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Numerical analysis on non-uniform flow and heat transfer of supercritical cryogenic methane in a heated horizontal circular tube

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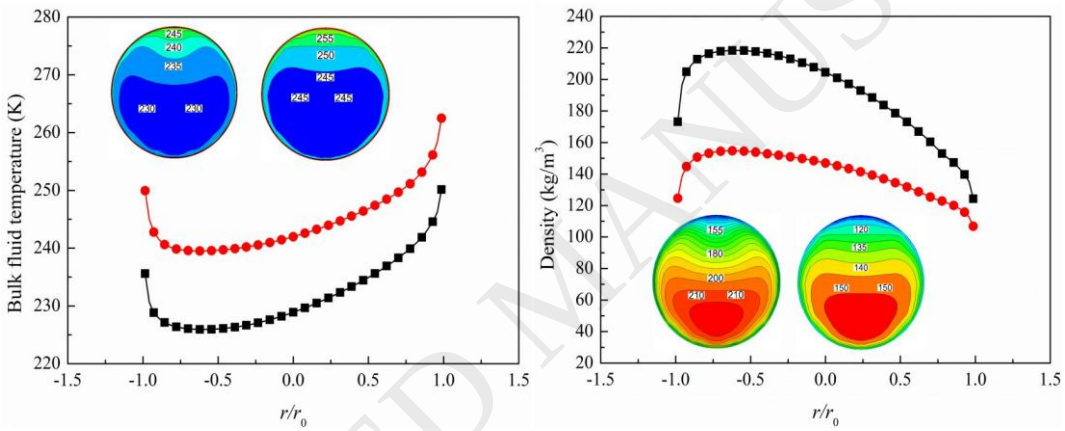
Graphical abstract



Highlights

- Non-uniform flow and heat transfer of supercritical methane was analyzed.
- Heat transfer mechanism and complex lateral secondary flows were presented.
- Effects of buoyancy force and flow acceleration on heat transfer were estimated.
- Blasius and Han models were suggested to predict pressure drop and heat transfer.

Abstract: This paper numerically studied non-uniform flow and heat transfer of supercritical cryogenic methane in a heated horizontal circular tube. Numerical results indicated that the peak value of heat transfer coefficient appeared near the vicinity of pseudo-critical point. The Reynold number monotonically increased with the augment of bulk fluid temperature, however, the Prandtl number exhibited both peak and trough values. Compared with mass fluxes, operating pressures had less influence on the heat transfer performances. Moreover, the flow stratification phenomenon and lateral secondary flows were developed as a result of the combined interaction of buoyancy and gravity. The "flow acceleration" caused by the variation of bulk fluid density had important effect on the decrease of heat transfer capacity. Further analysis demonstrated that the Blasius and Han models were suggested to predict the pressure drop and heat transfer of