ISSN NO: 9726-001X
Volume 10 Issue 01 2022

JOURNAL OF CURRENT SCIENCE

COMPUTATIONAL FLUID ANALYSIS ON ELECTRONIC DEVICES TO DEMONSRATE THE THERMAL EFFECTS ON MATERIAL

Mr. S. Samraj, Mr. K. Sedhuramalingam, Dr. V. Shantha, Dr. B. Rajeshkumar
Assistant Professor [1,2,4] Associate Professor [3]
ssamraj@actechnology.in, sedhuramalingam.k@actechnology.in,
Shantha.v@actechnology.in, RajeshKumar.b@actechnology.in

Department of MCT, Arjun College of Technology, Thamaraikulam, Coimbatore-Pollachi Highway, Coimbatore, Tamilnadu-642 120

Abstract

Electronic devices are becoming smaller and smaller as the number of functionality packed into a single chip continues to skyrocket. Therefore, effectively dissipating the chip's heat is a formidable obstacle. Various types of study have been conducted in this area during the last many decades. Researchers studying electrical cooling are increasingly turning to CFD models. Utilising computational fluid dynamics (CFD) models, this research examines the chip's cooling impacts. Space claim is used to represent the single chip module. In order to do the analysis, the governing equations for a flow through a channel via blockage are solved in the fluent module. As a function of chip temperature, the laminar flow of a viscous model is examined for the two metals (copper and aluminium).

Keyword: space claim, fluent, laminar flow, surface to surface radiation, free convection, chip cooling.

Introduction

Almost every part of our everyday lives is now accompanied by some kind of electronic gadget or technology. Among them, electronic computers—ranging in size from small portables to massive server farms—are among the most common. It is fairly uncommon for computers to be so integrated in other devices that they are hardly noticeable. In vehicles, spaceships, missiles, satellites, and so forth. From simple recreational games to intricate systems supporting critical economic, scientific, healthcare, mobile phone, and military operations, computers have a wide range of uses. In the same way as the number of functions per unit is increasing, the size of the instruments is decreasing with time.

Countless functioning components are crammed into an ever-shrinking system box, as seen most obviously in portable electronic components like computers, mobile phones, digital cameras, and other everyday objects. As a result of pressure to shrink box sizes and shorten wire lengths between electrical components, desktop and server computer packaging is likewise becoming smaller. Computer failure severely interrupts critical services and may potentially have fatal repercussions in an increasing number of applications. attempts to increase the speed and storage capacity of electronic computers and chips are vital, but so are attempts to make them more reliable.

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Effective heat evacuation has been a critical component in guaranteeing the dependable functioning of computer generations since the first electronic digital computers were developed in the 1940s. With its 18,000 vacuum tubes dissipating 140 KW, the "30-ton, boxcar-sized machine" known as the Electrical Numerical Integrator and Computer (ENIAC) needed a network of industrial cooling fans when it was dedicated in 1946. Virtually every early computer up to 1957 made use of vacuum-tube circuitry and was cooled by forced air, much like ENIAC.

Statement of the Problem

During the 1960s small scale and then medium-scale integration (SSI) and (MSI) led from one device per chip to hundreds of devices per chip. The trend continued through the 1970s with the development of large-scale integration (LSI) technologies offering hundreds to thousands of devices per chip, and then through the 1980s with the development of very-large-scale integration technologies offering thousands to tens of thousands of devices per chip. This trend continued with the introduction of the microprocessor. It continues to this day with INTEL and others projecting that a microprocessor chip with a billion or more transistors will be a reality before 2010. A decrease in circuit delay (i.e., faster speed) has often been achieved with the trend towards denser circuits by increasing power dissipation per circuit. The development of multi-chip modules, which represent the chip heat flux and the module heat flux, began in the late 1970s and is still going strong today. This is due to the need to further enhance packing density and minimise the signal latency between communication circuits. The heat flux associated with bipolar circuit technology has been rising continuously since its inception and truly took off in the 1980s. The chip heat flux, on the other hand, is increasing at a CGR of 7% per year. Heat flux is once again growing at a demanding pace, after a short reprieve with the shift to CMOS circuit technology in the 1990s. However, the desire for improved package density and performance has since reemerged. subatomic particles such as positrons and neutrons that make up secondary cosmic rays, which are created when main cosmic rays collide with the Earth's atmosphere. There is just the right amount of oxygen to oxidise all of the fuels it contains, but not enough to produce nitrogen oxides from the nitrogen in the mixture.

