CubeSat Heat Pipe Design

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Project Background

The oscillating heat pipe design, introduced in 1990, showcases excellent heat transfer abilities using pressure-driven two-phase fluid flow. By developing a specific and enclosed piping system with a working fluid, thermal energy can travel between two locations rapidly through oscillating fluid motion. This design has the potential to increase the heat conductivity properties of many materials without significant weight cost. The space industry is an important application area for this technology as it allows high-powered circuit operation without the danger of overheating.

Project Objective

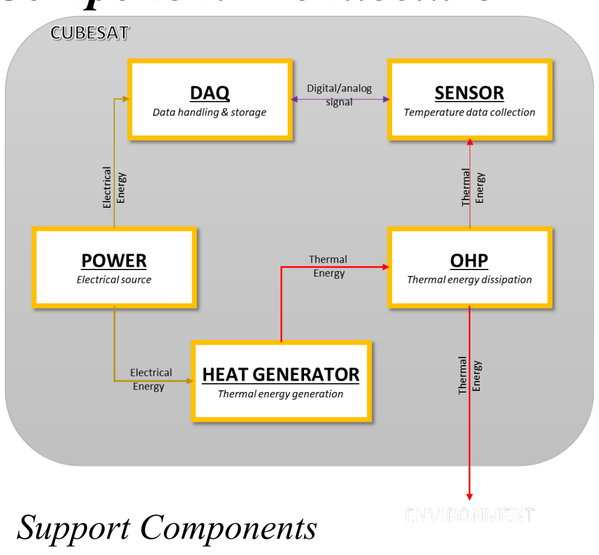
- Design an oscillating heat pipe (OHP) that will be fitted inside a CubeSat.
- Design an experiment within the CubeSat to test the performance of the heat pipe in space-like conditions.

System Requirement

Requirement	Objective	Method of Validation
Total Dimension	32cm x 8cm x 8cm (4U)	Design
Weight	<4.5 kg, max limit	Design
CubeSat Operational Temperature	4°C - 65°C	Test
Data Acquisition Unit	Able to collect and store data temperature	Design
Heater	Produce more than 10 Watts	Test
Condenser	Absorb all heat produce by heater	Test

Design Approach and Methodology

Component Architecture



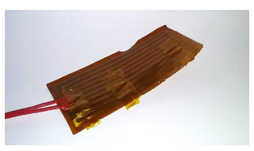
Support Components



12 V Battery Power Source



Arduino Data Acquisition Unit (DAQ)



Heating Pad

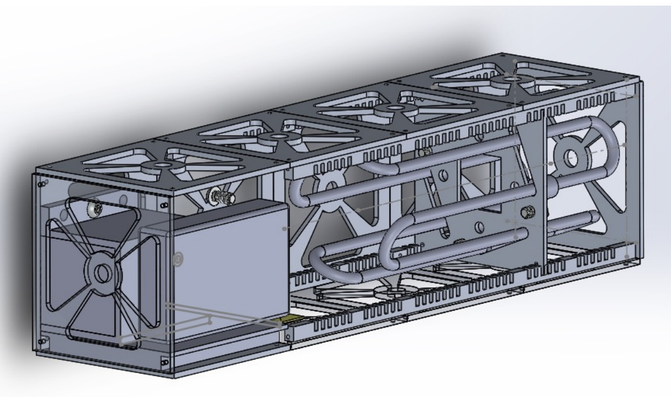


NTC 10KOhm Thermistor

Complete CubeSat with OHP Design

- The OHP, battery, DAQ, and condenser are housed into the CubeSat
- Battery and DAQ have 3D printed mounts
- OHP slots into 3D printed plate and mounted to the plate with 3D printed mounts
- Condenser is wrapped around the OHP and secured with thermal tape and foam



