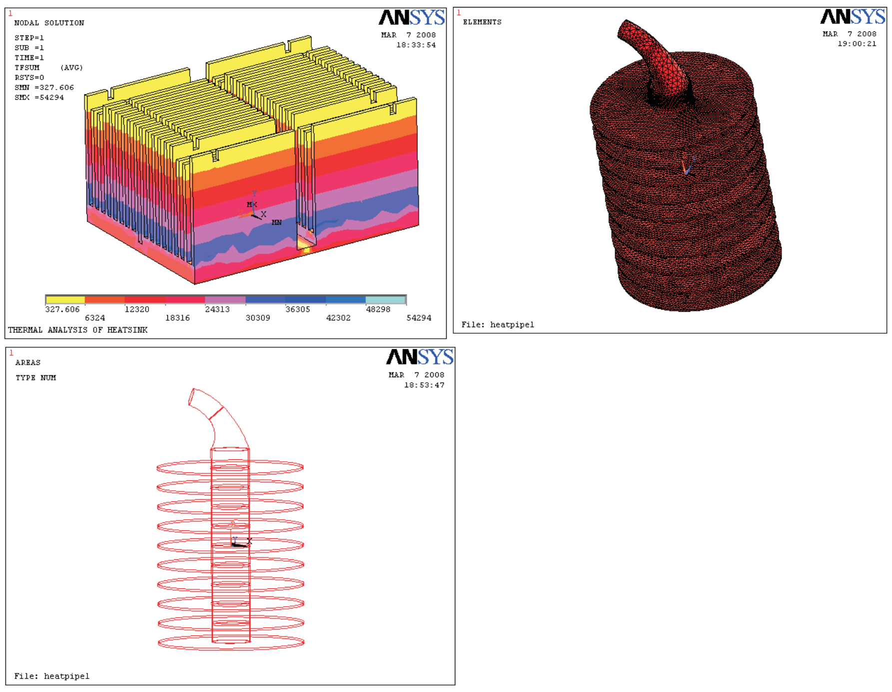


Fig: 3.2 Design of heat pipe by using ANSYS

3.4. HEAT TRANSFER RATE THROUGH FINS:

The following assumptions are made for the analysis of heat flow through the fin,

1)Steady state heat conduction
2)No heat generation within the fin.
3)Uniform heat transfer coefficient (h) over the entire surface of the fin.
4)Homogeneous and isotropic font material.
5)Negligible contact thermal resistance.
6)Heat conduction one-dimension.

As per the design considerations, the fin is considered as the long fin. Since the tip of fin temperature is approximately equal to the ambient temperature.

Heat transfer rate through one fin,

$$Q_{fin} = \sqrt{(PHKA_{CS})}\,(T_e - T_a)$$

Where,

P	=	Perimeter of fin (m)
h	=	Coefficient of heat transfer of Cu (w/m^2oC)
k	=	Thermal conductivity of Cu (w/m^oc)
A_{cs}	=	Area of cross section (m^2)
T_e	=	Evaporator temperature
T_a	=	Ambient temperature

= 15.21watts
No of Fins = 9
Total rate of heat from through fin Q = 136.0watts

4.0 EXPLANATION:

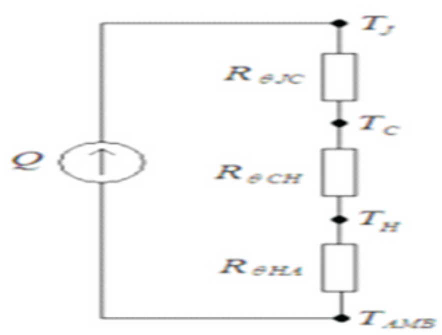


Fig: 4.0 Equivalent thermal circuits for a semiconductor device with a heat sink.

