AUTONOMY RESEARCH CENTER FOR STEAHM

Autonomy For Manufacturing And Construction

Thermal Management and Energy Systems

Fig. 1. CAD isometric view and manufactured setup of experimental test section.

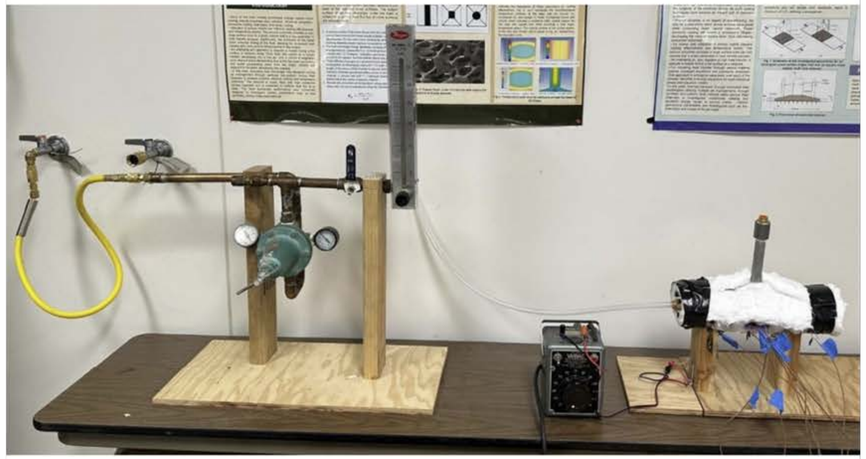

Fig. 2. Experimental setup.

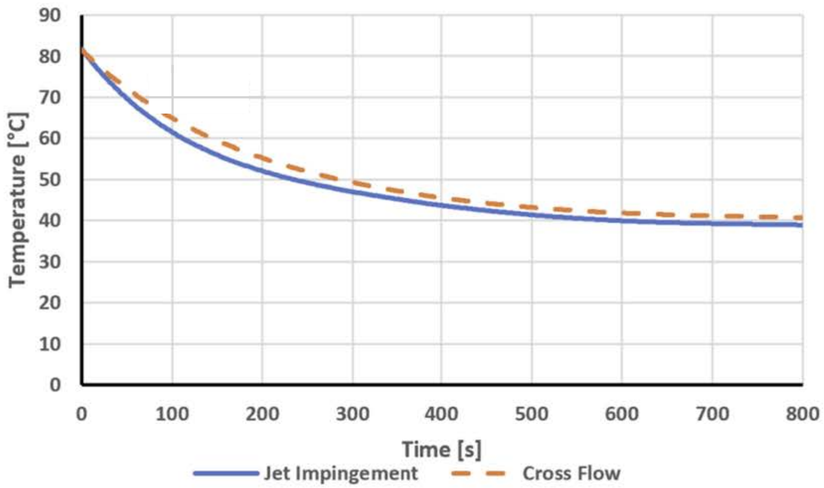

Fig. 3. Preliminary results.

Synopsis

- Better thermal management techniques are needed to efficiently cool the next generation of electronic devices.
- This can be accomplished through a wide range of techniques such as jet impingement, multi-phase heat transfer, and using porous media.
- In addition to electronics cooling, some thermal management systems also have applications in sustainable energy production and spacecraft technology.

Research Objective

- Manage the waste heat produced by high-performance electronic components.
- Investigate methods of thermal management to improve the efficiency of electronic systems and enable the use of more powerful components.
- Explore both passive and active cooling methods, as well as metal foam substrates to enhance heat transfer and improve thermal management of devices.

Research Approach

- Explore the cooling effect of air and water flowing over a heated area representing a computing component such as a CPU.
- Investigate the effect of employing ribbed and metal foam structures on top of the heated area.
- Investigate the effect of using a multi-phase heat transfer device for computer chip cooling, such as an oscillating heat pipe.

Research Results and Products

- Components: Enclosed and insulated aluminum channel, electric heating element, pressure regulator, flow meter, thermocouples, pressure transducers, data acquisition system (NI 9213, NI 9253, LabVIEW software).
- Jet impingement with air effectively cools the heated area. Crossflow also cools the heated area to a slightly lesser extent.
- In the next stage of research, the effectiveness of the cooling system will be investigated using water. The system will also be tested with metal foams using water and air as the working fluids.

Commercialization and/or Societal Impact Opportunities

- **Application:** Electronics cooling, sustainable energy production
- **Key Values:** Efficiently cool electronic devices to enable the use of more powerful computing components.
- **Potential Customers:** Tech companies, space agencies, energy providers

Team Names & Collaborators

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Citations

1- State-of-the-Art of Small Spacecraft Technology, Chapter 7. Thermal Control, NASA, Feb. 2024, https://www.nasa.gov/smallsat-institute/sst-soa/thermal-control/#7.3.
2- Corvera, C. and Mahjoob, S., "Thermal Analysis of Jet-in-Crossflow Technique for Hotspot Treatment in Electronics Cooling", ASME Journal of Heat and Mass Transfer, Vol. 146, No. 4, 2024.
3- Mahjoob, S. and Kashkuli, S., "Thermal Transport Analysis of Injected Flow through Combined Rib and Metal Foam in Converging Channels with Application in Electronics Hotspot Removal", International Journal of Heat and Mass Transfer, Vol. 177, 2021.
4- Zing, C. and Mahjoob, S., "Thermal Analysis of Multi Jet Impingement through Porous Media to Design a Confined Heat Management System", *ASME Journal of Heat Transfer*, Vol.141, No. 8, 2019.

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