Investigations of the Gravity Dependence of Large-Scale Helium Pulsating Heat Pipes

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Helium pulsating heat pipes (PHPs) are an emergent heat transfer technology with the potential to provide efficient, long-distance cooling power for numerous low-temperature technologies, such as superconducting magnets and space telescopes. In addition, helium PHPs are especially valuable as an enabling component for cryocooler utilization. They can readily transfer the localized cooling power from the tip of a regenerative cooler over long distances to various heat loads without compromising valuable cooling capacity. In this study, an experimental facility is developed to study the complex thermohydraulic behavior of large-scale helium pulsating heat pipes with adiabatic lengths greater than 1.25 m. Temperature and pressure measurements of the fluid at strategic locations in the adiabatic section reveal key insights into the fluid phase and flow behavior, which strongly suggest that helium pulsating heat pipes are primarily driven by gravity in the vertical orientation. Furthermore, phenomena such as length independence and the optimal fill ratio are subsequently described via a balance between the gravitational driving forces and the resistive viscous forces.