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C2Po2B-02 [15]: A study of thermal performance change of cryogenic heat pipes by wick structures for wide range of working fluid filling ratio

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In this research the performances of nitrogen cryogenic heat pipes with different wick structures were compared under the condition of a wide range of heat load and several filling ratios. The heat pipes tested are commercially available ones, which are originally designed for room temperature applications using water as a working fluid. For the present research working fluid, water, was replaced by liquid nitrogen. The size of the tubular copper heat pipe is; 6 mm in the outer diameter and 200 mm long. The lengths of the evaporator, the adiabatic and the condenser sections are 15, 120 and 65 mm, respectively. The heat pipe was installed horizontally. Three types of heat pipes, of which wick are axial grooves, sintered metal particles, and the combination of them, were tested for comparing the thermal performance of the heat pipes with different wick structures, which is characterized by the effective thermal resistance. The experimental data of the maximum heat transport capability (Qmax) was compared with theoretical predictions on the basis of the capillary limit for each wick structure. In order to obtain the Qmax data, the heat pipes with different liquid filling ratios were examined. Under high filling ratio condition wide range of heat load was supplied to investigate the variation of the thermal resistance. The thermal behavior in the film boiling and even in the local dry-out states in the case of very large heat input was also examined to investigate the On/Off conductance ratio for the potential application to a heat pipe heat switch. In the On-state of the heat switch, it works as a heat pipe having excellent heat transfer performance, while in the Off-state, it is in the dry-out state having very large thermal resistance because of dry-out state.

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