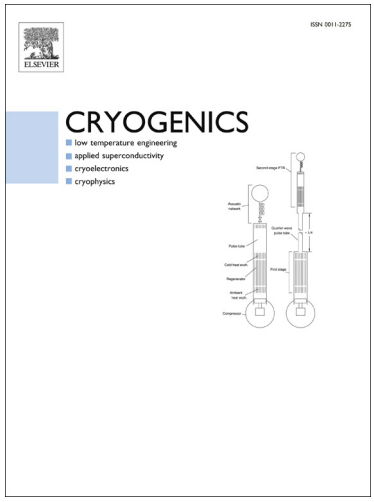

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Natural convection heat transfer of supercritical helium in a closed vertical cylinder

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Abstract

Experimental and numerical investigations are carried out to understand the natural convection heat transfer of supercritical helium in a long-closed vertical cylinder in this study, extending the study on the natural convection heat transfer in closed vertical cylinder with an aspect ratio of 27. The heat transfer performance in a large temperature range (from the critical temperature of helium to room temperature) is investigated experimentally, in which the effect of the helium charging amount is taken into account. The natural convection heat transfer of supercritical helium can be enhanced by increasing the charging amount. The heat transfer rate reaches over 25.0 W (charging amount 0.30 mol, T_h=259.9 K, T_c=89.6 K), and the thermal resistance decreases initially and then tends to be constant with the increase of heat transfer rate. Furthermore, the steady natural convection heat transfer of the supercritical helium is numerically studied. Because of the large temperature difference between the hot and cold parts of the cylinder, the variations of the thermal properties of supercritical helium are fully considered to model this heat transfer problem. The heat transfer results from the numerical calculation are consistent with the experimental results, and they both indicate that the Nusselt number varies exponentially with the Rayleigh number, which can be depicted as $Nu=0.0053Ra^{0.3334}$ according to the experimental results.

Keywords: Natural convection heat transfer; Supercritical helium; Closed vertical cylinder; Cryogenic thermosyphon

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