Experimental and CFD Simulation of Hydraulic Cooling of Heat Sink using Nano Fluid

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Abstract- *Proficient heat move has become significant need nowadays. In this research, both experimental and CFD examinations must be done to assess the cooling execution of a mini channel comprising of balances on upper surface of level plate. Nano liquids contain a mini division of strong nano particles in base liquids coursing through forests in base plate connected with radiator at base. Nano liquids cools mini channel heat sinks, have been expected to be a superb heat scattering technique for the cutting-edge electronic devices. Computational Fluid Dynamics (CFD) simulation is to be done to contemplate the heat sinks heat move instrument. The heat move guideline expresses that most extreme heat move is accomplished in small channels with least weight drop across it. In this research design of mini heat sink with proper design and modelling in CATIA software while CFD simulation in ANYSY FLUENT. In this examination work the exploratory and numerical examination for the improved heat move attributes of smaller than normal channel heat sink utilizing Al_2O_3/water nano with (1 and 2 % volume division) liquid is to be finished. The liquid stream qualities are likewise investigated for the serpentine moulded smaller than normal channel. Heating component of 130 W limits is to be utilized to warm up the heating component of base plate.*

Keywords—ANSYS, CFD, Heat sink, nano particles

I. INTRODUCTION

With the advances in processing innovation in the course of recent decades, hardware has gotten quicker, littler and all the more impressive. This outcomes in an ever-expanding heat age rate from electronic gadgets. Much of the time, the chips are cooled utilizing constrained wind current. Nonetheless, when managing a segment that contains billions of transistors working at high recurrence, the temperature can arrive at a basic level where standard cooling strategies are not adequate. Notwithstanding superior electronic chips, high heat transition evacuation is likewise required in gadgets, for example, laser diode exhibits and high-vitality mirrors. Progressed extremely enormous scope coordination (VLSI) innovation has brought about huge enhancements in the presentation of electronic frameworks in the previous decades. With the pattern toward higher circuit thickness and quicker activity speed, be that as it may, there is a consistent increment in the dissipative heat transition at the segment, module, and framework levels.

Most activity parameters of an electronic segment are emphatically influenced by its temperature just as its prompt warm condition. This prompts an expanding interest for exceptionally effective electronic cooling innovations. To fulfill this need, different electronic cooling plans have been created. Complete surveys of the diverse heat move methods utilized in electronic cooling. The utilization of smaller scale directs in heat move was first proposed by Tuckerman in the electronic chip which could be viably cooled by methods for water stream in miniaturized scale channels manufactured on the circuit board on which the chips are mounted. The requirement for warm administration in top of the line power electronic workstations cooling, application servers and server farms is an exceedingly requesting zone that requires persistent research endeavours to create proficient and cost serious cooling arrangements.

A portion of the regularly utilized heat move liquids are the Air, ethylene glycol and motor oil for the past certain decades. The Nano liquids were first presented by Choi in the Argonne National Laboratory, USA, who found that Nano particles increment the warm conductivity of the working liquid, in this manner improving the heat move execution. Nano liquids are characterized as suspension of nanoparticles in a base liquid. Some run of the mill Nano liquids are ethylene glycol based copper Nano liquids and water based copper oxide Nano liquids, Nano liquids are weaken suspensions of functionalized nanoparticles composite materials created about 10 years back with the particular point of expanding the warm conductivity of heat move liquids, which have now advanced into a promising Nano mechanical territory.

Fig. Existing heat sink

II. LITERATURE REVIEW

Valentin Apostol et.al [1], this paper presents investigation of the impact of Nano liquids on the miniaturized scale channel heat sink execution of PC cooling frameworks. In this analysis CeO_2, Al_2O_3 and ZrO_2 nanoparticles suspended in 20% ethylene glycol and 80% refined water are utilized as working liquids. The grouping of the nanoparticles ranges from 0.5% to 2%, mass stream rate ranges from 0.028 kg/s to 0.084 kg/s, and the surrounding temperature ranges from 25 C to 40 C. The outcomes got as CeO_2-EG/DW, at a grouping of 2% and a mass stream pace of 0.084 kg/s has with 8% a lower temperature than the other Nano liquids and with 29% a higher heat move coefficient contrasted and the base liquid. From this examination creator presume that the Al_2O_3-EG/DW shows the most minimal weight drop and siphoning power, while the CeO_2-EG/DW and ZrO_2-EG/DW show the most elevated. Consequence of this examination is discovering that the slight increment of siphoning force and weight drop is watched, the high improvement happen in the Nano liquid when contrasted with the base liquid.

