FY23 Topic Areas Research and Technology Development (TRTD)

Loop Heat Pipes for Smallsat Swarms (LHPss)

Principal Investigator: Scott Roberts (357);
Co-Investigators: Takuro Daimaru (353), Ian Luczon (512), Stephen Horst (334)

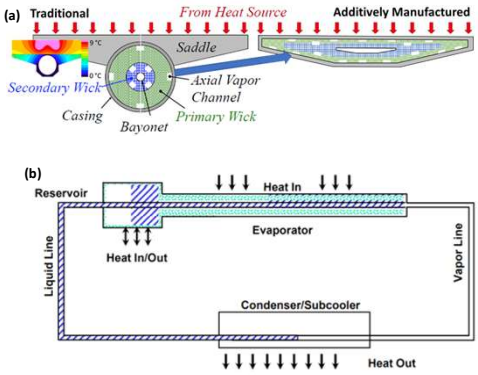
Strategic Focus Area: Thermal control systems

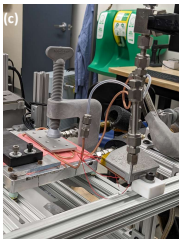
Objectives: The objective was to demonstrate the feasibility of additively manufacturing the entirety of the evaporator for a mini loop heat pipe. Overall performance was not considered a vital metric, only confirming startup and operation.

Background: Current state of the art themal management techniques are expensive, difficult to integrate, and require long lead times. As JPL seeks to both decrease the size and cost of our proposals, the need for multifunctional thermal structures will dramatically increase. Additionally, while modern electronics are more efficient than previous generations, their power density is increasing, requiring more heat to be removed from a smaller space. Top-tier solutions, such as loop heat pipes, can have lead times measured in years, and are not amenable to the shorter design cycles.

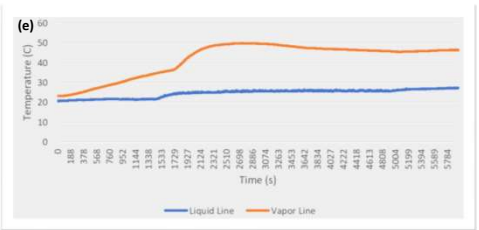
Approach and Results: We have developed at method to consolidate a 10+ piece, precision manufactured assembly into a single, monolithic additively manufactured structure. This is only possible due to the combined efforts of JPL's advanced manufacturing group's microporous printing technique along with the deep expertise of JPL's thermal systems engineers of loop heat pipes. In FY23 a testbed was developed for rapid testing of varying LHP evaporators/geometries. Additionally, we demonstrated the world's first additively manufactured loop heat pipe evaporator (fabrication cost <$2k). Both startup and continued operation > 1 hr were observed in an Al-6061-RAM2 based evaporator. Additional materials are currently on order and should all perform significantly better.

Significance/Benefits to JPL and NASA: We have demonstrated our ability to fabricate a single piece loop heat pipe evaporator and achieve both startup and continued operation. This is significant, as it can lead to the infusion of low cost, high precision, rapidly designable heat pipes capable of transferring heat over meters of distance.





(a) A schematic demonstrating a possible change in design philosophy for additively manufactured LHP evaporators.
(b) A schematic of the test LHP system. It is designed such that the evaporator can be rapidly swapped out while keeping the rest of the system constant.
(c) A picture of the test setup during operation
(d) A picture of six AM aluminum LHP evaporators
(e) A plot showing operation of the LHP with 20W input heat



National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

Clearance Number: CL#00-0000
Poster Number: RPC#23121

Publications: None (yet).

PI/Task Mgr. Contact Information:
Scott.n.Roberts@jpl.nasa.gov, *x4-5175*