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

Experimental Study of Flow Analysis In Single Phase Immersion Cooling Using Tomographic PIV

By: VIJAYA RAMA RAJU GORIPARTHI

Thesis Advisor: Dr. Agonafer Dereje
1:00PM, Monday, May 6th, 2024
WH 200

Abstract

As data centers evolve to support increasing server densities, the inadequacies of traditional air cooling in managing thermal loads have become evident. This is primarily due to an increased demand for powerful CPU and GPU-based platforms that can run Artificial Intelligence (AI) and Machine Learning (ML) workloads amongst others. Consequently, single-phase immersion cooling has gained prominence as an efficient, sustainable alternative, significantly reducing operational costs and energy consumption. This method has shown a remarkable ability to cut cooling energy by up to 90% and overall data center energy use by 50%. The current investigation uses Particle Image Velocimetry (PIV) to quantify the flow profiles in a functional 1U Coyote Pass server (M50CYP), cooled using an immersion fluid Polyalphaolefin 6 (PAO6), a synthetic hydrocarbon lubricant known for its thermal advantages, to cool a server with an inlet temperature set at 40 degrees Celsius. PG-25 water-based coolant circulates in a coolant distribution unit, coupled with a counterflow heat exchanger to optimize heat dissipation. The cooling system consists of a single-phase immersion-cooled 2U tank filled with PAO as a dielectric fluid.

This study aims to evaluate the effectiveness of single-phase immersion cooling in maintaining optimal server temperatures. The focus is on analyzing the 3D velocity vector field in critical components such as CPUs and heatsinks using Tomographic PIV. Tomographic PIV enables the measurement of fluid velocity by reconstructing a three-dimensional structure from a series of two-dimensional images and tracking the motion of particles suspended in the fluid. Additionally, this investigation examines the thermal performance of CPUs to gain insights into the overall effectiveness of the cooling system.