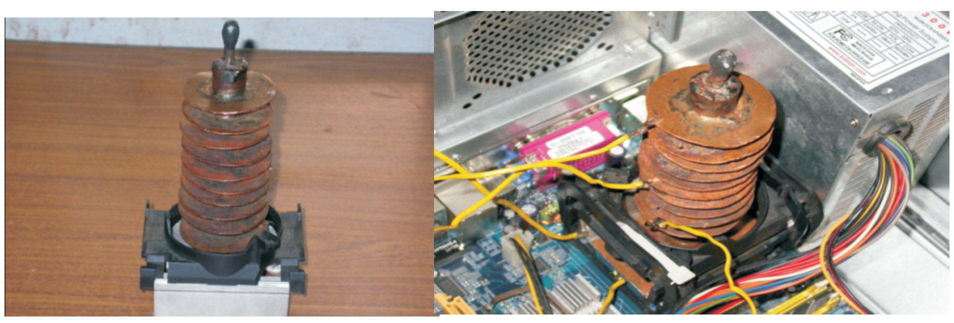


Fig: 4.Heat pipe manufactured with copper plate fig: 4.Thermocouples attached to a heat pipe during experiment

5.0 EXPERIMENT:

Date : 22 – 03 –2007
Time : 10:30 am
Processor Max Temp : 61.5°C

S. No	Different Sections of Heat pipe	T(°C)
1	Evaporator Section	54°C
2	Adiabatic Section	62.8°C
3	Condenser Section	36.6°C

Table: Temperatures at various sections of heat pipe.

S. No	Different Sections	Length (mm)	Difference in temp (°C)	Resistance of H.P (°C/W)	Q (W)
1	Evaporator	0-35	7.5	1.762	4.426
2	Adiabatic	35-70	8.8	1.762	4.99
3	Condenser	70-105	26.2	1.762	14.87

Table: Temperatures at various sections of heat pipe.

6.0 THERMAL DESIGN OF HEAT SINK:

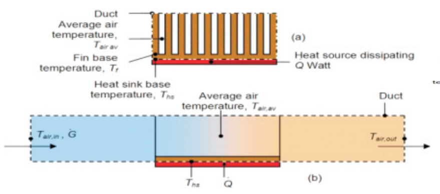


Fig: 6.0working and variables of heat sink

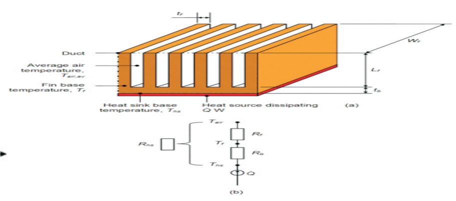


Fig: 6.0shows the parameters and thermal resistance of heat sink

6.1. Data considered for design of heat sink:

Material used for heat sink		:	Aluminum (K = 160 W/mK)
Base dimensions of heat sink		:	60mm x 80mm
Thickness of base	t_b	:	10mm
Width of fin	W_f	:	80mm
Thickness of fin	t_f	:	2mm

6.2 THERMAL RESISTANCE OF BASE (RB):

Thermal resistance of base of heat sink is given by

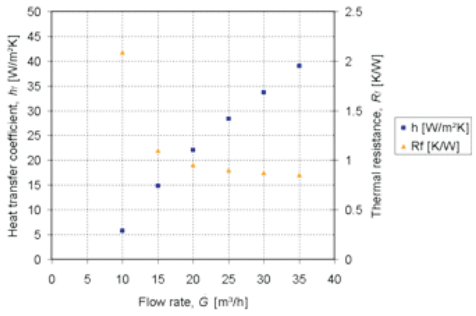
$$R_b = \frac{t_b}{K\ A_b} \text{-------- (7)}$$

Where Ab-base area of heat sink = 60x80mm^2 = 4.8x10^{-3} m^2

$$R_b = \frac{10X10^{-3}}{160X4.8X10^{-3}} = 0.013\ ^{o}\text{C/W}$$

6.3 THE THERMAL RESISTANCE OF FINS (RF):

Thermal resistance of fins should be less than 1°C/W i.e. 0.8 °C/W is chosen and heat transfer co-efficient is around 20W/m^2K for 20m^3/h flow rate from the figure 4.7.



