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Boiling heat transfer of R-22, R-134a, and CO_2 in horizontal smooth minichannels ☆

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Abstract

This study examined convective boiling heat transfer in horizontal minichannels using R-22, R-134a, and CO_2. The local heat transfer coefficients were obtained for heat fluxes ranging from 10 to 40 kW m^{-2}, mass fluxes ranging from 200 to 600 kg m^{-2} s^{-1}, a saturation temperature of 10 °C, and quality up to 1.0. The test section was made of stainless steel tubes with inner diameters of 1.5 mm and 3.0 mm, and a length of 2000 mm. The section was heated uniformly by applying an electric current to the tubes directly. Nucleate boiling heat transfer was the main contribution, particularly at the low quality region. An increasing and decreasing heat transfer coefficient occurred at the lower vapor quality with increasing heat flux and mass flux. The mean heat transfer coefficient ratio of R-22:R-134a:CO_2 was approximately 1.0:0.8:2.0. Laminar flow was observed in the minichannels. A new boiling heat transfer coefficient correlation based on the superposition model for refrigerants in minichannels was developed with a mean deviation of 11.21%.

Keywords: Refrigerant; R-22; R-134a; R-744; Carbon dioxide; Experiment; Heat transfer; Boiling; Microchannel; Smooth tube; Horizontal tube

R-22, R-134 et R-744 (CO_2) : transfert de chaleur à l'intérieur de microcanaux horizontaux lisses

Mots clés : Frigorigène ; R-22 ; R-134a ; R-744 ; Dioxyde de carbone ; Expérimentation ; Transfert de chaleur ; Ébullition ; Micro-canal ; Tube lisse ; Tube horizontal

1. Introduction

The two-phase flow boiling heat transfer characteristics of alternative refrigerant fluids to R-22 were analyzed. R-22, a HCFC, is still widely used in the refrigeration and air-conditioning industry even though some countries have

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