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Condensation Heat Transfer and Pressure Drop Characteristics of R466A inside A Micro-Fin Tube

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Extended Abstract

Due to the Kigali amendment and F-gas regulation, refrigerants with a higher GWP of 750 must be replaced for medium-large sized VRF systems. Most industrial and domestic heat pump systems use R410A as a working fluid which has a high GWP of 2088. As an alternative refrigerant for R410A, R32 has been widely used for small split systems in Japan. However, R32 has a flammability risk because of its A2L characteristics. To apply R32 to medium-large sized VRF systems, the hybrid VRF system with secondary water loops must be used to avoid leakage of the flammable refrigerant into indoor rooms [1]. On the other hand, R466A has non-flammability A1 characteristics which can be charged into a multi-split VRF system without secondary water loops. In addition, the alternative refrigerant R466A has a much lower GWP of 733 which satisfies modified regulation [2]. However, the study on the condensation heat transfer and pressure drop characteristics of R466A is still lacking, which mitigates the penetration of R466A in the air conditioner markets. In this study, the condensation heat transfer coefficient and pressure drop inside the micro-fin tube of R466A were investigated through experiments.

The experimental setup for investigating the heat transfer characteristics of R466A consists of three different loops which are main refrigerant loop, post condenser loop, and coolant loop. In the refrigerant loop, the refrigerant flows through the magnetic gear pump, preheater, double-pipe heat exchanger test section, post condenser, and receiver in sequence. The mass flux was adjusted by the magnetic gear pump and the inlet vapor quality of the test section was adjusted by using the preheater. Furthermore, a post condenser was installed to fully condense the two-phase refrigerant coming out from the test section outlet. The test section was constructed by a 600 mm double-pipe heat exchanger with a 7 mm diameter outer copper tube. A total of 12 sets of T-type thermocouples were soldered on the outer surface of the inner tube wall to measure the tube wall temperatures. The heat transfer coefficients were measured by flowing coolant water through the annulus outer copper tube and flowing refrigerant through the inner copper tube with various test conditions. In addition, the pressure drop was measured by installing the two pressure transmitters and the differential pressure gauge at the inlet and the outlet of the test section.

The condensation heat transfer and pressure drop of R466A were evaluated with various test conditions of vapor quality ranging from 0.1 to 0.9, mass flux from 200 to 600 kg m^{-2} s^{-1}, and saturation temperature from 35 to 45 °C. As a result, both heat transfer coefficient and pressure drop increased as the vapor quality and the mass flux increased. The condensation heat transfer coefficient and pressure drop increased by 2.1 to 2.4 times and 2.7 to 6.7 times larger, respectively, by increasing the vapor quality from 0.1 to 0.9 in constant heat flux. The condensation heat transfer coefficient and pressure drop increased by 1.5 to 4.8 times and 1.7 to 11.7 times larger, respectively, by increasing mass flux from 200 to 600 kg m^{-2} s^{-1} in constant heat flux.

References

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