Master's Thesis Defense Announcement
Mechanical and Aerospace Engineering Department
University of Texas at Arlington

EXPERIMENTAL STUDY ON THERMAL PERFORMANCE OF METAL FOAM HEAT SINKS IN SINGLE-PHASE LIQUID IMMERSION COOLING

By: **Manish Kumawat**

Thesis advisor: Dr. Dereje Agonafer

December 14, 2023. 10 AM CST, Woolf Hall, 413

ABSTRACT

Single-phase liquid immersion cooling is a method of cooling electronic components where the components are completely immersed in a dielectric liquid (electrically non-conductive). In conditions where high-performance computing and data center applications require significant heat dissipation, single-phase liquid immersion cooling is a more efficient technique than air cooling, particularly in high heat flux, efficient heat removal, uniform cooling, improved reliability, and longevity of components. The process is termed "single-phase" because the cooling liquid remains in the same phase. This work presents an experimental study on the thermal performance of aluminum foam heat sinks in single-phase liquid immersion cooling (SPLIC). A set of heat sinks with varying pores per inch (PPI) and height is employed to test the thermal properties of heat sinks under different flow rates and power. Metal foams are used in place of conventional heat sinks for cooling, particularly aluminum alloy (Al-6101-T6) foam, which is a type of lightweight porous material with a cellular structure consisting of a large volume fraction of gas-filled open pores. It has a higher surface area-to-volume ratio, higher thermal conductivity, is lightweight, has increased turbulence, and has structural integrity at high temperatures. The goal of this experiment is to analyze the thermal and fluid properties of an aluminum foam heat sink when it is immersed in a synthetic dielectric fluid (EC-100). A customized tank was designed and fabricated for the experimental setup with a Thermal Test Vehicle (TTV), enabling the control of flow rate, heater temperature, and inlet temperature of the fluid. A set of experiments were conducted using aluminum foam heat sinks with varying pores per inch (5, 10, 20, and 40 PPI) for varying flow rates (1, 2, and 3 LPM) and heights (0.5 and 0.75 inches) with a relative density of 10~12%, mounted on a heater plate of heat flux 19 W/cm^2 and 23.8 W/cm^2 respectively. Major outcomes from the experiment were that the heat sink of 10 PPI exhibited the best heat transfer and lowest thermal resistance, while the heat sink of 5 PPI exhibited the highest "overall surface area efficiency" in all conditions. The heat transfer was increased from 0.5-inch-high to 0.75-inch-high foam cores.