

Flow Boiling Heat Transfer Characteristics of Carbon Dioxide in Horizontal Micro-Fin Tubes

Ken Kuwahara^{C, S}

Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Kasuga, Fukuoka, Japan

Shinya Higashiiue

Mitsubishi Electric Corp., Suruga-ku, Shizuoka, Japan

Shigeru Koyama

Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Kasuga, Fukuoka, Japan

From the viewpoint of global warming protection, working fluids for refrigerators, air-conditioners and heat pumps are making the shift to natural refrigerants in place of halogenated hydrocarbons. In the natural refrigerants, carbon dioxide (CO₂) is a non-toxic, non-flammable and low GWP natural refrigerant. Therefore, CO₂ has been proposed as a working fluid for various kinds of refrigeration systems. With this background, it is important to clarify in-tube heat transfer characteristics of CO₂ in order to develop a design method for heat exchangers. It is also necessary to increase the performance of heat exchangers by using micro-fin tubes as the heat transfer tubes. Most investigations of CO₂ heat transfer, however, are intended for smooth tubes. In this study the flow boiling heat transfer characteristics of CO₂ are measured with five kinds of spirally grooved micro-fin copper tubes. The experiment was performed at 3, 4 and 5 MPa in pressure with varying mass velocity from 135 to 650 kg m⁻² s⁻¹. The correlation was developed based on an existing correlation of in-tube forced convective heat transfer, taking account of the effect of grooves on a forced convection term, and it was also considered that the nucleate boiling term of micro-fin tubes is larger than that of smooth tubes. The new correlation for flow boiling of CO₂ in micro-fin tubes predicted almost all of measured data within ±30% accuracy.