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Measurements of convection heat transfer coefficients for hydrocarbon mixtures during boiling in a heated horizontal pipe from 100 K to room temperature

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A Joule–Thomson refrigeration cycle (JT) using non-azeotropic gas mixtures as the working fluid has a greater thermal efficiency than a system using a pure fluid (e.g., by an order of magnitude) in the cooling temperature range from 80 to 230 K. The main component of the Joule-Thomson cycle is a regenerative heat exchanger, and the cycle efficiency is driven by the effectiveness of the regenerative heat exchanger. The regenerative heat exchanger effectiveness is higher when the gas mixture experiences a phase change in the heat exchanger. An optimized composition of the non-azeotropic gas mixtures could allow having two-phase flow in both sides of the regenerative heat exchanger over most of its length. The details of the heat transfer process are typically not taken into account during the optimization of the cycle because there are very little data or theory currently available regarding the heat transfer coefficient associated with these two-phase, multi-component mixtures at cryogenic temperatures. This research shows measurements of convection heat transfer coefficients for hydrocarbon mixtures (methane, ethane, propane, and argon (for dilution)) while the fluid flows and evaporates within a heated horizontal pipe over a range of temperatures (from 100 K to room temperature). The results attempt to show the sensitivity of the heat transfer coefficient to parameters such as heat flux, mass flux, pressure, and composition.

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