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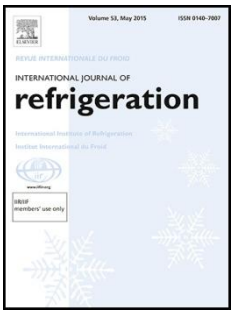

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A RESEARCH ON THE DRYOUT CHARACTERISTICS OF CO_2'S FLOW BOILING HEAT TRANSFER PROCESS IN MINI-CHANNELS

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Highlights

- Research on two-phase flow boiling heat transfer of CO_2 in horizontal mini-channel is carried out
- The heat transfer and dryout characteristics of CO_2 are analyzed qualitatively and quantitatively
- The Fang correlation of CO_2 flow boiling heat transfer is introduced and validated

Abstract: The experimental and theoretical researches have been carried out to get the flow boiling heat transfer characteristics of carbon dioxide (CO_2 or R744) as a refrigerant in horizontal mini-channel. Based on infrared thermal imaging tests and experimental studies on heat transfer coefficients, the heat transfer coefficients and dryout characteristics of CO_2 are analyzed qualitatively and quantitatively in following conditions: Heat flux: 2~35 kW/m^2, Mass flux: 50~1350 kg/(m^{2}s), Saturation temperature: -10~15 ℃, mini-channel inner diameter: 1mm and 2mm. Primary conclusions can be drawn from the results of the experiments: The increase of heat flux enhances the nucleate boiling heat transfer of the refrigerant inside mini-channel, which leads to the remarkable increase of heat transfer coefficient. But it speeds up the process of dryout. It also has a certain influence on vapor qualities of dryout at both the starting and the ending stage. The effect of mass flux on heat transfer enhancement depends on the dominant heat transfer mode in the tube. With the increase of mass flow rate, the vapor quality at the start of dryout has a decreasing trend. But the heat transfer coefficient increases at the end of dryout process or even after dryout process; the heat transfer coefficient doesn't vary monotonically with the saturation temperature: when the saturation temperature is high and even close to CO_2's critical temperature, the heat transfer coefficient increases with the increase of saturation temperature; When the saturation temperature is low, the heat transfer coefficient increases with the decrease of saturation temperature. Besides, during the heat transfer process, the dryout vapor quality falls monotonically with the increase of saturation temperature. It is reasonable to conclude that dryout characteristics have significant influence on heat transfer coefficient. Fang correlation that predicts the heat transfer coefficient of CO_2 is in good agreement with the experimental data, which has a mean absolute deviation of 15.7%, and predicts 71.98% of the entire database within ±20% and 86.84% of the entire database within ±30%.