Objectives of the study

- Surface to surface
- The material of the chip replaced by different materials i.e copper, aluminum.
- Aluminum dissipates heat up to 15 times faster than stainless steel.
- Copper has 60% better than thermal conductivity rating than aluminum and almost 30 times more thermal conductivity than stainless steel.

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Review of Literature

In order to handle the rising cooling demand and thermal management issues of new electronic gadgets, Chang YW [1] noted that traditional cooling methods are progressively failing. Consequently, cutting-edge methods, mechanisms, and coolants with excellent heat transfer capabilities are required to keep high performance chips or devices at a consistent working temperature. According to Lasance and SimonsR [2], there are a plethora of methods for dissipating heat from a device; nonetheless, they all boil down to one basic idea: using convection, conduction, or radiation to transfer the heat from the device to the surrounding medium, which is often air. The SMS [3] that Murshed sent out For the purpose of expediting their use in industrial-scale hot steel rolling, environmentally acceptable and inexpensive water-based nano lubricants were created, which comprise rutile TiO_2 nanoparticles (NPs). In a 2-high Hille 100 experimental rolling mill operating at 850 °C, the lubrication performance of newly created nano lubricants was compared to that of water. According to the findings, nano lubricant may be used to improve surface hardness, minimise rolling force, and decrease oxide scale thickness and surface roughness. High performance processors' power density has increased dramatically due to developments in semiconductors and other micro and nanoscale electronic technologies, as discussed by Murshed SMS and Nieto de Castro CA [4]. Ciudad Nieto de Castro [5] The boiling heat transfer and droplet spreading behaviour of nanofluids are discussed in this article. These fluids are a combination of nanoparticles and base fluids, and they have better thermal characteristics than regular fluids. Heat pipes, refrigeration systems, and nuclear reactors are just a few of the possible uses of nanofluids that the authors cover. Hernandez Nieto and Murshed SMS [6] Interest in nanofluids has skyrocketed as it is a relatively new area of study.

from scholars all throughout the globe and have been the focus of heavy investigation as of late. Nanofluids are the next big thing in heat transfer fluids due to their amazing thermophysical characteristics, heat transfer capabilities, and vast array of possible uses. (Carol) Nieto de Castro and Murshed SMS [7] This study and discussion focusses on the most up-to-date findings about the possible uses and thermal properties of nano-fluids packed with carbon nanotubes. The existing research on the heat transfers of this particular type of nanofluids is reviewed in depth, including boiling, convection, and conduction, in addition to a briefing on their manufacture. We also show that boiling critical heat flux, convective heat transfer coefficient, and thermal conductivity are affected by various factors including temperature and carbon nanotube concentration. By V.K. Wong and O. De Leon [8]The article continues by discussing the present and prospective uses of nanofluids, which include lubricants, coolants, and heat transfer fluids in a variety of mechanical systems. Nanofluids have many possible uses in electronics, including temperature control of microelectronic devices, and in biomedicine, including medication delivery and cancer treatment, as the authors further explain.

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Research Methodology

CONVECTION

Convection is the process of heat transfer by the bulk movement of molecules within fluids such as gases and liquids. The initial heat transfer between the object and the fluid takes place through conduction, but the bulk heat transfer happens due to the motion of the fluid.

Convection is the process of heat transfer in fluids by the actual motion of matter. It happens in liquids and gases. It may be natural or forced. It involves a bulk transfer of portions of the fluid. When a fluid is heated from below, thermal expansion takes place. The lower layers of the fluid, which are hotter, become less dense. We know that colder fluid is denser. Due to Buoyancy, the less dense, hotter part of the fluid rises up. And the colder, denser fluid replaces it. This process is repeated when this part also gets heated and rises up to be replaced by the colder upper layer.This is how the heat is transferred through convection. There are two types of convection, and they are:

NATURAL CONVECTION

When convection takes place due to buoyant force as there is a difference in densities caused by the difference in temperatures it is known as natural convection. Examples of natural convection are oceanic winds.

