FABRICATION OF A COOLING LOOP

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ABSTRACT

In order to increase the reliability of electronic devices and higher efficiency, the generated heat from the various components of the electronic devices must be dispersed from them. A thermal management system with high heat flux removal technologies has been widely designed and applied in the system to maintain lower operating temperatures. Firstly, the cooling system with air as the coolant has been proposed, which is the predominant option of the day, and to identifying research initiatives that would enhance its efficiency. However, the removal capability of coolant is limited by the coolant flowing through the systems and increasing heat generation densities at the electronic devices. Therefore, these trends are stimulating interest in the liquid cooling system. .

Keywords- *Heat Sink, Microchannel Heat Sink, Nanofluid.*

LITERATUREREVIEW

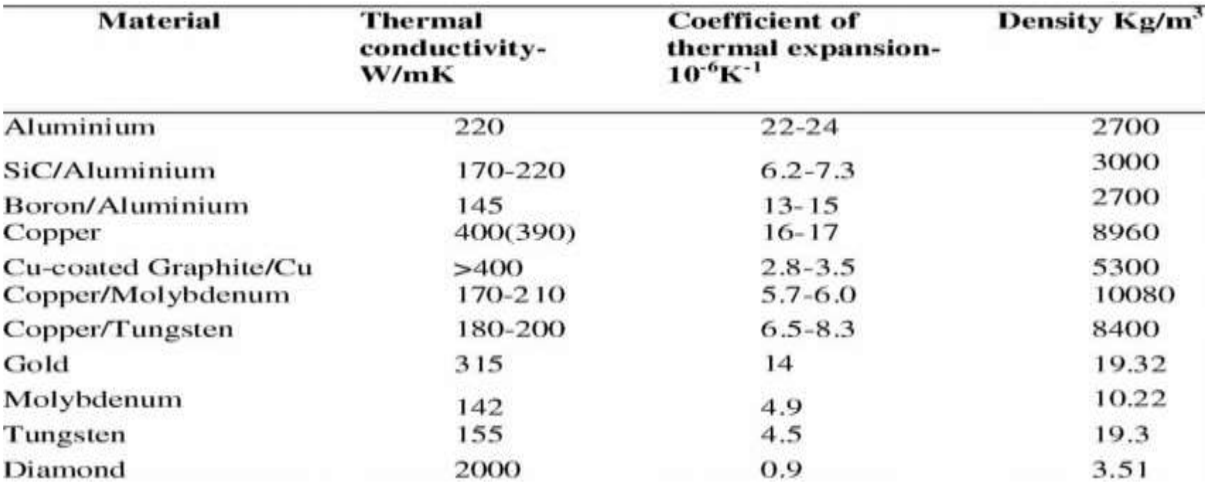
Arabpour A et al. Thermal resistance decreases on increasing the volume fraction and slip velocity coefficient. Heat transfer increases with Reynolds number and volume concentration of nanoparticle . Increasing in volume fraction has increased the friction coefficient due to enhancement in viscosity and density. Tran N et al, • Thermal resistance was improved up to 6.7% when using TiO2 with 1.0vol.% compare to DI water. Thermal resistance for TiO2 with 1.0vol.% is lower than Al2O3 with same concentration and DI water The higher thermal performance could be achieved with the nanofluid that have higher thermal conductivity and concentration. Sarafraz et al. • Optimum concentration of silver nanofluid (0.05wt.%) has enhanced the overall thermal performance up 37% at the Reynolds number of 1400 • Silver nanofluid with 0.1wt.% has increased the heat transfer coefficient by 47% and it exhibit the highest one. Abdollahi et al No significant effect on pressure drop by using nanofluid in interrupted MCHS. At least 2.0vol.% is required to obtained an enhancement in heat transfer performance. Al2-O3/water with 5.0vol.% can enhance Nusselt number more than 30% and give a great impact on heat transfer performance.

BASIC CONCEPT

Concept to design a project to make one of the suitable cooling technique to cool microelectronics. As number of transistors on the circuit board is increasing day by day, it becomes challenging to remove such a high heat flux from a small space.

So,It is a necessary to grow high performance cooling technology and heat discharge process which is meet our current requirements for secure, safety and stable operation for micro-electro mechanical system (MEMS).

Material requirement:-Different materials having different thermal conductivity , so in order to increase the rate of heat transfer different metals and heat alloys are introduced .Generally copper has two times more thermal conductivity value of aluminum . As copper cost is high therefore aluminum is generally preferred.



