A Comparison of Scaling Models of Thermodynamic Properties along the Coexistence Curve Including the Critical Point

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Experimental data on properties, F = (the densities, ρ_l, ρ_g, the refractive indexs, n_l,n_g), of several substances (HFC 134a, HFC 143a,HFC 236ea, H_2O) along the coexistence curve (CC) are analysed in the work. The input data sets are formed. They are placed in the temperature interval from T_{tr} up to T_c and include reliable results, (F_{exp},t). Theoretical models of properties, F = (ρ_l, ρ_g), are suggested by Landau, 1972, and Wegner, 1985. These models and the equations of Anisimov, 1990, Rabinovich, 1995, Shimansky, 1996, et al. are taken to compare with the input data sets. One more analytical form of F is considered. It has a combined structure with scaling and regular parts

$$F = F_{scale}(t,D,B1)\ \ F_{reg}(t,B2), \qquad (1)$$

here D = (α,β,δ,T_c,P_c,ρ_c) – critical characteristics, t = 1 - T/T_c – a relative distance of T from the critical temperature, T_c, B =(B1,B2) – amplitudes. Model (1) is obtained by the authors [1]. The power laws of the scaling theory (ST) were taken into account to express F_{scale}(t,D,B). Adjustable coefficients of Model (1) have to be determined by fitting F to the input data sets. Several criterions, S1, S2, S_{cm}, are taken into account: S1 represents a RMS deviation of measured (F_{exp},t) - values from F_{scale} (t,D,B) in the critical region, 0<t<0.1, S2 represents a RMS deviation of measured (F_{exp},t) - data from the combined model, (1). A compromise criterion is chosen as S_{cm}^2 = (S12 S22). A routine is elaborated to calculate B coefficients of Models (1). Our tests have shown [1,2] that it is possible to find an optimal realization, F_{opt} = f(D_{opt},B_{opt},t). It follows to a condition: Sñm(D_{opt},C_{opt}) – Scmmin < epsilon. Models (1) of F = (ρ_l,ρ_g,n_l,n_g) are built for HFC 134a, HFC 143a, HFC 236ea, H_2O. Calculated results correlate with the measured data in acceptable limits of an experimental accuracy. For example, there are data of Zhang H., Sato H., 1995, Defibaugh D., Moldover M., 1996, Aoyama H., Sato H., 1996, Schmidt J., Moldover M., 1996, for HFC 236ea those are taken for the analyses. Characteristics, D_{opt} = (α,β)$_{opt}$ are placed not fare from theoretical values recommended by ST. Known models are compared with the input data sets and with Model (1). For example, there are equations elaborated by Zhang H., Sato H., 1995, Defibaugh D., Moldover M., 1996, Aoyama H., Sato H., 1996, Schmidt J., Moldover M., 1996, for HFC 236ea those are taken for the treaty.

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