Hybrid Heat Pipes for High Heat Flux Applications

FIRM: ADVANCED COOLING TECHNOLOGIES, INC.
PI: N/A Proposal #:S3.07-9763

SBIR·STTR America's Seed Fund POWERED BY NASA

NON-PROPRIETARY DATA

Objectives

The overall technical objective of the Phase I and Phase II programs is to develop hybrid wick heat pipes with a sintered evaporator and a grooved condenser wick, increasing the allowable heat flux from 15 to more than 50 W/cm^2, and making them suitable for the higher heat flux requirements from instruments such as laser diodes. The hybrid heat pipes can also operate against gravity on planetary surfaces, accommodating the tilts experienced on Lunar and Martian landers and rovers. The principal Phase I technical objective was to demonstrate the feasibility of the hybrid wick concept; while the principal objective of the Phase II project was to validate the hybrid CCHPs and VCHPs for high heat flux and planetary applications.

ACCOMPLISHMENTS

Notable Deliverables Provided

- Aluminum-SS/ammonia CCHPs were manufactured and successfully tested to demonstrate the hybrid wick concept.
- Successfully tested the high heat flux hybrid CCHPs. These heat pipes demonstrate an improvement in heat flux capability of more than **3 times** over the standard axial groove CCHP design.
- Developed hybrid wick aluminum-SS/ammonia VCHPs for the Moon Age and Regolith Explorer (MARE) configuration.
- Developed hybrid wick warm reservoir VCHPs for space applications.
- The hybrid wick warm reservoir VCHP was validated after thermal testing that performed on-board the International Space Station.
- Developed HiK^{TM} plates with embedded copper/water heat pipes and tested successfully on-board the ISS.

Key Milestones Met

- Successfully sintered a metal wick to the desired requirements.
- Demonstrated the hybrid wick concept for high heat flux and planetary applications.
- Developed new hybrid wick CCHPs for spacecraft applications and have demonstrated a more than 3x improvement in heat flux capability, compared to current standard products.
- Achieved space flight heritage for copper/water heat pipes and High Conductivity (HiK™) plates following the successful thermal testing on board the ISS.

FUTURE PLANNED DEVELOPMENTS

Planned Post-Phase II Partners

- ACT plans to work with Astrobotic to develop and test hybrid wick aluminum-SS/ammonia non-integrated warm reservoir VCHPs for lunar landers.
- ACT will work with MSFC and JSC to validate the high-heat-flux titanium/water CCHPs and warm reservoir VCHPs in micro-gravity.
- The achieved high flux performance met the heat flux needs of advanced satellite laser applications being developed by LMCT.

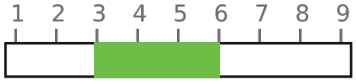
Planned/Possible Mission Infusion

The hybrid wick CCHPs can be used to cool high power electronics on NASA spacecraft, such as laser diodes. The hybrid wick VCHPs are also suitable for NASA landers and rovers. ACT plans to work with NASA to incorporate these heat pipes into future missions, since a variable conductance version can provide a low cost variable thermal link.

Planned/Possible Mission Commercialization

Hybrid wick heat pipes developed on this program improve the typical axial groove heat flux by more than three times, allowing higher heat flux operation on future missions. ACT plans to work with LMCT to further develop these heat pipes for high flux applications. ACT has already commercialized copper/water heat pipes for spacecraft applications, since flight heritage in space was demonstrated.

CONTRACT (CENTER): NNX15CM03C (MSFC)
SUBTOPIC: S3.07 Thermal Control Systems
SOLICITATION-PHASE: SBIR 2014-II
TA: 14.2.3 Heat Rejection & Energy Storage



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