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Evaporation Heat Transfer and Pressure Drop Characteristics of R245fa in a Plate and Shell Heat Exchanger

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Extended Abstract

The efficiency of components for a refrigeration system is being important for increased concern on environment and energy. Many studies have been done on the evaporation heat transfer and pressure drop characteristics of various refrigerants in a heat exchanger [1-4]. However, most studies have been done on the characteristics of conventional refrigerants in a tube and a plate heat exchanger. In this study, the evaporation transfer and pressure drop characteristics of R245fa were investigated in a plate and shell heat exchanger. The tested heat exchanger has the combined advantages of a plate and a shell-tube heat exchanger with high thermal efficiency at high pressure and temperature conditions.

The plate and shell heat exchanger has four circular plates and fluid flows in counter direction. Convective heat transfer at water side was estimated from water to water experiments using the modified Wilson plot method. The evaporation heat transfer coefficient and pressure drop of R245fa were measured by varying vapour quality, mass flux, saturated temperature, and heat flux.

As the vapour quality increased, the velocity and effect of forced convection increased for the increased vapour specific volume in the same mass flow rate. The thermal resistance decreased with the increase in the vapour quality because of the decreased thickness of liquid film, which resulted in an increase in the heat transfer coefficient. In the same way, the pressure drop increased with the increase in the vapour quality because of the increased vapour specific volume and decreased friction factor with the decreased effect of surface roughness. As the mass flux increased, the heat transfer coefficient and pressure drop increased and the friction factor decreased because of the increased velocity. As the saturated temperature increased, the heat transfer coefficient decreased because the decrease in the vapour specific volume is dominant compared to the variation in other properties. The pressure drop decreased with the increase in the saturation temperature and the friction factor increased because of the decreased vapour specific volume. In addition, as the heat flux increased, the heat transfer coefficient and pressure drop increased because of the increased number of active nucleation sites, which increased the turbulence intensity [5]. Empirical correlations for the evaporation heat transfer coefficient and pressure drop of R245fa in the plate and shell heat exchanger were developed from the experimental results.

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References

[1] L. M. Schlager, M. B. Pate and A. E. Bergles, "Heat transfer and pressure drop during evaporation and condensation of R22 in horizontal micro-fin tubes," *Int. J. Refrig*., vol. 12, no. 1, pp. 6-14, 1989.

[2] M. Goto, N. Inoue and N. Ishiwatari, "Condensation and evaporation heat transfer of R410A inside internally grooved horizontal tubes," *Int. J. Refrig*., vol. 24, pp. 628-638, 2001.

[3] Y. Y. Yan, H. C. Lio and T. F. Lin, "Condensation heat transfer and pressure drop of refrigerant R-134a in a plate heat exchanger," *Int. J. Heat Mass Transfer*., vol. 42, pp. 993-1006, 1999.

[4] D. H. Han, K. J. Lee and Y. H. Kim, "Experiments on the characteristics of evaporation of R410A in brazed plate heat exchangers with different geometric configurations," *Appl. Therm. Eng*., vol. 23, pp. 1209-1225, 2003.

[5] C. B. Chiou, D. C. Lu and C. C. Wang, "Pool boiling of R-22, R-124 and R-134a on a plain tube," *Int. J. Heat Mass Transfer.*, vol. 40, pp. 1657-1666, 1996.