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FORCE FED MICRO CHANNELS FOR HIGH FLUX COOLING APPLICATIONS

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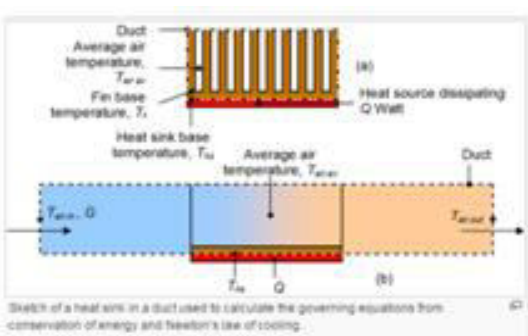
ABSTRACT: The reliability of electronic components are affected critically by high temperature now a days. As operating powers and speed increase, and as designers are forced to reduce overall system dimensions, the problems of extracting heat and controlling temperature can become crucial. The continuing 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 finheat sinks are commonly used devices for enhancing heat transfer in electronics components. In my research work, investigation has been carried out to determine the heat transfer rates in a heat sink by means of varying pitch of the fin with air and nitrogen as the working fluids. Analysis is carried out for heat sink with closed and open enclosure constant wall heat flux and different mass flow rates calculated for Reynolds number 800, 1000, 1200 and 1400. CFD analysis is performed for different cases to determine heat transfer coefficient, pressure drop, mass flow rate and heat transfer rate. Thermal analysis is to determine heat flux and temperature distribution with different aluminum alloys (aluminum alloy, aluminum alloy 7075).3D modeling is done in PRO-Engineer. Thermal and CFD analysis is performed in ANSYS software.

Key Words: CFD Analysis, Aluminum alloy, Aluminum alloy 7075, Finheat, Pro-E, Heat sink, Working fluids.

CHAPTER-1

INTRODUCTION

1.1 HEAT SINK: A heat sink is a passive heat exchanger that transfers the heat generated by an electronic or a mechanical device to a fluid medium, often air or a liquid coolant, where it is dissipated away from the device, thereby allowing regulation of the device's temperature at optimal levels. In computers, heat sinks are used to cool central processing units or graphics processors. Heat sinks are used with high-power semiconductor devices such as power transistors and optoelectronics such as lasers and light emitting diodes (LEDs), where the heat dissipation ability of the component itself is insufficient to moderate its temperature. A heat sink is designed to maximize its surface area in contact with the cooling medium surrounding it, such as the air. Air velocity, choice of material, protrusion design and surface treatment are factors that affect the performance of a heat sink. Heat sink attachment methods and thermal interface materials also affect the die temperature of the integrated circuit. Thermal adhesive or thermal grease improve the heat sink's performance by filling air gaps between the heat sink and the heat spreader on the device. A heat sink is usually made out of copper and aluminum. Copper is used because it has many desirable properties for thermally efficient and durable heat exchangers. First and foremost, copper is an excellent conductor of heat. This means that copper's high thermal conductivity allows heat to pass through it quickly. Aluminum is used in applications where weight is a big concern.



Sketch of a heat sink in a duct used to calculate the governing equations from conservation of energy and Newton's law of cooling.

1.2 HEAT TRANSFER PRINCIPLE: A heat sink transfers thermal energy from a higher temperature device to a lower temperature fluid medium. The fluid medium is frequently air, but can also be water, refrigerants or oil. If the fluid medium is water, the heat sink is frequently called a cold plate. In thermodynamics a heat sink is a heat reservoir that can absorb an arbitrary amount of heat without significantly changing temperature. Practical heat sinks for electronic devices must have a temperature higher than the surroundings to transfer heat by convection, radiation, and conduction. The power supplies of electronics are not 100% efficient, so extra heat is produced that may be detrimental to the function of the device. As such, a heat sink is included in the design to disperse heat to improve efficient energy use. To understand the principle of a heat sink, consider Fourier's law of heat conduction. Fourier's law of heat conduction, simplified to a one-dimensional form in the *x*-direction, shows that when there is a temperature gradient in a body, heat will be transferred from the higher temperature region to the lower temperature region. The rate at which heat is transferred by conduction is proportional to the product of the temperature gradient and the cross-sectional area through which heat is transferred. Consider a heat sink in a duct, where air flows through the duct.

