Electronic Cooling with Jet Impingement

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Introduction

There are three forms of heat transfer in cooling electronic devices: convection, conduction, and radiation. Convection and conduction are the two main forms of heat transfer used in jet impingement. Jet impingement relies on a fluid passing through a nozzle onto a heat plate in order to cool an electronic device.

Hypothesis

What type of nozzle will result in the most effective cooling for an electronic device, and what is the best way to visualize it?

Background

- Energy transfers through a heat plate to the water from electronics that need to be cooled.
- Electronics are designed to function within certain parameters. One of which is maximum temperatures.
- To maintain the temperature, electronics need to be cooled through some method. One method is through the use of jet impingement with water.
- Water is an excellent coolant because of its high specific heat.

Materials/Methods

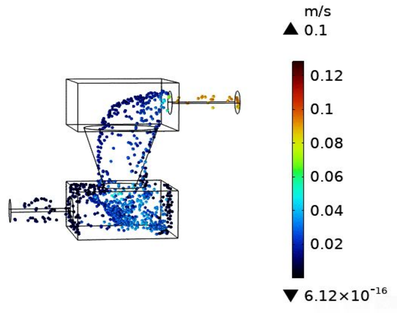
- SolidWorks- CAD software
- 3D printer
- Comsol- simulation software

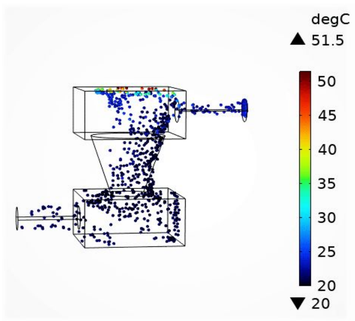
Ranked in order of most efficient to least efficient based on heat absorbed from top to bottom

Divergent Nozzle

Velocity: 0.0292m/s:
Heat absorbed: 31.5℃

½ inch to ¾ inch nozzle

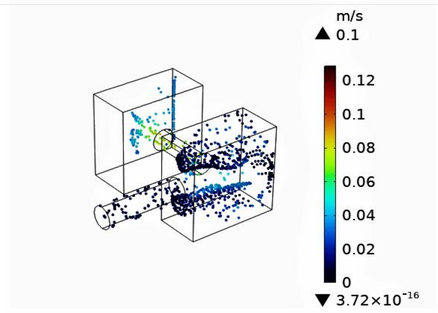


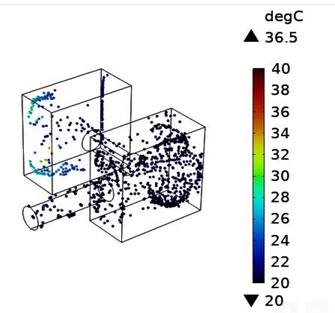


Straight Nozzle

Velocity: 0.066 m/s
Heat Absorbed: 19.1℃

½ inch to ½ inch nozzle

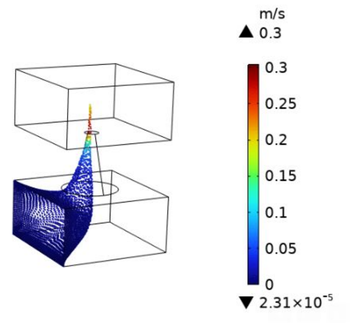


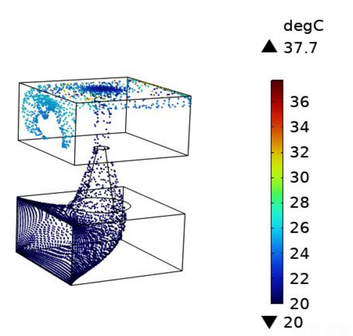


Convergent Nozzle

Velocity: 0.263m/s
Heat Absorbed: 17.7℃

½ inch to ¼ inch nozzle

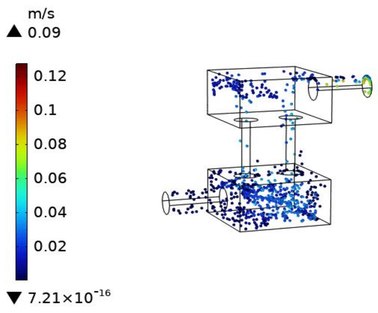




Double Straight Nozzle

Velocity: 0.263m/s
Heat Absorbed: 16.4℃

¼ inch to ¼ inch nozzle

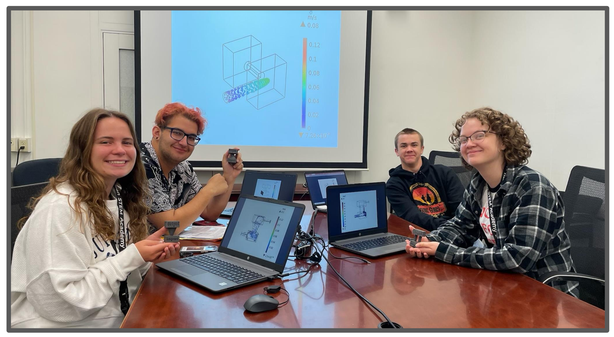


Results

- The simulations ran between convergent, divergent, single, and double nozzles.
- The divergent nozzle conducted the most heat, making it the best fit for cooling electronic devices.
- The straight nozzle had poor velocity and decent heat absorbency.
- The convergent nozzle had decent velocity but the heat absorption was poor.
- The double straight nozzle had poor velocity and heat absorbency.

Conclusion

We found that the divergent nozzle works best for efficiently cooling electronic objects with jet impingement. The fluid dynamics simulation showed the effectiveness of the divergent nozzle as opposed to the others. Using jet impingement to cool electronic objects will become more prevalent in the future as an emerging technology, while it is used now but not as frequently. Jet impingement is used in turbines, gas turbines, compressors, electric-powered cars, and supercomputers. Currently engineers and researchers are moving towards making nozzles more compact, lighter weight, and more efficient.



Acknowledgments

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