Material	Thermal conductivity-W/mK	Coefficient of thermal expansion-$10^{-6}K^{-1}$	Density Kg/m^3
Aluminium	220	22-24	2700
SiC/Aluminium	170-220	6.2-7.3	3000
Boron/Aluminium	145	13-15	2700
Copper	400(390)	16-17	8960
Cu-coated Graphite/Cu	>400	2.8-3.5	5300
Copper/Molybdenum	170-210	5.7-6.0	10080
Copper/Tungsten	180-200	6.5-8.3	8400
Gold	315	14	19.32
Molybdenum	142	4.9	10.22
Tungsten	155	4.5	19.3
Diamond	2000	0.9	3.51

FACTORS TO BE CONSIDERED WHILE DESIGNING HEATSINKS:--

- Power that needs to be dissipated .
- Maximum allowable component temperature .
- Available space/volume for heat sink .
- Power density .
- Air Flow parameters .
- Pressure Drop .
- Bypass effects .
- Manufacturability .
- Cost .

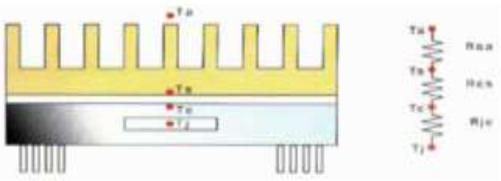
Heat sinks sections :-

$$R_{sa} = \frac{T_j - T_a}{Q} - R_{jc} - R_{cs}$$

Where ,
Tj, Rjc and Q will be provided by the component manufacturer.
Rcs – Thermal resistance of the interface material .
Ta – Ambient temperature.
Ta and Rcs are parameters that we can control to a certain extent.
Rsa is the number that will help us identify a heat sink that will meet our criteria .

$$R_{j-c} = \frac{\Delta T_{jc}}{Q} = \frac{T_j - T_c}{Q}$$

Rj-c is the Junction to case thermal resistance. Usually a parameter that is published by the component manufacturer



$$R_{c-s} = \frac{\Delta T_{cs}}{Q} = \frac{T_c - T_s}{Q}$$

Rc-s is the thermal resistance across the thermal interface material between the heatsink and the component.

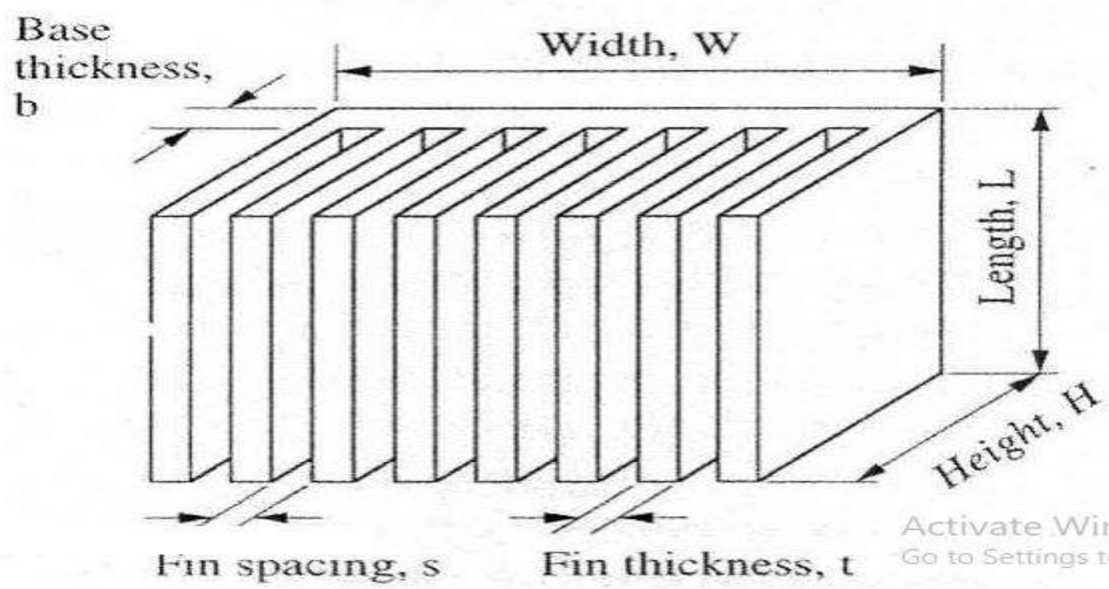
$$R_{s-a} = \frac{\Delta T_{sa}}{Q} = \frac{T_s - T_a}{Q}$$

Rs-a is the thermal resistance of the heatsink.

