Heat Pipe with Separable and Reconnectable Evaporators and Condenser

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Program: R&TD Innovative Spontaneous Concept

Project Objective:

- A separable heat pipe (SHP) technology consists of individual evaporators, condensers and adiabatic sections
  - Evaporators can be connected in parallel, in series, or in a combination of these two configurations
  - Capillary structures in individual components are connected with novel capillary inserts
- Enables a heat pipe thermal bus to connect a complex network of evaporators and condensers, while eliminating the need for a mechanical pump with moving parts
- Use evaporators embedded in heat generating components to reduce number of thermal interfaces

FY18/19 Results:

- Developed a porous insert design with features to connect two separate wick segments
  - Adequate travel (> 2mm) and structural strength under compression
  - Compatible with standard VCR fittings
- Successfully demonstrated fabrication of porous insert samples by 3-D printing
  - Leverage JPL's additive manufacturing expertise
  - Proper tradeoff between pore size and permeability
  - Sufficient travel and structural strength
- Demonstrated key performance features of SHP technology
  - Porous insert was able to draw liquid from a lower wick and transfer it to the upper wick
  - Evaporation rate in connected wick is 45% of maximum evaporation rate in one-piece wick,
    - Expected with an insert having flow x-section area of about 50% of adjacent wick and longer flow path in the insert
  - Effective pore size of interface between insert and adjacent wick is very close to parent wick materials (91 µm vs 84 µm)
- Feasibility of separable heat pipe technology demonstrated

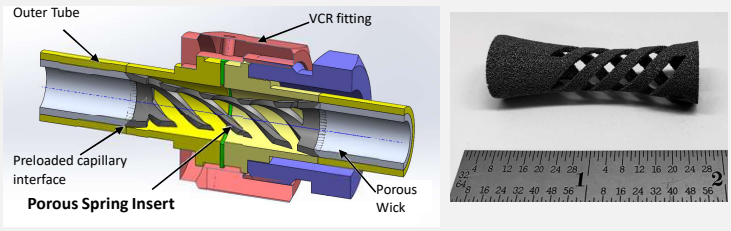
Benefits to NASA and JPL:

Significantly simplify thermal subsystem design and performance verification

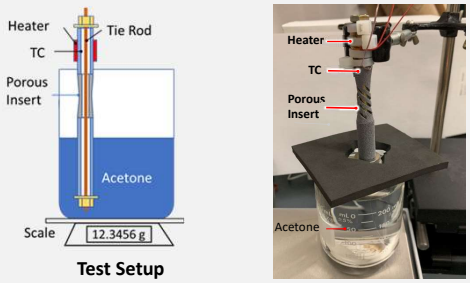
- Enable new thermal management capability for spacecraft and instruments
- Provide greater flexibility in the layout of heat-generating components in a spacecraft
- Simplify system integration and performance verification
- Significantly reduce mass by eliminating unnecessary thermal interfaces

Expand current state of the art

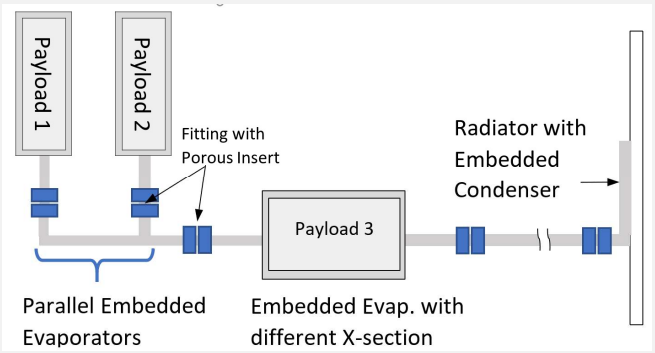
- Enable a complex network of evaporators and condensers in a heat pipe
  - Achieve performance benefits of a pumped loop, but eliminating the need for a mechanical pump
- Enable a heat pipe with different cross-section geometry along the length to enhance performance
- Allow the use of different types of wicks to enhance overall performance of heat pipe and facilitate ground testing



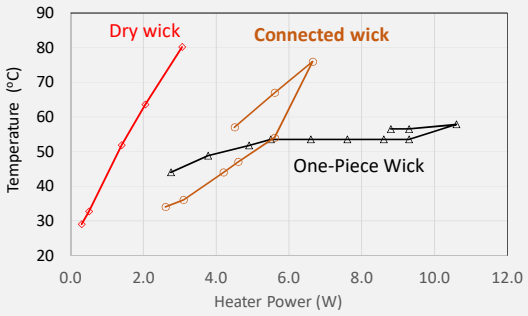
SHP Connector Design Concept



Test Setup



Potential SHP Layout. A SHP can support a network of individual evaporators/condenser with interconnecting capillary structure and vapor flow passages



Wick Thermal Performance Comparison

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