Graph: 6.3 Thermal resistance and heat transfer coefficient plotted against flow rate for the specific heat sink design .The data shows that for an increasing air flow rate, the thermal resistance of the heat sink decreases.

Thermal resistance of fins is given by $R_f = \frac{1}{n h_f W_f (t_f + 2\eta_f L_f)}$ ---------- (8)

Where R_f = 0.8 °C/W; n- no of fins=12; η_f = 0.9; L_f= length of fin to be determined Rearranging the equation (8)

$$L_f = \frac{1}{2\eta_f}\left(\frac{1}{n h_f W_f R_f} - t_f\right) \quad => L_f = \frac{1}{2X0.9}\left(\frac{1}{12X20X0.08X0.8} - 0.002\right)$$

L_f = 35mm

6.4 THERMAL RESISTANCE OF HEAT SINK RHS:

Thermal resistance of heat sink is the sum of that of base and fins

$R_{hs} = R_b + R_f$-------------- (9)
= 0.0133 + 0.8 = 0.8133 oC/W

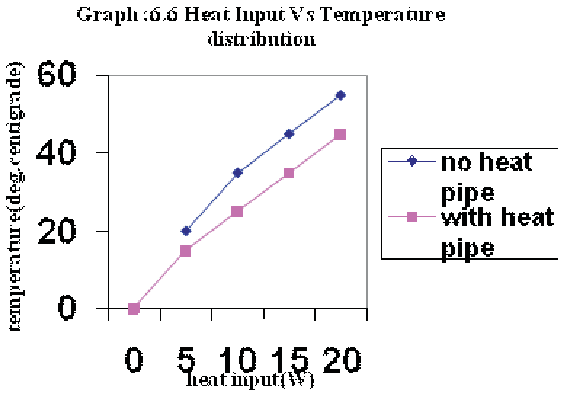
The heat transfer rate of heat sink is also given by

$$Q_{hs} = \frac{\Delta T}{R_{hp}} = \frac{56-38}{0.8133} = 22.13W$$

The heat transfer by heat sink is 22.13W but it is required transfer 5.44W only. This is due to the fact that after usage of some period of time, heat sink is covered by a layer of dust particles as air flows over fin continuously unless it is not cleaned, which increases thermal resistance there by reducing heat transfer rate. In those situations also, the heat sink may transfer at least 5.44W to surroundings. This is for safety only

6.6 HEAT INPUT VS TEMPERATURE DISTRIBUTION:

This shows the test result. The y-axis of the graph represents the temperature difference (oC) between an atmosphere and the processor temperature and the heat input (W) is represented along x-axis. The variations in the difference in temperatures with heat pipe and without heat pipe are represented in the graph. It should be pointed out that the temperature drop is very less when heat pipe is in use and the temperature drop is more for the system without heat pipe.



7.0 CONCLUSIONS:

The fabrication of heat pipe has been carried out and experiments were done comparing with heat pipe and heat sink of the computer processing unit (CPU). The temperature without using heat pipe is reduced from 64oC to 46oC and by introducing heat it is reduced further to 36oC. The obtained values are tabulated in the tables. As a result, overall heat transfer rate was calculated. Experimental calculations are also done and results are represented in graphs. As a result of the tests, maximum heat transfer rate and reliability of the heat pipe developed were obtained and it was indicated that the heat pipe can be applied to electronic equipment cooling.

8.0SCOPE FOR FUTURE WORK:

More recently, synthetic diamond cooling sinks are being researched to provide better cooling. Also, some heat sinks are constructed of multiple materials with desirable characteristics, such as phase change materials, which can store a great deal of energy due to their heat of fusion.

Now a-days the heat pipes are widely used in different fields such as in electronic cooling system, in space craft technology, in laptops, in the isothermal furnaces etc., This will be more advantageous in IC engines and in air-crafts.

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