1.3 ADVANTAGES OF HEAT SINK

• dissipate more heat than conventional heat sinks with the same footprint

• reduce heat sink and overall system

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volume
• increase the aluminum extrusion cooling surface area by two to three times
• Thermoelectric modules
• uninterruptable power supplies
• variable speed motor controls
• ac welding switches
• power rectification equipment
• laser power supplies
• traction drives

2. PROBLEM METHODOLOGY

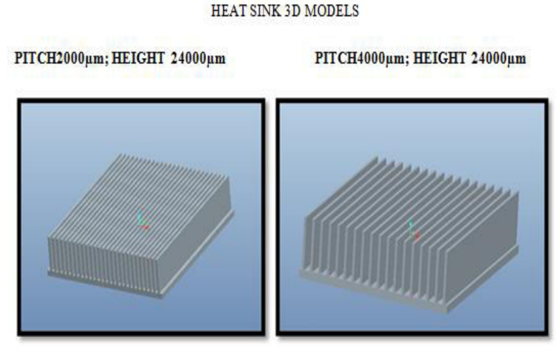
- Identifying the problems and searching for resolving the problems.
- Reading all the journal and research papers of same problem optimization.
- Planning for problem resolving methods.
- Selecting material.
- Taking inputs from literature review.
- Measuring dimensions and designing a cad model
- Developing a 3d model.
- Carrying of ANSYS and CFD analysis on the model with following parameters.
- Heat sink base height4000µm
- Fin height 24000, 48000µm
- Pitch2000µm,4000µm

3. RELEATED STUDY

3.1 Objectives of the Work: The main objective of the project design and analysis of Micro channels of various sizes to dissipate heat from the source Thermal analysis is to determine heat flux and temperature distribution with different aluminum alloys (aluminum alloy, aluminum alloy 7075)

3.2 Review of Papers: A 3D numerical study of heat transfer in a single-phase micro-channel heat sink using graphene, aluminum and silicon as substrates by ahmed jassim shkarah, describes numerical simulations conducted on micro-channel heat sinks [1]. Experimental study on cooling performance of minichannel heat sink using water-based mepcm particles by ching-jenq ho, wei-chen Chen experimental study was performed to investigate the cooling performance of a minichannel heat sink (mini-chs) with microencapsulated phase change material (mepcm) particles/water as the coolants [2]. Fluid flow and heat transfer investigations on enhanced microchannel heat sink using oblique fins with parametric study by yong jiun lee enhanced microchannel heat sink with sectional oblique fin is used to modulate the flow in contrast to continuous straight fin [3]. Analysis of three-dimensional heat transfer in micro-channel heat sinks by weilin qu, in this paper by, the three-dimensional fluid flow and heat transfer in a rectangular micro-channel heat sink are analyzed numerically using water as the cooling fluid [4].

4. Design &Modeling Meshing



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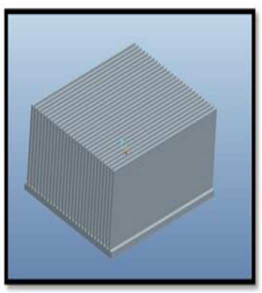
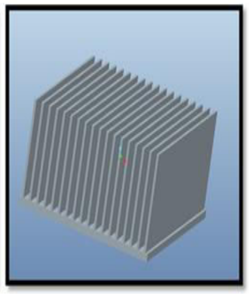
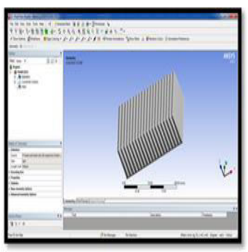
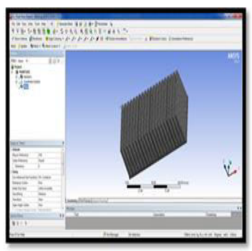
PITCH2000µm; HEIGHT48000µm PITCH4000µm; HEIGHT 48000µm

