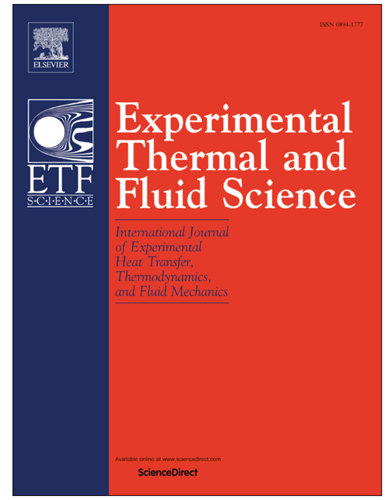

Experimental study of the heat transfer characteristics of supercritical pressure R134a in a horizontal tube

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Experimental study of the heat transfer characteristics of supercritical pressure R134a in a horizontal tube

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Abstract: This study experimentally investigates the heat transfer characteristics of R134a at supercritical pressures in a 10.3 mm horizontal tube to provide basic heat transfer data and heat transfer correlation. The experiments cover wide parameter ranges of p=1.02-1.2 p_c, G=400-1500 kg/m^{2}s, and q''=20-100 kW/m^2. The influences of the heat flux, the mass flux and the pressure on the wall temperature and heat transfer coefficient are analyzed. The results show that in a horizontal tube, the buoyancy effect due to density variations causes non-uniformity of the wall temperatures in the circumferential direction. The heat transfer deteriorates along the top surface at high q''/G (heat flux to mass flux ratio), while the heat transfer along the bottom surface is enhanced at all operating conditions. The pressure mainly affects the heat transfer coefficient on the bottom surface at small q''/G because of the c_p variation with pressure. Nine heat transfer correlations are evaluated with the results showing that the Dittus–Boelter type correlations with property modifications have acceptable accuracy for the bottom surface but all of the correlations fail to predict the heat transfer coefficients on the top surface. A new correlation using a buoyancy parameter to include the buoyancy effect is then developed to predict the top surface temperatures and a DB type correlation with property modifications is used to predict the bottom surface temperatures. Results show that the new correlations agree well with the data.

Keywords: heat transfer experiment, supercritical, R134a, correlation

1. Introduction

Heat transfer of fluids at supercritical pressures is a key issue studied in many engineering applications such as the supercritical water-cooled reactor (SCWR), supercritical fossil power plant, supercritical heat pump and rocket cooling [1-3]. With the development of the utilization of renewable energy and waste heat, supercritical organic Rankine cycle (ORC) [4], as a promising low-grade heat utilization technology, is becoming more attractive, which leads to requirements for study of supercritical heat transfer of organic