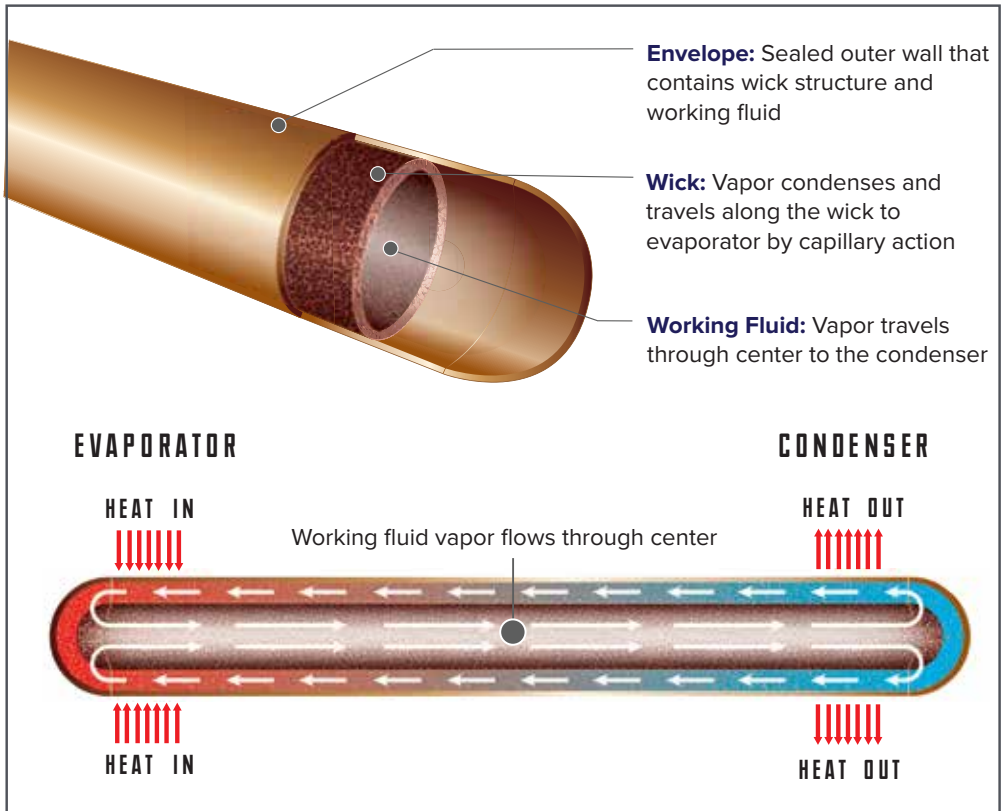
COPPER-WATER HEAT PIPES

Product Overview

Typical electronics operating temperatures range from -45 to 85°C, and thermal management becomes a prime concern at the high end of the ambient temperature range.

Copper-water heat pipes are valuable for thermal management because they provide extremely low resistance thermal transport from 1 to 200°C. As electronics continue to push the envelope on performance, thermal management systems are becoming increasingly more important.

Electronics applications frequently require copper-water heat pipes to move heat from discrete components to air heat sinks. High heat fluxes are reduced and heat is moved to open volumes where heat sinks can be located. Heat pipes are excellent for reducing heat fluxes and transporting heat to heat sink hardware.



COPPER-WATER HEAT PIPE ORIENTATION

INDUSTRIES USING HEAT PIPES INCLUDE

- Military and Commercial Electronics
- Avionics
- Consumer Electronics
- Lighting
- Renewable Energy
- Satellites and other Space

ACT's copper-water heat pipes have space flight heritage.

ADVANTAGES

- Thermal Conductivity = 10,000 to 200,000 W/m-K
- Shock & Vibration Tolerant Assemblies
- Freeze-Thaw Tolerant Assemblies
- Tested to withstand thousands of extreme thermal cycles
- -60 to +200°C Survival
- +1 to +200°C Operation

Copper-Water Heat Pipes

Design Specification of Heat Pipe Systems

Heat pipes are fully passive, self-contained heat transfer devices. The liquid-vapor phase change of a saturated working fluid is used to achieve effective thermal conductivities from 10,000 to 200,000 W/m-K. This is hundreds to thousands of times higher than aluminum, which has a thermal conductivity between only 160 to 200 W/m-K.

Two main factors are taken into consideration when designing heat pipe systems. These factors are the heat transport requirement (watts) and thermal resistance.

Because heat pipes operate by fluid flow, the pressure balance and flow characteristics of the system are predicted. After a heat pipe or heat pipe array is designed that can carry the required power is specified the thermal resistance is calculated to predict the thermal performance. In most applications, copper-water heat pipes have a ΔT between 2 and 5 °C.

Materials Selection

Water is used as the working fluid because of its excellent thermophysical properties. The high latent heat of vaporization is a major driving force in heat pipe operation and is much greater than other fluids in electronics operating temperatures. Not only that, but water's combination of viscosity and ability to generate high capillary pressures enable copper-water heat pipes to operate long distances and against gravity.

HEAT PIPE PERFORMANCE

Heat pipe operation and power capacity are dependent on the flow characteristics of the working fluid during operation. Factors to consider in the design process include:

- Length
- Diameter
- Orientation
- Wick Structure

CAPILLARY LIMIT

In terrestrial applications the main limit of concern is typically the capillary limit. This is the capillary wick's ability to overcome any pressure drops in the heat pipe, including:

- Gravity
- Liquid Pressure Drop
- Vapor Pressure Drop

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