Tu-Chieh Hung et al. [2], in this paper numerical examination is accomplished for improve the heat move in a 3-D smaller scale channel heat sink (MCHS) by utilizing Nano liquids. Thermo physical properties of coolant liquid are changes by expansion of nanoparticles in it. Creator do the computations in this investigation which recommend that the best heat move improvement can be gotten by utilizing a framework with an Al_2O_3 water Nano liquid cooled MCHS. At the point when the base liquids have lower dynamic consistency, (for example, water) and substrate materials with high warm conductivity it will assist with expanding the warm exhibition of the MCHS. From this examination they found the outcome that as the molecule volume part of the Nano liquid builds, the warm obstruction first abatements and afterward increments. For a moderate scope of molecule estimates, the MCHS yields better execution when Nano liquids with littler nanoparticles are utilized. By expanding the siphoning power, the general warm obstruction of the MCHS is decreased. Scientists finish up the outcome that the heat move execution of Al_2O_3 water and precious stone water Nano liquids was 21.6% superior to that of pure water.

Amin Jafarimoghaddam et al. [3], The primary motivation behind the examination is to tentatively research heat move execution of rectangular and semi-roundabout cylinders within the sight of Ag/water Nano liquids. Here they utilize seven distinctive volume groupings of nanoparticles of Ag (silver, for example, 0.03%, 0.07%, 0.1%, 0.2%, 0.4%, 1% and 2%. This investigation depends on moderately low Reynolds quantities of 301 to 740. To keep the external surface of the cylinders under a steady heat motion condition a warmer with the intensity of 200W is utilized. They keep normal nanoparticles size is 20 nm. The consequences of the work show that, for all the inspected Reynolds numbers, the semi-roundabout cylinder has higher convective heat move coefficient for all the used volume groupings of Ag nanoparticles. From this examination they discover that the ordinary plan for cooling arrangement of photovoltaic cells is a heat sink with the rectangular graves. Additionally, infer that utilizing a semi-round structure have the bit of leeway over the rectangular one in convective to warm exchange coefficient improvement and henceforth a superior cooling execution for these sun-oriented cells.

Ali Ijam et al. [4], this paper present cooling of small scale channel heat sink utilizing Nano liquid. Nano liquids contain a little part of strong nanoparticles in base liquids. Writer utilized Nano liquids with various volume divisions of nanoparticles as a coolant for the small-scale channel. For the copper small channel heat sink Al_2O_3 water Nano liquid and TiO_2 water Nano liquid are tried, with the base of 20×20 mm laminar stream as a coolant, through pressure driven breadths. Consequence of the examination show that by adding Al_2O_3 nanoparticles to water at 4% of volume parts increment the warm conductivity by 11.98% and by scattering TiO_2 to the base liquid was 9.97%. At the point when they use Nano liquid, for example, Al_2O_3 water rather than water, cooling expanded by 2.95% to 17.32% and by utilizing TiO_2 water, 1.88% to 16.53% is accomplished. The most elevated siphoning power by utilizing Al_2O_3 water and TiO_2 water at 4 vol. % and 0.1 m/s was 0.000552W and at 4 vol. % and 1.5 m/s was 0.12437W.

Ravindra Kumar et al. [5], in this paper they talk about the exhibition improvement of heat exchanger. The exhibition of a miniaturized scale channel heat exchanger can be expanded by decreasing the water driven measurement or by utilizing a working liquid which has preferred warm conductivity over regular working liquids. Nano liquids increment the warm conductivity of base liquid upgrades warm conductivity of base liquid and improve the heat move execution of Micro channels. From this investigation it is seen that saw that the upgrade in heat move relies upon volume portion centralization of Nano liquid, nanoparticle size and material. The normal Nusselt number increments with an expansion in Nano liquid volume focus and Reynolds number just as reduction in nanoparticle size. From this investigation it is presume that ideal volume part of Nano liquid fixation improves heat move and a slight increment revealed in pressure drop when contrasted and pure liquid

III. PROBLEM STATEMENT

Nowadays it is observed that in microprocessor gets heated up due to overload simulation due to which system gets at high temperature. To avoid this heat sink with proper content of nanofluid volume fraction is to performed to enhance more heat dissipation from system.

IV. OBJECTIVES

1. To understand the cooling performance for water and nano fluid in designed square plate design with groves on base plate and with rectangular pin fin arrangement on upper plate is designed and modelled in CATIA software.
2. To understand the effect of nano particle (Al_2O_3) with two different volume concentration 1% & 2% at different flow rates to enhance the cooling performance for heat sink.
3. To determine the temperature, pressure plot distribution across heat sink apparatus.
4. Experimental investigation is to be carried out to for heat sink using different cooling mediums namely water and nano fluid.
5. Comparison of experimental and CFD simulation results.

