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PROCEEDINGS

Effect of Channel Aspect Ratio on Flow Boiling in Mini-Channels

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ABSTRACT

Flow boiling offers superior heat transfer performance compared to single-phase flow, therefore holding significant potential for application in thermal management. In mini-channel applications, due to their narrow dimensions, the size characteristics of the channel have a particularly notable impact on bubble dynamics and flow boiling heat transfer performance. This study employs the VOSET method to explore the impact of different aspect ratios (1:3, 1:2, 1:1, 2:1, 3:1) on the heat transfer performance of mini-channels. By maintaining a consistent equivalent diameter across the channels, the study aims to unveil the mechanism by which aspect ratios affect heat transfer performance under various flow velocities and heat flux densities. The results indicate that at lower flow velocities, channels with smaller aspect ratios lead to difficulty in bubble detachment, with bubbles being pressed against the heating surface by the top of the channel, thus forming larger dry patch areas and significantly reducing heat transfer performance. Conversely, under conditions of larger aspect ratios, bubbles are confined by the side walls of the channel, which affects the replenishment ability of the thermal wall and similarly leads to a decrease in heat transfer performance. Therefore, this study identifies an optimal aspect ratio, under which the influence of the walls on bubble detachment is minimized, achieving the best heat transfer coefficient. Additionally, as flow velocity increases, bubble size decreases, and their behavior is dominated by inertial forces, which causes the heat transfer differences induced by aspect ratios to gradually diminish. The findings of this study offer important guidance for the design and optimization of mini-channels, helping to determine the optimal aspect ratio to achieve maximized heat transfer performance during the design process.

KEYWORDS

Flow boiling, Heat transfer, VOSET method, aspect ratio

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