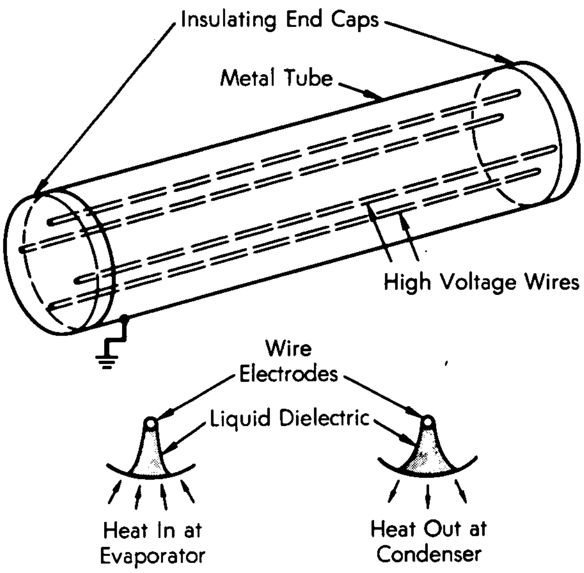
NASA TECH BRIEF
Ames Research Center

An Electrohydrodynamic Heat Pipe

The problem:

To find a substitute for the capillary wicks which provide liquid flow from the condenser section to the evaporator section in conventional heat pipes.



The solution:

Use a dielectric liquid for transfer of heat, and guide or "pump" the working fluid by an array of wire electrodes connected to a high-voltage source.

How it's done:

The heat pipe is constructed from thin-walled tubing of aluminum, or other good electrical and thermal conductor, with end-caps made from electrically insulating material (e.g., a polymer). An array of wire electrodes, stretched taut and firmly supported by the insulated end-caps, is uniformly arranged around the inside periphery of the heat pipe; all electrodes are parallel to each other and parallel to the axis of the pipe. A suitable dielectric liquid is sealed in the pipe under vacuum.

In operation, about 40 kilovolts is applied to the grid structure with respect to the pipe. Heat is applied at one end of the pipe and removed at the other; for simplicity, the diagram indicates that heat is removed from one side of the cylinder and transferred to the other. As normally occurs in heat pipe operation, evaporation causes a net recession of the dielectric fluid interface at the heated end while condensation causes the liquid interface to bulge out into the vapor space at the cooled end (see diagram). Because the net normal electromechanical surface tensions experienced by the two interfaces are different, there exists a negative internal pressure gradient within the dielectric fluid from the cooled to the heated end; thus, there will be a net flow of liquid from the condensing end of the pipe to the heated end. The vapor flow in the central core balances the liquid flow and carries thermal energy stored as the latent heat which is released on condensation. The result is a true heat pipe mode of operation with very little temperature loss from heated to cooled end and with a condensate return capability much greater than is obtained with ordinary capillary wick systems.

Notes:

1. The internal surface area of the heat pipe may be increased by internal threading.
2. The long-term degradation of dielectric working fluids in the presence of corona or intermittent arcs has not been evaluated.

(continued overleaf)

3. Requests for additional information may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP72-10251

Patent status:

No patent action is contemplated by NASA.

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