Junction to ambient is the sum of the = Rj-c+Rc-s + Rs-a = (Tj -Ta)/resistance(Rj-C)

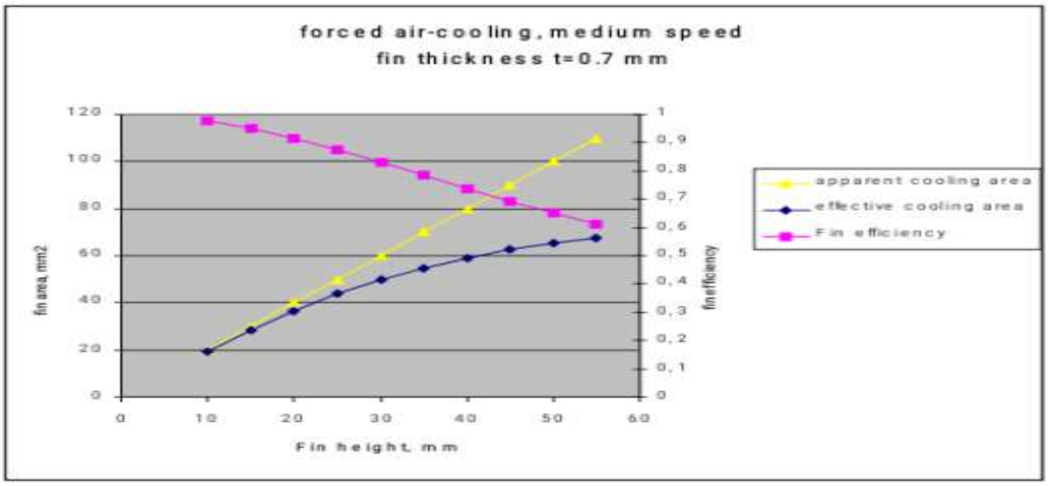
Heat sink Design parameters:-

A heatsink can be optimized for performance by varying the different dimensions shown. Of course, the optimized design should consider manufacturability.



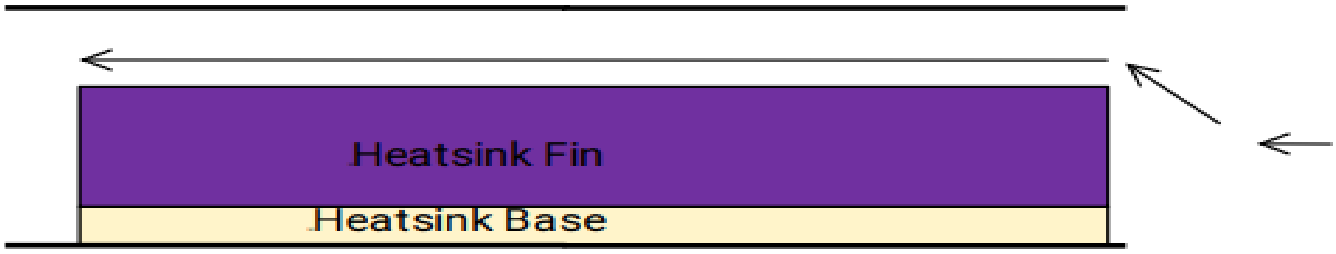
Fin efficiency Apparent cooling area vs. effective cooling area:-

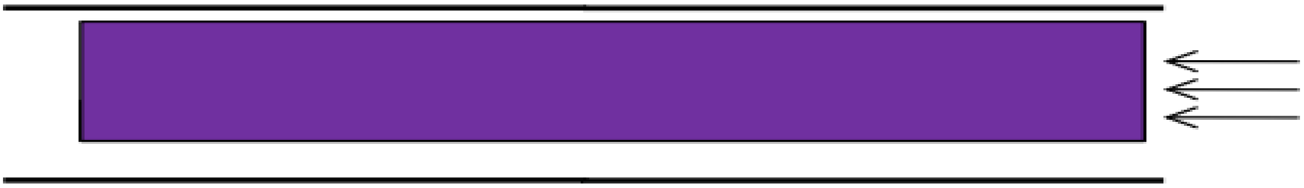
$$q = h \cdot A \cdot (T_{hs} - T_{air})$$



If height of a fin is increased to a limiting extent then the performance of fin is reduced compared to optimum design of fin.It also contains space ,cost, maintenance which is undesirable for us.

