



ADVANCED COOLING TECHNOLOGIES, INC.

ISO9001 & AS9100
Certified

Innovations in Action

Constant Conductance Heat Pipes Design/Manufacturing Notes and Extrusion Catalog



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Introduction:

Constant Conductance Heat Pipes (CCHPs) have been a proven technology for spacecraft thermal control for more than 30 years. A CCHP transports heat from a heat source to a heat sink with a very small temperature difference. Axial groove capillary wick structures are utilized because of the relative ease of manufacturing (aluminum extrusions) and their demonstrated heritage in spacecraft and instrument thermal control applications. CCHPs are typically used to transfer heat from specific thermal loads to a radiator panel or as part of an integrated heat pipe radiator panel. Common working fluids include: ammonia, propylene, and ethane.

Aluminum/ammonia CCHPs are the most common. Aluminum/ammonia CCHPs in the range of $\frac{3}{8}$ " to $\frac{1}{2}$ " diameter have the following typical properties. Specially designed extrusions can offer performances beyond these ranges.

- Heat Transport Capability: 3,000 to 10,000 Watt-in
- Evaporator Conductance: $> 2.5 \text{ W}/^\circ\text{C}$ – linear inch
- Condenser Conductance: $>3.0 \text{ W}/^\circ\text{C}$ – linear inch
- Heat Flux Capability: up to 40 W/ linear inch

Advanced Cooling Technologies, Inc. (ACT) manufactures CCHPs according to its AS9100-B certified Quality System. The materials used for manufacturing are certified and qualified to meet the most demanding aerospace requirements. Each extrusion is fully characterized to determine thermal and pressure containment capabilities as functions of operating temperature and fluid charge. The welding processes are performed by welders certified to AWS 17.1 Specification for Fusion Welding for Aerospace Applications. Throughout the manufacturing process, physical/chemical cleaning, vacuum bake-out, working fluid charging/purging, and non-condensable gas checking are repeated to ensure the highest level of cleanliness inside the heat pipe for the longest operation life.

ACT has proprietary heat pipe models to simulate each design application. These models are used to assist with the selection of the right extrusion for each application. This software calculates the capillary limit of the heat pipe taking into account the exact extruded groove geometry. The optimum fluid charge is determined for each specific application and the effect of excess fluid charge is determined for both 0-G and 1-G operations.

ACT has specialized equipment required to manufacture flight quality CCHPs. This includes: dedicated cleaning baths for chemically cleaning raw extrusions, triple distillation apparatus for working fluid purification, state-of-the-art helium mass spectrometer leak detector, dedicated charging, processing and non-condensable gas venting stations, and specialized test setups for testing and characterization at various temperatures.

ACT has personnel that have decades of experience making high quality, long life heat pipes. To date, ACT has manufactured and delivered flight ready CCHPs and other thermal control assemblies for several satellites including GOES-R and TacSat-4. Experienced personnel, manufacturing a proven technology, using rigorous industry standard procedures equals a very low technical risk for our customers.

More detailed information follows regarding several key areas of CCHP design and production.

- Analysis Capabilities
- Extrusion Qualification
- Thermal Testing Capabilities
- Ammonia Purity
- Welding
- Soldered Assemblies
- Complex Bending and Precision Machined CCHPs
- Coatings and Finishes
- Three Dimensional CCHPs
- Life Testing
- Standard Extrusion Dimensions and Mass

The remainder of this document contains competition sensitive information. Customers and potential customers please contact ACT for a copy of the document.

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Re: CCHP catalog

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