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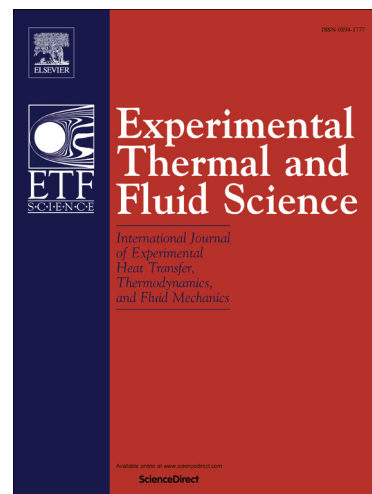
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Experimental study on saturated flow boiling heat transfer of nitrogen in a small-diameter horizontal heated tube

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Abstract

In this study, experiments were performed to study the saturated flow boiling heat transfer characteristics of saturated nitrogen in a horizontal stainless steel heated tube with an internal diameter of 2.92 mm and length of 1000 mm. The heat transfer coefficients (1134 data points) were obtained under a wide range of operation conditions (109 cases), *e.g.* heat flux of 1.4–43.7 kW/m², mass flux of 170–310 kg/(m²s), inlet pressure of 192–350 kPa, and vapor quality of 0.0015–0.71. Results showed that nucleate boiling dominated the heat transfer mechanism in the small-diameter horizontal tube under the conditions in the tests. The heat transfer coefficients had little dependence on mass flux or vapor quality but had strong correlation with heat flux and working pressure. Instability of heat transfer was also observed in the experiments when the vapor quality is greater than 0.2. In the experiments, the temperature oscillations show a relatively strong relationship with vapor quality rather than heat flux, suggesting the flow pattern change from steady bubble or plug flow to unsteady annular flow or intermittent local dry out when vapor quality is about 0.2. The correlation of Tran et al. can give predictions in good agreement with the experimental data, and therefore it is recommended in predicting heat transfer coefficient of saturated nitrogen flow boiling in small-diameter horizontal tubes.

Keywords: Liquid nitrogen, flow boiling, heat transfer coefficient, small diameter tube, horizontal flow

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