Thermal performances of Two-Metal (Cu-Ag) Micro Heat Pipe of different conductivity of circular cross section using different liquids of low boiling point

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Abstract

Electronic machines are rapidly being developed with the increasing benefits while getting smaller in sizes resulting in more thermal stress. To manage this thermal stress, a comparative study was conducted between a two-metal (Cu-Ag) micro heat pipe (TMMHP) and the presently utilized single-metal (Cu) micro heat pipe (SMMHP). Thermal effects of TMMHP of circular cross section at steady state are experimentally investigated. The tube possesses three common basic dimensions – 150 mm long hollow axial space, 3.0 mm hydraulic diameter and 0.3 mm thickness. The evaporator and condenser section is made of pure copper and silver. The adiabatic section is made of two parts – first half is made with copper and the second half is made with silver. Water and three low boiling point liquids – ethanol, methanol and iso-propanol – are used as working liquids. Tests are conducted by placing the heat pipe at three different orientations – horizontal, vertical and at 45o inclination. To provide heat flux electric heater-coil is spiraled around the evaporator and simultaneously the condenser section is directly cooled by water in an annular space. Internal fluid-flow is considered one dimensional. Ten calibrated K-type thermocouples are installed at different locations. Temperatures are recorded by digital electronic thermometers. Unlike in the SMMHP, it is found that the boiling and super heat effects in the evaporator of TMMHP transform the two-phase flow into a single phase superheated vapor flow, which increases TMMHP's heat transfer capability to three and half times the capacity of SMMHP. Such an enhanced heat transfer coefficient may be possible from the improved convection which is developed from the different heat conductivity of metals that enables the TMMHP to reject heat at a higher rate through its condenser than the rate it can take heat in SMMHP through its evaporator.

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