V. METHODOLOGY

Step 1:- Initially research paper are studied to find out research gap for project then necessary parameters are studied in detail. After going through these papers, we learnt about CFD simulation of heat sink.
Step2:- Research gap is studied to understand new objectives for project.
Step 3:- After deciding the components, the 3D Model and drafting will be done with the help of CATIA software.
Step 4:- The modal Analysis of the components will be done with the help of ANSYS using CFD.
Step 5:- The Experimental manufacturing of setup and testing under specified conditions.
Step 6:- Comparative analysisbetween the experimental and analysis result.

DESIGN OF FIN ACROSS HEAT SINK

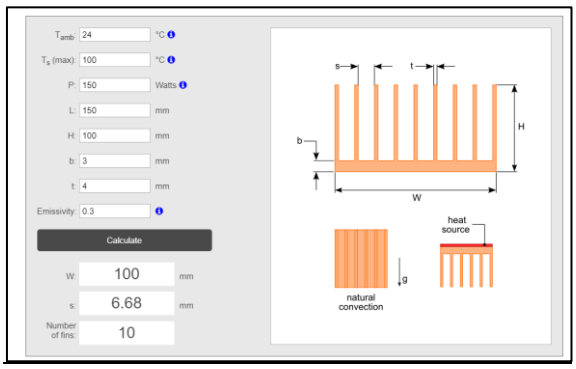
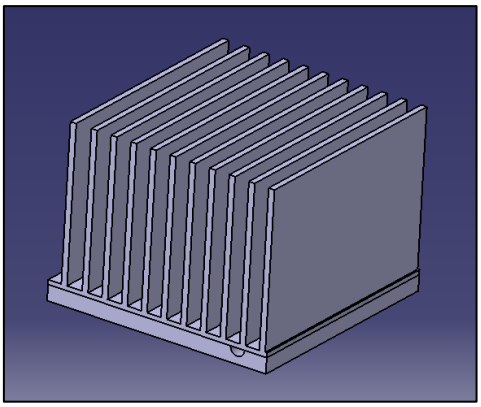


Fig. Design of heat sink

In present research heat sink with base plate having groves are performed and top plate contain pin fin rectangular arrangement.

In pin fin to calculate the number of fins required for efficient heat dissipation on top plate it is calculated by heat sink calculator in which required parameter are filled namely length, with, heating temperature to calculate number of fins.

So, approximately for convenience 11 fin are selected.



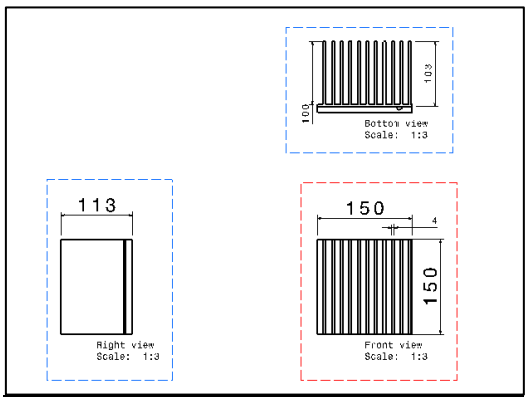


Fig. CATIA and drafting of heat sink

Computational fluid dynamics (CFD) is a branch of fluid mechanics that uses numerical analysis and data structures to analyze and solve problems that involve fluid flows. CFD is now recognized to be a part of the computer-aided engineering (CAE) spectrum of tools used extensively today in all industries, and its approach to modelling fluid flow phenomena allows equipment designers and technical analysts to have the power of a virtual wind tunnel on their desktop computer.

CFD PROCEDURE

- Fine meshing is performed for CFD simulation.
- Named selection is performed in CFD to define air inlet, outlet and surface.
- In general box model gravity is defined in perpendicular direction and energy is kept on to perform conservation of mass, momentum and energy equation to solve.
- In viscous model k epsilon, realizable and standard wall function is selected to maintain turbulence flow.
- Selection of k epsilon model with wall scalable function along with material as air as fluid and base material for model are selected.

- Inlet velocity of 1 m/s and heater temperature is defined as 100 C is defined for solution initialization hybrid is selected.
- Number of iterations of approx. 150 is provided and calculation is performed.
- Calculation of pressure plot, heat transfer coefficient has been plotted.