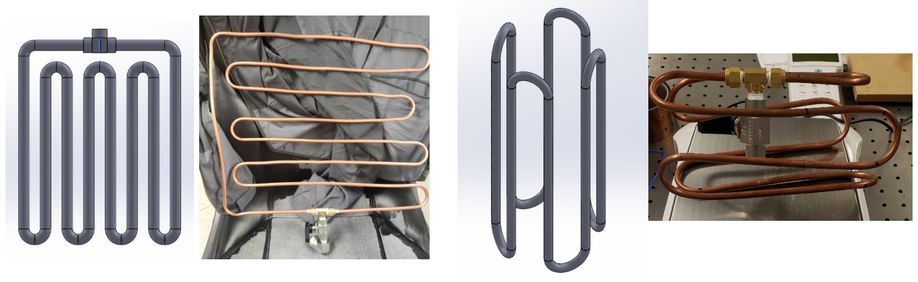


DAQ Design

- Self-Powered
- MicroSD Data Storage
- Temperature and Acceleration Sensors

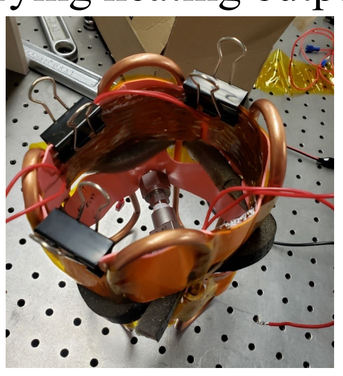
OHP Design

- The 4-bend OHP geometry allows the pipe to fit into 2 CubeSat units. The pipe is a ¼" outer diameter copper pipe



Experimental Procedure

- Use in-lab refrigerant pump to control the ratio of working fluid within the OHP
- Use heating pads to generate thermal energy and track heat transfer through OHP
- Maintain heat sink through ice packs
- Insulate and perform tests on the OHP with varying heating output.

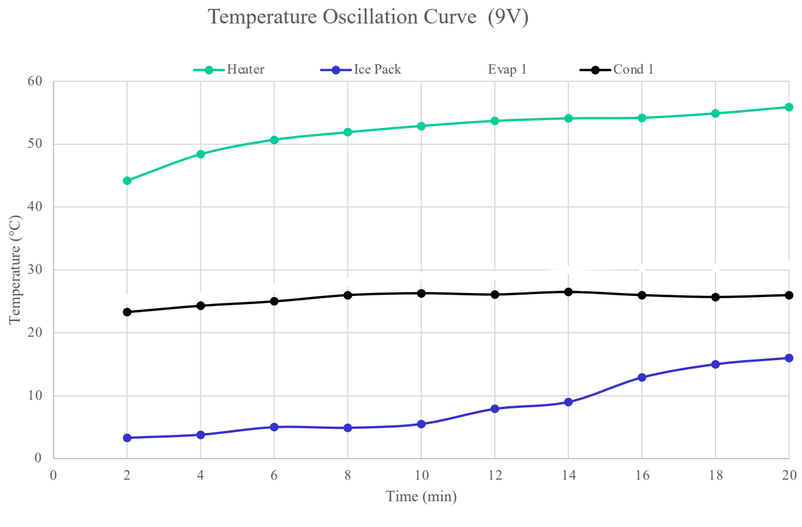




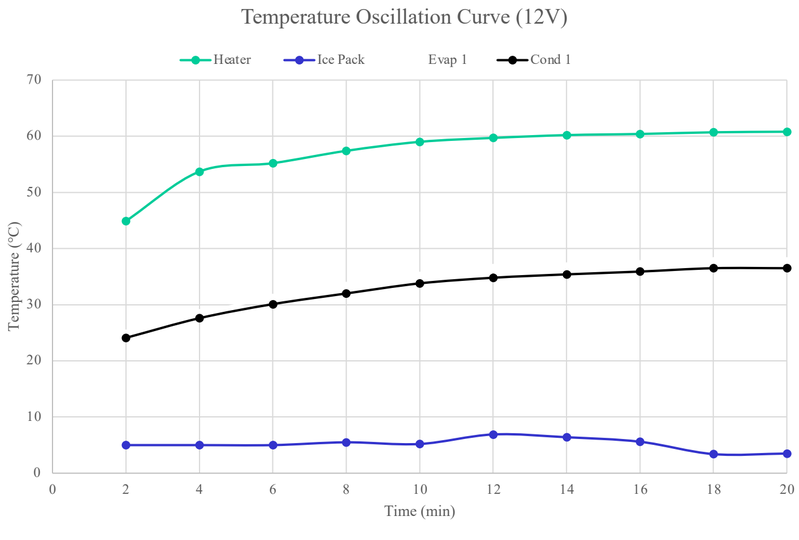
Result and Conclusion

System Performance

Temperature test with 9V



Temperature test with 12V



Conclusion

- The heat pipe has entered the testing phase, some of data gathered show that the working fluid is operating
- The weight and center of gravity of the CubeSat still need to be determined
- CubeSat frame is still being reconsidered as the housing for interior components has just been worked out