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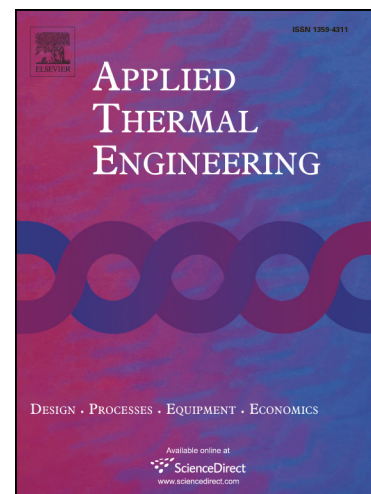
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Investigation on CHF of saturated liquid nitrogen flow boiling in a horizontal small channel

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ABSTRACT: The critical heat flux (CHF) characteristics of saturated liquid nitrogen flow boiling in a horizontal small channel are experimentally investigated over a wide range of heat flux, mass flow flux and inlet pressure. The results show that the departure from nucleate boiling (DNB) type CHF and the dry-out type CHF dominate the heat transfer separately depending on the vapor quality. The mass flow flux and the axial position along the channel affect the DNB type CHF, which occurs at the end of the channel with a vapor quality of 0.4. The higher mass flow flux and inlet pressure increase the dry-out type CHF as well as the corresponding vapor quality. These two types of CHF are both significantly affected by the gravity effect. By comparing the dry-out CHF with six existing correlations, it is found that almost all the correlations overpredict the CHF. This is because the flow boiling instability is relatively evident in small channels, which leads to the periodical vibration of the mass flow flux and consequently the earlier dryout in the lower mass flow flux region. In comparison, Qu and Mudawar's and Zhang's correlations match better with the dry-out type CHF under the present operating conditions.

Keywords: Liquid nitrogen; Horizontal flow boiling; Small channel; Critical heat flux

1. Introduction

Flow boiling in small channels is receiving increasing attention in many applications such as high heat flux thermal management, compact heat exchanger and micro-electromechanical system owing to its unique advantages of excellent heat transfer performance and high compactness [1, 2]. For cryogenic applications including the cooling of high temperature superconductors, cryogenic surgery apparatus and so on, liquid nitrogen has been widely acknowledged as the optimum working fluid for its prominent thermophysical property and security [3]. To optimize the compact heat exchange system, it is of great significance to gain a deep insight into the heat transfer mechanism

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