

DATASHEET – Loop Heat Pipes

Thermacore's Loop Heat Pipe technology offers effective heat removal over long distances without sensitivity to gravity. These unique systems are bendable, flexible, and routable. In addition, Loop Heat Pipes have the ability to operate as thermal diodes and prevent backward heat leak. Loop heat pipes can have multiple evaporators to accommodate dispersed heat sources and can include passive/active thermal regulation.

Applications

- Aircraft
- Satellite
- Commercial / Industrial

Aircraft Thermal Control

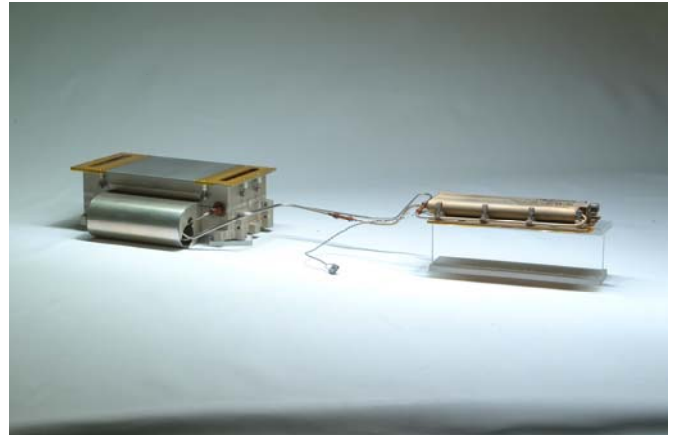
The More Electric Aircraft, MEA, approach removes the hydraulic system and replaces it with wires, motors and electronics. By removing the hydraulic system it increases aircraft reliability and control. The drawback is it removes an effective cooling system. As the MEA approach is implemented, electronics and motors are being moved closer to the components they control. This places critical electronics and motors in remote locations throughout the aircraft where their thermal control is a challenge. The loop heat pipe has proved to be an effective cooling alternative.



Over a period of several years, the Navy, Air Force and NASA helped Thermacore to qualify loop heat pipes for aircraft thermal control applications. This qualification process included thermal performance testing, high-g spin table testing, flex fatigue testing, shock/vibration testing and freeze/thaw testing. As a result of this work, loop heat pipes are now being implemented into aircraft thermal control applications. The most notable is the use of an LHP on the F-16 to cool electro optics. Under contract to Northrop Grumman, Thermacore has delivered over 100 production LHPs for use on the new Block 60 F-16

aircraft. Other suitable aircraft applications for LHPs include:

- » Actuator-mounted electronics cooling
- » Wing and cowl anti-icing using engine waste heat
- » Avionics Cooling



Loop Heat Pipe for Electro Optics Cooling

Satellite Thermal Control

More and more electronics are being packaged into satellites than ever before. Thermal control of these electronics is a significant issue because there is not enough surface area to adequately radiate the heat from the satellite. Heat rejection radiator panels that can be stowed for launch and then deployed from the satellite on orbit are required. The loop heat pipe makes this possible. The most relevant demonstration of Thermacore's deployable loop heat pipe radiator is our delivery of the



TSAT Deployable Radiator Engineering Model to LMSSC in March, 2007. This unit met and in some cases surpassed the technical requirements set forth for the TSAT application.



Commercial / Industrial Applications

The loop heat pipe is a thermal product that is moving down the path of a “high end-technology to high volume commercialization” similar to the path the standard heat pipe followed in 1990’s. The LHP is able to compensate for some of the inherent weaknesses of a heat pipe, consequently, it potentially represents the next generation of product to replace heat pipes in the future. Thermacore has developed small loop heat pipes for commercial / industrial applications. They can be used for:

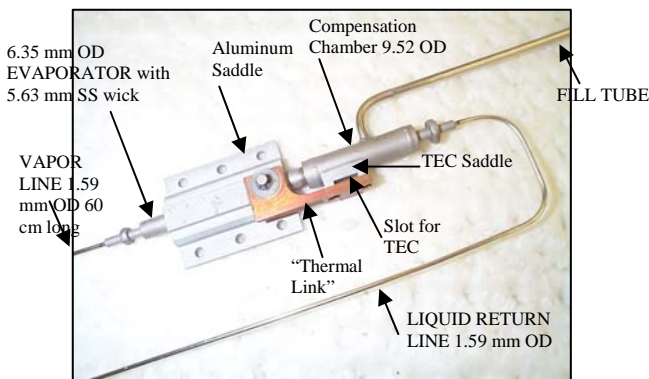
- » Computer or Server Microprocessor Cooling
- » Telecommunications Electronics Cooling
- » Medical / Test Equipment Cooling

Thermacore Loop Heat Pipe Advantages

- **Totally Passive**
 - » No external energy required
 - » Heat Input drives operation
- **Long Distance Heat Transport**
 - » Up to 75 feet (23 meters) transport capable
- **Broad Operating Temperature Range**
 - » Cryogenic to High Temperature Applications
- **Flexible**
 - » Transport Lines can be made flexible
 - » Flex Fatigue Resistant (>7.5M flex cycles)
- **Environmental Operating Conditions**
 - » 9g capable
 - » Shock and Vibration (34g random)
 - » Freeze/thaw survivable
- **Heat Loads**
 - » There are LHP designs for dissipating several Watts to multi-kilowatts

Other References:

- “Loop Heat Pipe Qualification for High Vibration and High-G Environments”, Phillips, A.L., Fale, J.E., Gernert, N.J., Sarraf, D.B., and Bienert, W.J., AIAA, Washington D.C., AIAA-98-0885, 1997
- “Loop Heat Pipes for Avionics Thermal Control”, Gernert, N.J., Baldassarre, G.J., Gottschlich, J., SAE, Warrendale, PA, SAE #961318, 1996
- “Development of a Flexible Loop Heat Pipe Cold Plate”, Gernert, N.J., and Brown, R., SAE, Warrendale, PA, SAE #951436, 1996



Miniature Loop Heat Pipe