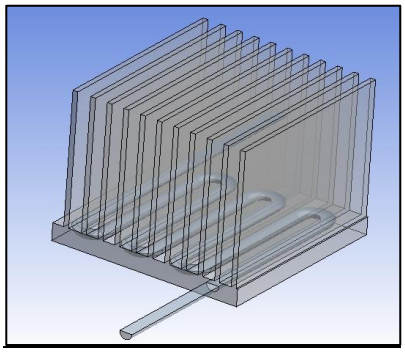
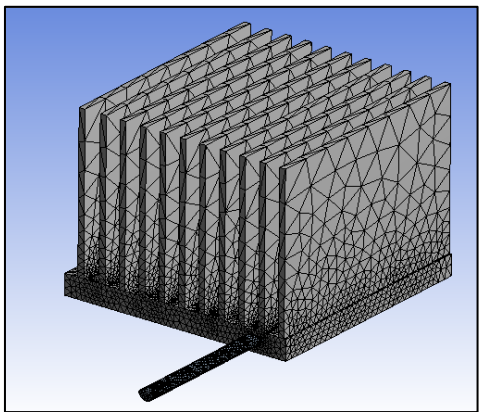


Fig. Geometry imported in ANSYS for CFD simulation

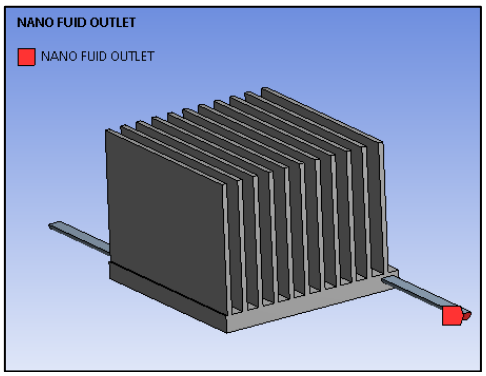
Mesh

In ANSYS meshing is performed as similar to discretization process in FEA procedure in which it breaks whole components in small elements and nodes. So, in analysis boundary condition equation are solved at this elements and nodes. ANSYS Meshing may be all-purpose, intelligent, automated high-performance product. It produces the foremost acceptable mesh for correct, economical metaphysics solutions. A mesh well matched for a selected analysis may be generated with one click for all elements in a very model.



Statistics	
Nodes	77619
Elements	353899

Fig.: Details of meshing of heat sink



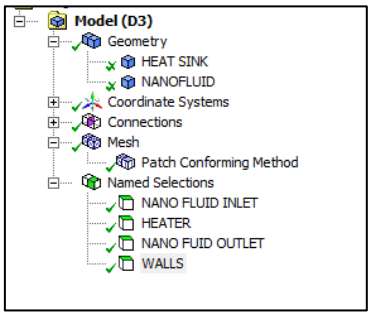


Fig. Named selection for CFD simulation

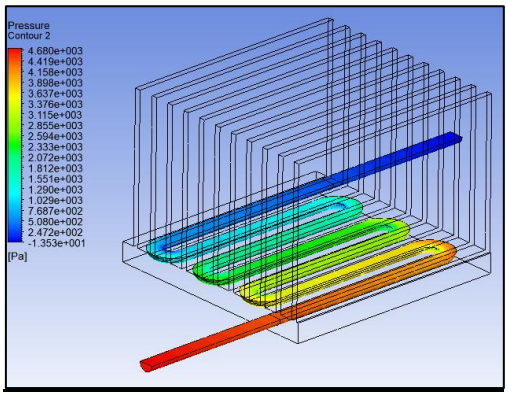
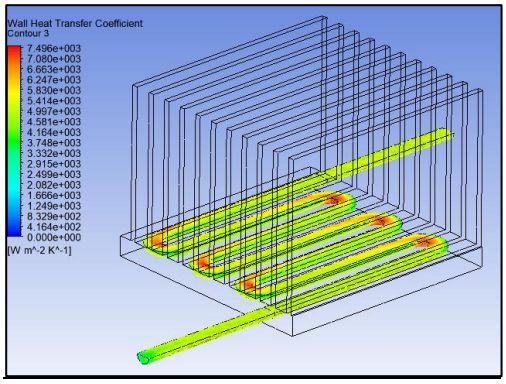