RADIATION

The word "radiation" arises from the phenomenon of waves radiating(i.e., traveling outward in all directions) from a source. This aspect leads to a system of measurements and physical units that are applicable to all types of radiation is shown in below figure-1

Fig.1 Radiation

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BOUNDARY CONDITIONS

The boundary conditions of electronic chip is shown in below figures [2-3].

INLET

Attheinletthetemperaturetakenas45c.

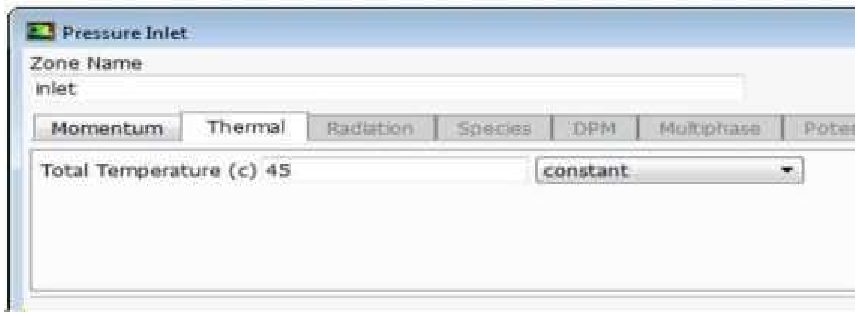

Fig.2 Pressure Inlet

OUTLET

At the OUTLET the gauge pressure is taken as zero.

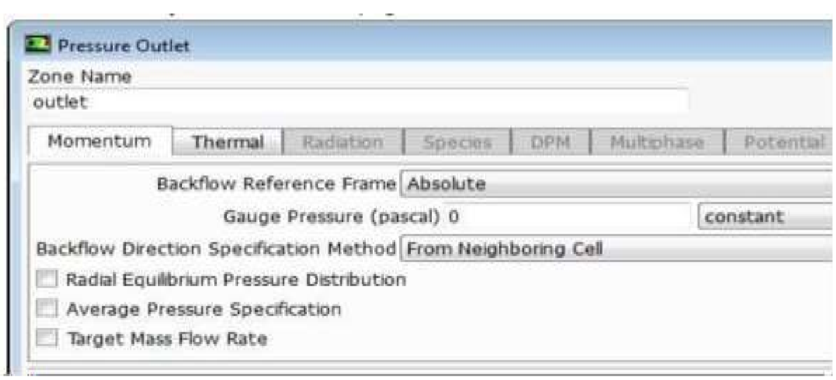

Fig.3 Pressure Outlet

Results and Discussion

CFD ANALYSIS CHIP USING COPPER (CU)

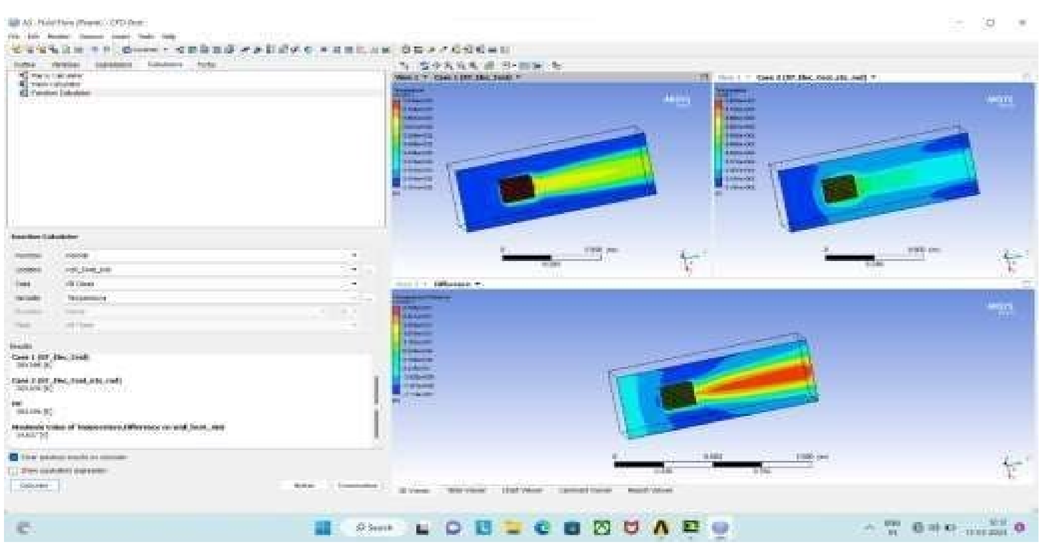

Fig.4CFD Analysis for COPPER

CFD Analysis for copper is shown in the above figure 4. If copper has thermal conductivity is about 387.6 w/kg.k . If higher the thermal conductivity high heat transfer through the heat sink so the copper has heat transfer rate is about 364.5 k.

