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Marshall Space Flight Center

Literature Review and Experimental Investigation of Heat Pipes

A literature review and experimental investigation were conducted on heat pipe theory and design, including operating limits, external boundary conditions, noncondensable gas effects, startup behavior, and geometric configurations. The heat pipe is a closed structure containing an evaporator, a condenser, a wick, and a working fluid (liquid plus vapor). The system transfers thermal energy from the evaporator by vaporizing the liquid, transporting and condensing the resulting vapor (with concomitant release of its latent heat to the condenser), and subsequently returning the condensate to the evaporator by capillary action of the wick. The work reported took into consideration the characteristics of various working fluids and wick materials, as well as applications of the heat pipe principle for temperature control, heat-flux conversion, and thermal conductance control.

The experimental program consisted of three parts: (1) The design and construction of an apparatus for measuring wick properties; (2) the design, construction, and testing of a conventional cylindrical heat pipe; and (3) the testing of a coplanar heat pipe. In the second phase, wall temperatures were measured along the pipe as a function of both heat input and pipe orientation. The temperatures at the evaporator end were found to be extremely sensitive to orientation.

The tests were conducted in order to determine the extent of separation (concentration changes) of the fluid components (water and methanol) in a two-component heat pipe. Temperature was measured under the wicks and in the vapor space for various combinations of heat input to the evaporator, orientation, and methanol mass fraction. It was found that stratification affected the temperature distribution within the vapor. Temperature profiles in the vapor indicated that only a partial separation of components had occurred.

It was generally concluded from this study that, while the heat pipe may be advantageous for high-temperature and space applications, it should not be regarded as the ultimate solution to many ordinary heat transfer problems where greater economy, performance, and reliability are possible with more conventional heat transfer methods.

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.95)

Reference:
NASA-CR-102943 (N71-14065), The Study and Classification of Two and Multi-Component High Thermal Conductance Devices

Patent status:

No patent action is contemplated by NASA.

Source: W. O. Barsch, E. R. F. Winter, R. J. Schoenhals, and R. Viskanta of Purdue University
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