Fig. Pressure contour for heat sink



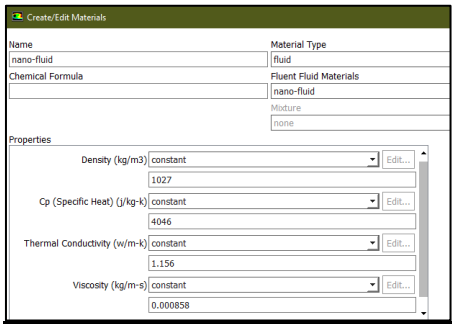
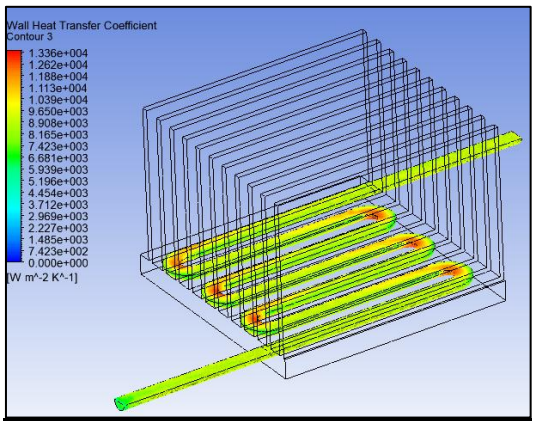


Fig. : Details of nano fluid with 1% volume fraction



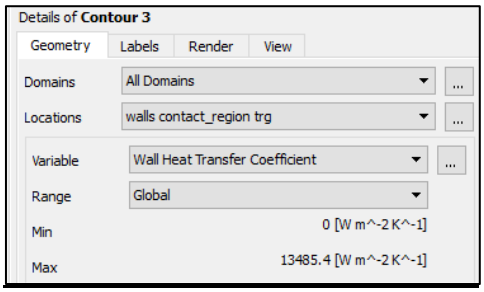


Fig. : Details of wall heat transfer coefficient with 1% nano fluid fraction

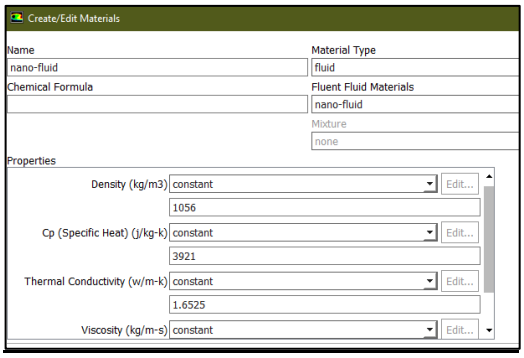
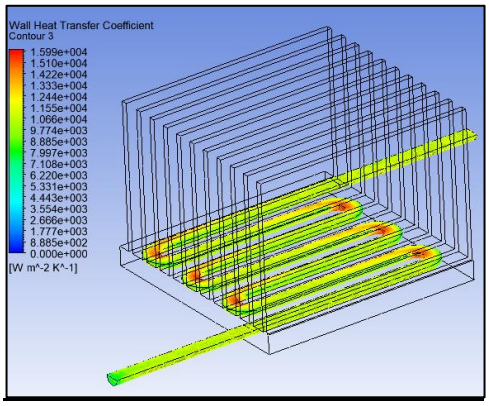


Fig. : Details of nano fluid with 2 % volume fraction



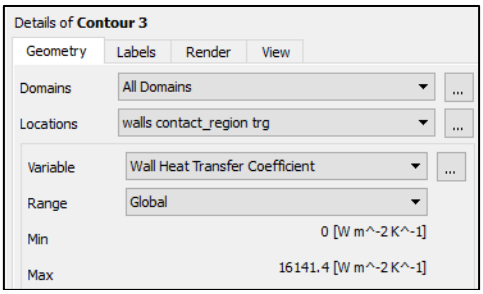


Fig. : Details of wall heat transfer coefficient with 2 % nano fluid fraction

EXPERIMENTAL WORK

- Initially heat sink of specified designed dimension is manufactured with specified groves in internal section along with heat sink placed on top.
- Copper plate is selected in which heater junction probe are attached to behave as heating plate with specified temperature.
- In inlet and outlet water and nanofluid are transfer to study the effect on outlet temperature and heat sink surface temperature.
- Heat sink is placed on copper or heating plate then water is provided through inlet section with submersible pump through blue pipe in groves of sink and outlet water temperature is measured by thermocouple.
- Similar procedure is performed with nanofluid and also for different heating temperature for both cases.

Fig. Experimental testing setup

VI. CONCLUSIONS

1. In present research water have been used in existing condition to study its physical properties to enhance heat transfer parameters.
2. Heat sink have been designed to study cooling performance of component with heating element placed below bottom plate.
3. In present stage water as coolant medium is studied to determine pressure, temperature and heat transfer coefficient contour plot.
4. It is observed that using alumina as nanofluid with 1 and 2 % volume fraction temperature as well as pressure drop have been reduced along with increase in heat dissipation heat transfer coefficient is observed.
5. Experimental testing has been concluded that water containing nanofluid have been more effective with more heat absorbing characteristics and less heated surface of fin of heat sink with specified temperature applied by heater.

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