A Practical Equation of State for 2,3,3,3-Tetrafluoropropene (HFO-1234yf) to Calculate Saturation Properties

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A novel equation of state for 2,3,3,3-tetrafluoropropene (HFO-1234yf) has been proposed to calculate saturation properties, including vapor pressure, saturated liquid and vapor densities, and latent heat. Recently, this refrigerant has been considered as a viable replacement for R-134a (1,1,1,2-tetrafluoroethane), due to its low global warming potential. In the future, automobile makers are expected to use the refrigerant in mobile air conditioners; however, a practical equation of state for the refrigerant has not been published yet. The new equation of state was developed by modifying the Patel-Teja equation, which is one of the most widely-used cubic equations of state. Since the Patel-Teja equation uses two substance-dependent parameters in addition to critical constants and the acentric factor, the equation can reasonably predict both vapor pressure and saturated liquid density. In order to obtain better agreement with experimental data, the new equation treats the parameters as a function of temperature, while the original equation keeps the parameters constant. Recent experimental data for the critical constants and saturation properties of the refrigerant were incorporated to determine an optimum functional form of the parameters. The equation is valid for temperatures from 250 K to the critical temperature. The estimated uncertainties of properties calculated using the equation are 0.2 % in vapor pressure, 0.5 % in saturated liquid density, 2 % in saturated vapor density, and 1 % in latent heat at temperatures below 340 K. Deviations in the critical region are higher for all properties except vapor pressure. The ideal-gas heat capacity was estimated using a group-contribution method. Polynomial correlations for vapor pressure, saturated densities, and latent heat were produced. Although the new equation of state is an interim equation, it can represent the saturation state of the refrigerant with sufficient accuracies.