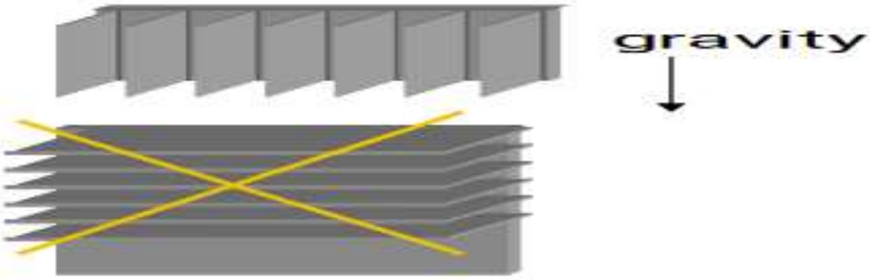
by pass effect in force convention :-When there is a significant gap between the heatsink and the top surface of the enclosure air will bypass the heatsink. This reduces the performance of the heatsink. Bypass effect is more pronounced in heatsinks with closely packed fins. Here the air is forced to go through the heatsink and in this case the performance of the heatsink is optimized.

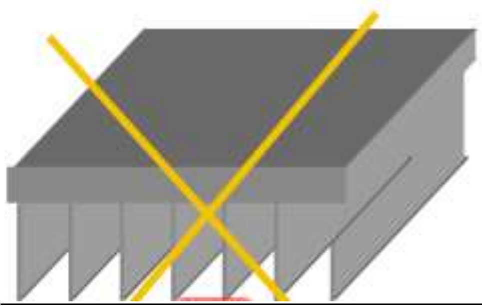


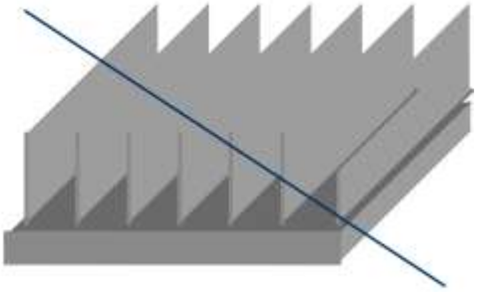


Heat sink orientation natural convection:-

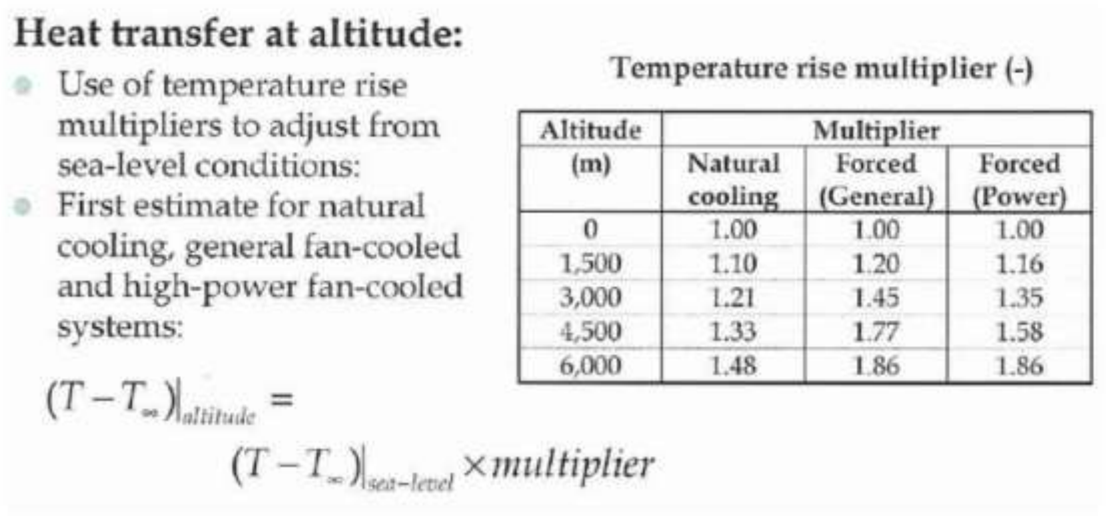
The buoyancy effects of air forces hot air to move up and cold air to come down. .Orient the heatsink keeping in mind the direction of gravity . Fin thickness and fin pitch are important factors to consider while optimising the heatsink.







Cooling at Altitude:-



Heat transfer at altitude:

- Use of temperature rise multipliers to adjust from sea-level conditions:
- First estimate for natural cooling, general fan-cooled and high-power fan-cooled systems:

$$(T - T_\infty)\big|_{altitude} = (T - T_\infty)\big|_{sea-level} \times multiplier$$

