Master's Thesis Defense Announcement

Mechanical and Aerospace Engineering Department

University of Texas Arlington

Numerical Simulation and Optimization of Fin Configurations for Enhanced Heat Sink Performance in Aluminum and Copper Materials

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Online on Teams

Meeting Link: Teams Link

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Abstract

The constant evolution of data centers and high-power electronic systems has raised critical challenges in heat dissipation and thermal management. Single-phase immersion cooling, where electronic components are submerged in a thermally conductive but non-electrically conductive liquid (dielectric liquid), offers improved heat dissipation capabilities and emerges as a promising alternative to traditional air-cooling methods, which often fail to meet the thermal demands of densely packed, high-power systems. This study investigates and compares the thermal performance of aluminum and copper heat sinks with fin thicknesses of 0.33 mm and 0.54 mm, respectively, using finite element analysis based on computational fluid dynamics (CFD) simulations. A continuous heat input of 650 W was applied, and performance was assessed by varying the fin numbers and across flow rates of 3, 5, and 7 liters per minute (LPM). Copper, with a thermal conductivity of 400 W/m·K, consistently outperformed aluminum (237 W/m·K). The simulation results demonstrate that increasing the fin count from 20 to 40 significantly enhanced cooling performance, particularly for copper, where maximum temperatures remained below 74.9°C and thermal resistance dropped to 0.0487 K/W at 7 LPM. In contrast, aluminum reached a maximum temperature of 87.2°C and a thermal resistance of 0.07548 K/W under the same conditions.

Keywords: immersion cooling, computational fluid dynamics, thermal resistance, thermal conductivity