CFD ANALYSIS CHIP USING ALUMINIUM (AL)

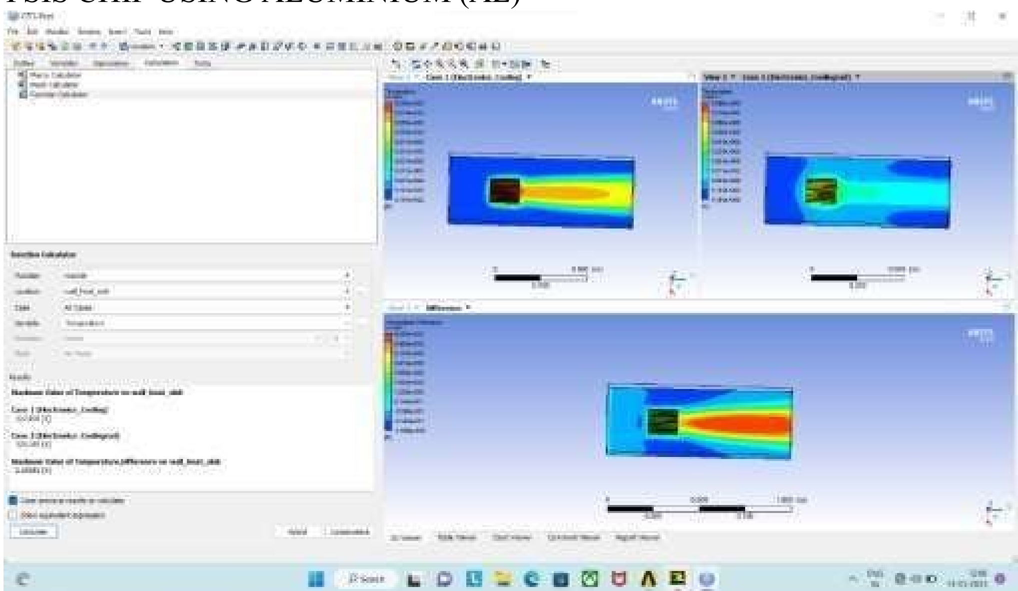

Fig.5 CFD Analysis for ALUMINIUM

CFD Analysis for ALUMINIUM is shown in the fig 5. If aluminum has thermal conductivity is about 241 w/kg.k . If higher the thermal conductivity high heat transfer through the heat sink so the aluminum has heat transfer rate is about 360 k.

Scaled Residuals

Copper

If scaled residuals contains continuity, x-velocity, y-velocity, z-velocity and energy. In this analysis we will find the energy variation up to 0.3 the due to the medium thermal conductivity as shown in below fig 6

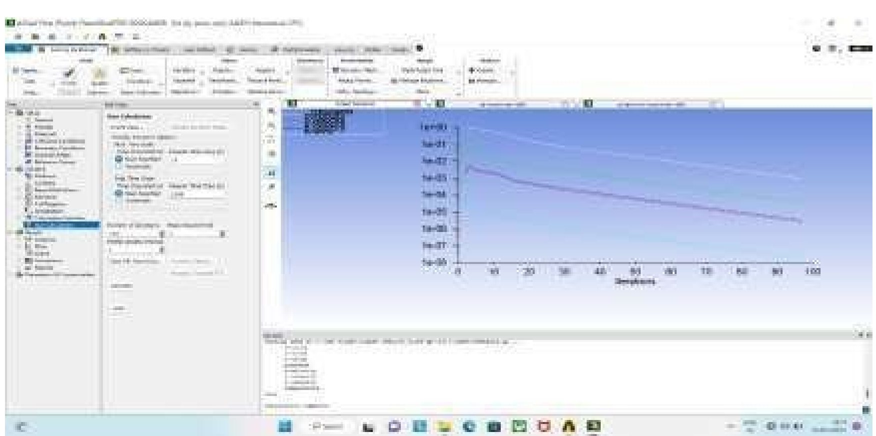

Fig.6 Scaled residuals for copper

ALUMINIUM

ISSN NO: 9726-001X
Volume 10 Issue 01 2022

If scaled residuals contains continuity, x-velocity, y-velocity, z-velocity and energy. In this analysis we will find the energy variation up to 0.1 due to the less thermal conductivity when compare to copper as shown in below fig 7.

