A Preliminary Equation of State for 3,3,3-Trifluoroprop-1-ene (R-1243zf)

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A first fundamental equation of state explicit in the Helmholtz energy is presented for 3,3,3-trifluoroprop-1-ene (R-1243zf). This refrigerant is considered as one possible replacement for 1,1,1,2-tetrafluoroethane (R-134a), because the GWP of the refrigerant is expected to be very low (approximately 10 or less), and because recent research has shown that the refrigerant exhibits similar thermodynamic behavior to R-134a. The independent variables of the equation of state are the temperature and density. All thermodynamic properties can be derived as derivatives of the Helmholtz energy. The equation of state is composed of two parts; one is an ideal-gas part representing ideal-gas properties and the other is a residual part corresponding to the influence of intermolecular forces. The ideal-gas part is analytically calculated from a correlation for the ideal-gas isobaric heat capacity. The residual part is empirically determined from experimental data for the critical parameters, vapor pressures, and liquid and vapor densities including those at the saturation state. A conventional functional form for the residual part is optimized by using a nonlinear least-square fitting to the experimental data. The final form consists of 17 terms (5 polynomial terms and 12 exponential terms). The equation is valid for temperatures from 234 K to 376 K and for pressures up to 35 MPa. Estimated uncertainties in the range are 0.1 % for the vapor pressures, 0.05 % for the liquid densities, and 0.6 % for the vapor densities. The equation shows reasonable extrapolation behavior in regions away from the experimental data. Although the equation is an interim model, it is the best currently available property representation for R-1243zf, and it provides reliable calculations of the thermodynamic properties to most technical applications.