

A Combined Equation of State for HFC 218

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This investigation is connected with an equation of state (EoS) written in the form of Helmholtz free energy $F(\rho, T)$ as a function of the density and the temperature. Its structure includes a singular addend, $F_{nr}(d\rho, t, D, U)$, and a regular addend, $F_r(\rho, T, C)$. The first one includes critical characteristics $D = (\alpha, \beta, \delta \text{ a.o.})$ and relative distances $(d\rho, t)$ in keeping with the scaling theory (ST). F_{nr} is elaborated in the form [1] that consists of asymptotic and non asymptotic parts. Its singular derivatives in the critical point coincide with the same derivatives of a well known model [2] that has polar coordinates but not physical arguments. The $Z(\rho, T)$ model of the EOS is produced as the compressibility factor. $Z(\rho, T)$ has the help of $F(\rho, T)$ and has been adopted to several border conditions, among them: 1) there are zero derivatives of the pressure, P , in the critical point, 2) The value of $Z(\rho_c, T_c)$ coincides with the experimental value of Z_c . The methodical part of the work contains our efforts [3] to build an EOS that is valid in the critical region and operates with the physical arguments, ρ, T .

The adjustable coefficients, U, C , have to be established by fitting the $Z(\rho, T)$ model to experimental properties of HFC218. An optimization routine was elaborated and included two steps. First, values of $D = (\alpha, \beta, \Delta, \rho_c, T_c \text{ a.o.})$ were chosen. In the second step, a weighted sum of squares, S , was minimized. The function S includes such addends as deviations of experimental data on properties: P, V, T - data in a single-phase area, C_v , the saturation pressure, and the chemical potentials on the coexistence curve. Input data sets were formed including measured results of Brown I. A. (1963), Geller V.Z. (1980), Baryshev V.P., (1981), Ryabusheva T.I. (1979), and Rykov V.A. (1980). The routine was based on a linear weighted least-squares analysis.

Properties calculated with the help of the EOS have been compared with experimental data and tabulated values. The EOS represents measured data with following RMS deviations: 0.34 % for the density, 0.5 % for the pressure, 0.7 % for C_v , 0.74 % for the vapor pressure, 0.14 % for the liquid density, 0.41 % for the heat of evaporation, 2.4 % for C_p , and 2.2 % for the sound velocity. An acceptable agreement of calculated results with literature data demonstrates that the EoS can successfully represent experimental data both in the regular and singular areas. The EoS can be used over the following limits: $T = 160$ to 470 K and $P = 0.001$ to 70 MPa.

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