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C3Or2C-03: Experimental results of long-distance helium pulsating heat pipes with varying adiabatic length, fill ratio, and applied heat load

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Pulsating heat pipes (PHPs) are passive thermal management devices that, like traditional heat pipes, use thermally driven fluid flow and phase change to transfer heat efficiently. PHPs have been a subject of experimental research for a few decades due to their many potential applications, and improvements over the current state-of-the-art. However, many aspects of their operation are unknown, and their thermal performance is difficult to predict owing to stochastic fluid behavior and the numerous interdependent design and operating parameters. These issues are exacerbated for PHPs using cryogenic working fluids since PHP visualization experiments have yet to be realized at cryogenic temperatures, and due to the unique properties of cryogenic fluids, especially helium. Thus, PHPs using cryogenic working fluids such as nitrogen, neon, and helium have been prominent in recent experimental research. At the University of Wisconsin –Madison, an experimental test facility was constructed to accommodate long-distance helium pulsating heat pipe tests. As a result, 7-turn helium PHPs with adiabatic lengths of 1.25 m, 1.5 m, and 1.75 m have been tested, where their thermal performances have been analyzed as a function of adiabatic length, applied heat load, and fill ratio. Effective thermal conductivity values up to 350 kW/m-K have been achieved. Additionally, several adiabatic temperature and pressure measurements have shown fluid phase and flow behavior trends as functions of heat load and fill ratio. These experiments have shown that phase change in alternating adiabatic tubes can be linked to performance and flow regime changes.

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