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Experimental investigation on convective heat transfer of supercritical NOVEC 649 in a horizontal miniature tube

Wei-Jen Lin[a], Ben-Ran Fu[b,*], Chin Pan[a, c, d,*]

[a] Department of Engineering and System Science, National Tsing Hua University, Hsinchu, Taiwan.

[b] Department of Mechanical Engineering, Ming Chi University of Technology, New Taipei City, Taiwan

[c] Institute of Nuclear Engineering and System Science, National Tsing Hua University, Hsinchu, Taiwan.

[d] Department of Mechanical and Biomedical Engineering, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong

* brfu@mx.nthu.edu.tw ; chinpan@cityu.edu.hk

Supercritical fluids are of significant interest for fundamental research as well as for a variety of applications. Compared to supercritical water and carbon dioxide, studies that focus on supercritical refrigerants are rare. The proposed study investigates the convective heat transfer characteristics of an advanced refrigerant—NOVEC 649—as the working fluid for use under supercritical operating conditions. To the best of our knowledge, there is lack of such an investigation in the literature. NOVEC 649 demonstrates a critical pressure that is comparatively lower than those of common refrigerants—R134a and R245fa—thereby facilitating experimentation to be performed at relatively lower pressures. Heat transfer performance of supercritical NOVEC 649 in a horizontal tube has been investigated in the present study. The inner diameter and length of the channel used were 2 mm and 200 mm, respectively, and experiments were performed under different conditions of mass flux—177, 195 and 212 kg/m^{2}s—with the operating pressure varying within the range of 19 – 24 bar. The tube was heated uniformly with the heat flux ranging from 60.6 to 69.3 kW/m^2. Results of the experiments reveal that the heat transfer coefficient of the working fluid, ranging from 554 to 968 W/m^{2}K, increases with an increase in mass flux and decreases with increase in the system pressure before and after the pseudo-critical temperature, while the peak value of the heat-transfer coefficient increases with increasing system pressure in the supercritical region of operation. The experiments reveal a significant enhancement as well as deterioration in heat transfer under particular conditions. The trend was found to be in good agreement with previous experimental results using other supercritical fluids. The results also reveal that the local heat-transfer coefficient is strongly affected by the sharp change in thermo-physical properties induced by operation under supercritical conditions [1].

REFERENCES

[1] Liu Z.H., Bi Q.C., Guo Y., Yan J.G. and Yang Z. Q., Convective heat transfer and pressure drop characteristics of near critical temperature hydrocarbon fuel in a minichannel, Applied Thermal Engineering, Vol. 51, 2013, pp. 1247–1054.