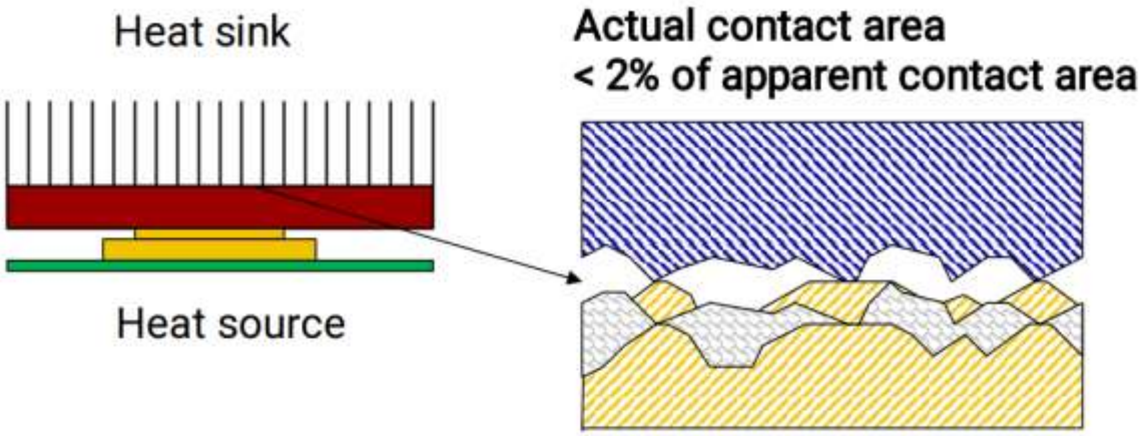
Temperature rise multiplier (-)

Altitude (m)	Multiplier		
	Natural cooling	Forced (General)	Forced (Power)
0	1.00	1.00	1.00
1,500	1.10	1.20	1.16
3,000	1.21	1.45	1.35
4,500	1.33	1.77	1.58
6,000	1.48	1.86	1.86

Conduction, contact surface :-

- Perfect contact can never be ensured between the heatsink and the package. This could lead to potential problems since trapped air acts as an insulator.

- The performance of the heatsink can be much lower than estimated leading to high component temperatures. To combat this problem, it is necessary to use a thermal interface material.



Thermal interface materials – Different types

Double sided PSA

- Pressure sensitive adhesive is used to adhere the heatsink to the heat source.

- Easy to assemble with protective liner tabs .
- The component package type will determine the kind of tape to use – acrylic based or silicone based The thermal conductivity of these tapes are moderate and depends on their thermal performance depends on the contact area that can be achieved between the bonding surfaces .
- Typically 0.005 -0.10.
- thick Not recommended when the heatsink fins are oriented vertically – i.e along the direction of gravity .

Single sided PSA

- Provides adhesion only to the heatsink.

- Mechanical fastening of the heatsink to the component is needed. Typically 0.05 – 0.01" thick .

Phase Change Material

- Available as peel and stick pads at room temperature.
- When heated the material reflows to fill all the interface voids .
- Very good performance – high thermal conductivity.
- Conforms to minimize thermal path thickness.
- Mechanical fastening of heatsink is required .
- Could be messy during re-work .

Gap Filler

- Soft, thermally conductive silicone elastomers. Used in places where a large and variant gap exists between the components and heatsink .
- Typically used in places where a common heatsink is used for multiple components .
- Mechanical fastening of heatsink required .0.5mm – 5 mm thickness .

Epoxy

- Room temperature vulcanizing materials which function both as thermal pathway and mechanical attachment .
- Not favored by assemblers due to the possible prep work and inability to .rework .

Grease

- Excellent thermal conductivity and void filling capability.
- Mechanical attachment of heatsink to component required .
- Can be messy and not favored by assemblers .
- Can be as thin as 0.01".

Methodology:-

There are several method to increase the rate of heat transfers
1. introduction of coolant in MCHS .
2. Orientations of fin
3. introduction of notches in fins.
4. introduction of Nano particles in MCHS .

CONCLUSION

From the above review, it was observed that the aqueous CNT nanofluids were found to be the promising coolant among the other nanofluids due to the plausible better heat transfer characteristics. The maximum temperature difference for 0.1vol% aqueous CNT nanofluids was found to be 24°C at higher power density of 275W [78]. For the same, the enhancement in 'h' was found to be 57% as compared with the basefluid. However there still exists a demand for cooling with increase in processing speed and it was expected that the power density will reach about 360W in 2020. Hence, it is mandatory to choose a coolant with better performance characteristics than the existing fluid for cooling of electronics chips providing the enhanced temperature difference optimizing several parameters such as reduction in size, increasing operational time, increasing speed, cost of the coolant etc. Studies revealed that the micro channels operated with nanofluids serves as a better promising technology for the cooling of electronics in the upcoming generations increasing the performance of electronics. Extensive studies are to be made for choosing the best nanofluids on the electronics cooling for commercial scale applications in all the industrial sectors.

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