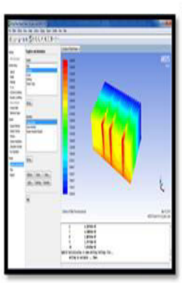
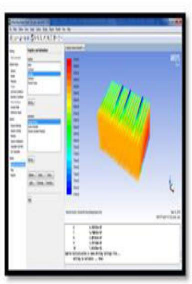
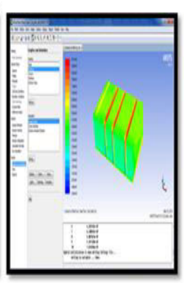
4.2 CFD ANALYSIS OF MICRO CHANNEL HEAT SINK

FLUID -water

REYNOLDS NUMBER – 1400

PRESSURE VELOCITY HEAT TRANSFER COEFFICIENT

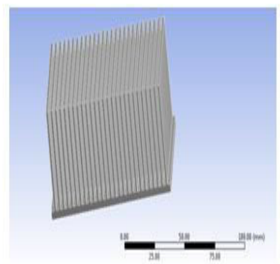
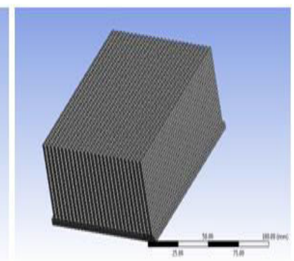
MASS FLOW RATE HEAT TRANSFER RATE

Mass Flow Rate	(kg/s)
inlet	0.2994732
interior-partbody	-9.6228695
outlet	-0.29947451
wall-partbody	0
Net	-1.3113022e-06

Total Heat Transfer Rate	(w)
inlet	18598.105
outlet	-18598.18
wall-partbody	0
Net	-0.07421875

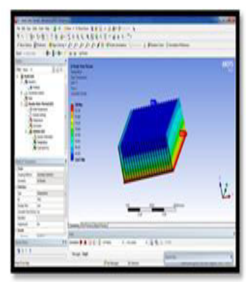
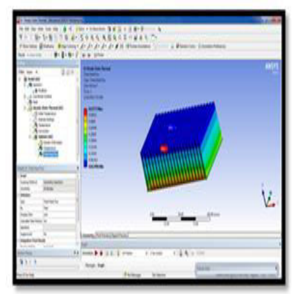
4.3 THERMAL ANALYSIS OF MICRO CHANNEL HEAT SINK MATERIALS- ALUMINUM ALLOY &ALUMINUM ALLOY 7075

IMPORT GEOMETRY MESHING

4.4 MATERIAL- ALUMINUM ALLOY 7075

TEMPERATURE HEAT FLUX

5. COMPARISON BETWEEN DIFFERENT REYNOLDSNUMBERS

5.1 CFD ANALYSIS RESULT TABLE

Reynolds numbers	Pressure (Pa)	Velocity (m/s)	Heat transfer coefficient (w/mm2-k)	Mass flow rate(kg/s)	Heat transfer rate(w)
800	2.03e+00	5.90e-02	7.81e+02	1.3515e-05	0.84277
1000	2.50e+00	7.28e-02	7.96e+02	6.75022e-06	0.3828125
1200	2.90e+00	8.65e-02	8.69e+02	5.3644e-07	0.048828
1400	3.49e+00	1.01e-01	9.37e+02	1.31130e-06	0.0421875

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5.2 THERMAL ANALYSIS RESULTS TABLE

materials	Temperature(°C)		Heat flux(w/mm²)
	Max.	Min.	
Aluminum alloy	100	24.647	0.44188
Aluminum alloy 7075	100	34.677	0.63773

6. CONCLUSION

In my research work, investigation will be carried out to determine the heat transfer rates in a heatsink by means of varying pitch of the fin with air &nitrogen as the working fluids. Analysis is carried out for heatsink with closed and open enclosure constant wall heat flux and different mass flow rates calculated for Reynolds number 800,1000,1200&1400.CFDanalysis is performed for different cases to determine heat transfer coefficient, heat transfer rate, mass flow rate and pressure drop. Thermal analysis isto determine heat flux and temperature distribution by with different aluminum alloys (\aluminum alloy, 7075). By observing the CFD Analysis the heat transfer coefficient values are increases by increasing the Reynolds number. By observing the thermal analysis the heat flux value more for aluminum alloy 7075 material. So we conclude the aluminum alloy 7075 material is better for heat sink.

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