Unique Scaling Description of Densities of Vapor-Liquid Coexistence and of the Singularity of the Coexistence Curve Diameter in One-Component Fluids

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In our previous paper [1] that was reported at the 12th Symposium on Thermophysical Properties (Boulder 1994) we made the statistical analysis of the temperature dependencies of order parameter for coexisting liquid and vapor phases of benzene from the triple point to the critical point. In wide range near the critical point our experimental data on liquid and gas densities were obtained by gravitation effect measurements (Teopler optical method, reference prisms method and free microfloats method). In the vicinity of the triple point the literature data were used. We got the three-term equation for the order parameter. In this equation the critical index of the leading term is equal to $\beta_0 = 0.352 + 0.002$. The present report continues these investigations.

In the present paper a new approach to the analysis of the coexistence curve (CC) diameter is proposed. In this method the critical parameter ρ_c is refined during the fitting; exponents β_i and coefficients B_i are the adjustable parameters. For benzene we use the same data array as in [1] as well as the data from [2]. It is shown that the diameter of CC has the singularity with the exponent $\beta_1 = 0.70 + 0.05$. The liquid and vapor branches of CC are described correctly by the unique four-term scaling equation in the whole coexisting range from the triple point to the critical point. The exponent β_2 of the first correction term in the symmetrical part of CC is essentially larger than the singularity index β_1 of the CC diameter ($\beta_2 > \beta_1$)

The CC diameters of C_7H_{16} (our experimental data [3]), SF_6, HD and some other substances, cited in [4], are analyzed. The results for singularity of CC diameter are similar for all substances studied: $\beta_1 = 0.7 + 0.1$.

These experimental results within the limits of the experimental errors contradict to the classical predictions $\beta_0 = 0.5$, $\beta_1 = 1$) as well as to the values of RG-calculations for the 3-d Ising model $\beta_0 = 0.325$, $\beta_1 = 1 - \alpha = 0.89$). Thus, it is questionable whether one could regard real liquids as substances of the same universality class as the Ising model.

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