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Heat pipes (/thermal-management/heat-pipes.html) are the most common passive, capillary-driven of the two-phase systems. Two-phase heat transfer involves the liquid-vapor phase change (boiling/evaporation and condensation) of a working fluid. The heat pipe technology industry leader, Aavid, Thermal Division of Boyd Corporation (/aavid.html) has specialized in the design, development and manufacturing of passive, two-phase heat transfer devices since 1970.

Heat pipes have an extremely effective high thermal conductivity. While solid conductors such as aluminum, copper, graphite and diamond have thermal conductivities ranging from 250 W/m•K to 1,500 W/m•K, heat pipes have effective thermal conductivities that range from 5,000 W/m•K to 200,000 W/m•K. Heat pipes transfer heat from the heat source (evaporator) to the heat sink (condenser) over relatively long distances through the latent heat of vaporization of a working fluid. Heat pipes typically have 3 sections: an evaporator section (heat input/source), adiabatic (or transport) section and a condenser section (heat output/sink).

Key Components of a Heat Pipe

The three major components of a heat pipe include:
•A vacuum tight, sealed containment shell or vessel

•Working fluid

•Capillary wick structure

They all work together to transfer heat more efficiently and evenly. The wick structure lines the inner surface of the heat pipe shell and is saturated with the working fluid. The wick provides the structure to develop the capillary action for the liquid returning from the condenser (heat output/sink) to the evaporator (heat input/source). Since the heat pipe contains a vacuum, the working fluid will boil and take up latent heat at well below its boiling point at atmospheric pressure. Water, for instance, will boil at just above 273° K (0°C) and start to effectively transfer latent heat at this low temperature.

Heat Pipe Shell or Containment Vessel

Heat pipes can be constructed from a variety of different materials. Aavid has constructed heat pipes from aluminum, copper, titanium, monel, stainless steel, inconel and tungsten. The most common for electronics cooling applications is copper. The choice of heat pipe containment material is largely dependent on the compatibility with the working fluid.

cesium, potassium, NaK and sodium (873–1,473 °K).

Heat Pipe Working Fluid	Operating Temperature Range (°C)	Heat Pipe Shell Material
Low Temperature or Cryogenic Heat Pipe Working Fluids		
Carbon Dioxide	-50 to 30	Aluminum, Stainless Steel, Titanium
Helium	-271 to -269	Stainless Steel, Titanium
Hydrogen	-260 to -230	Stainless Steel
Methane	-180 to -100	Stainless Steel
Neon	-240 to -230	Stainless Steel
Nitrogen	-200 to -160	Stainless Steel
Oxygen	-210 to -130	Aluminum, Titanium
Mid Range Heat Pipe Working Fluids		
Acetone	-48 to 125	Aluminum, Stainless Steel
Ammonia	-75 to 125	Aluminum, Stainless Steel
Ethane	-150 to 25	Aluminum
Methanol	-75 to 120	Copper, Stainless Steel
Methylamine	-90 to 125	Aluminum
Pentane	-125 to 125	Aluminum, Stainless Steel

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		Haynes
NaK	425 to 825	Stainless Steel, Inconel, Haynes
Potassium	400 to 1,025	Stainless Steel, Inconel, Haynes
Sodium	500 to 1,225	Stainless Steel, Inconel, Haynes
Lithium	925 to 1,825	Tungsten, Niobium
Silver	1,625 to 2,025	Tungsten, Molybdenum

Wick Structures

The heat pipe wick structure is a structure that uses capillaries to move the liquid working fluid from condenser back to the evaporator section. Heat pipe wick structures are constructed from various materials and methods. The most common heat pipe wick structures include: axial grooves on the inner heat pipe vessel wall, screen/wire and “sintered powder metal.” Other advanced heat pipe wick structures include arteries, bi-dispersed sintered powder, and composite wick structures.

Aavid manufactures all of the common wick structures, as well as the advanced wick structures. However, Aavid specializes in a "sintered powder metal" wick structure that allows the heat pipe to provide the highest heat flux capability, greatest degree of gravitational orientation insensitivity and freeze/thaw tolerance.

Aavid Heat Pipe Technologies for Any Application

Embedded heat pipe (/thermal-management/embedded-heat-pipe-spreader-solutions.html) designs give you enhanced performance for existing heat sinks by up to 50% with minimal design changes.

Vapor chamber heat sinks alleviate spreading resistance and accept higher heat fluxes than traditional solid heat sinks when used as the base of a heat sink.

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pipes using fluids such as ammonia and propylene used for spreading heat over extended distances for applications such as satellite thermal control.

Isothermal Furnace Liners (IFLs) (/thermal-management/isothermal-furnace-liners.html), are high temperature heat pipes used for creating uniform or isothermal temperatures for applications such as Thermocouple Calibration and Semiconductor Crystal Growth.

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