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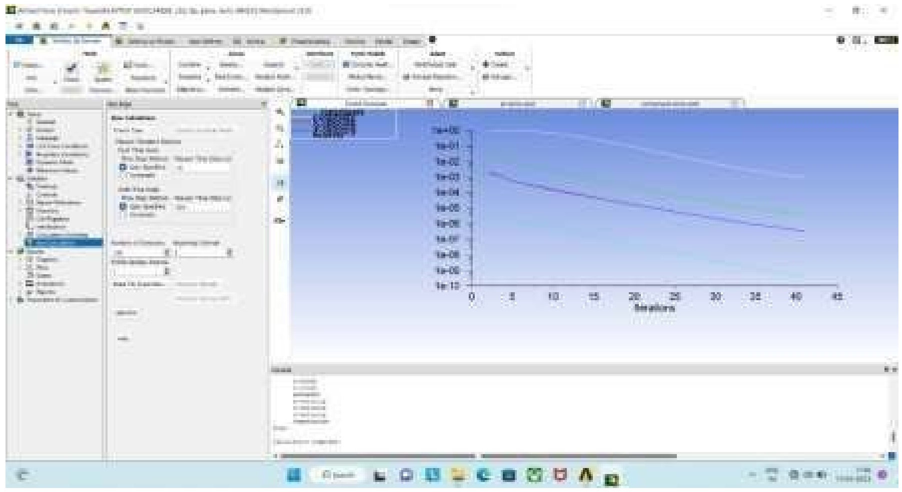


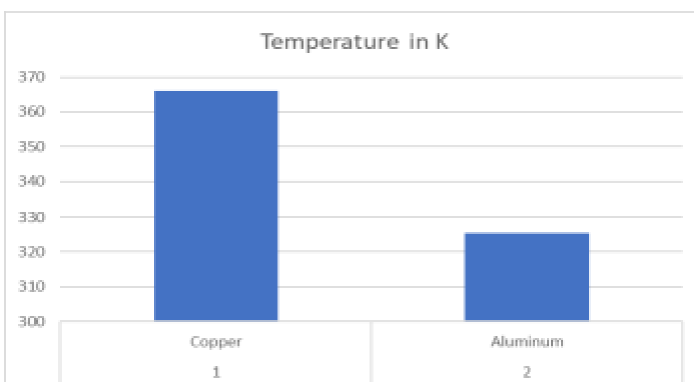
Fig.7 Scaled residuals for Aluminum

By using these values we will find out that if higher the thermal conductivity value, the higher the energy variation. By using those values copper has high energy variation as shown in graph1 and properties are given in table 1.

Result:

REMOVAL OF TEMPERATURE FROM CHIP

S.No.	Material	Temperature in K
1	Copper	365.936
2	Aluminum	325.355



Graph 1 removal of temperature from chip

Conclusion

The heat flux density of high-performance chips and components has risen dramatically due to developments in semiconductor technology, and traditional cooling methods and coolants aren't keeping up with the ever-increasing cooling demands of these power-hungry electronic devices. Although significant strides have been achieved in the last few decades, there are still

there are significant technological obstacles in controlling the heat and cooling these gadgets. To maintain normal performance and durability, high-

ISSN NO: 9726-001X
Volume 10 Issue 01 2022

performance chips and devices need coolants with a high heat transfer capacity, as well as unique mechanisms and strategies to boost the cooling rate. Thanks to their exceptional cooling capabilities and thermal characteristics, nanofluids show a lot of potential for used as fluids for the cooling of advanced electrical equipment and sectors. Emerging methods, such as microchannels filled with these novel fluids, may represent the cooling technology of the future.

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