Scaled Equation of State for Multi-Component Fluids

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Theoretical approach based on the concept of "complete scaling" has been extended to multicomponent mixtures. The approach does not depend on the number of mixture components provided that the average mixture composition is fixed. It has been shown that all thermodynamic values of multicomponent mixture can be parameterized in a universal way by means of two independent scaling fields of 3D-Ising model. As a result, the equation of state (EOS) for near-critical mixture with given composition has been formulated. The EOS allows calculating various thermodynamic properties, in particular, the derivative $(\partial P/\partial T)_{\rho,x}$, the isochoric heat capacity $C_{\rho,x}$ and the equation for dew-bubble curves in the vicinity of liquid-vapor critical points in mixtures. It has been shown that $(\partial P/\partial T)_{\rho,x}$, the heat capacity $C_{\rho,x}$ and the second derivatives $(d^2T/d\rho^2)_{DBC}$ and $(d^2P/d\rho^2)_{DBC}$ (taken along the dew-bubble curves) reveal cusp-like anomalies at the critical point. This specific feature enables us to propose a simple method for the estimation of the critical parameters of multicomponent mixtures. To verify the validity of the obtained EOS, it was applied for the description of experimentally studied thermodynamic properties of several binary, ternary and multicomponent mixtures. The measurements of the pressure, the derivative $(\partial P/\partial T)_{\rho,x}$ and the heat capacity $C_{\rho,x}$ were carried out along the isochores in a wide range of temperatures including the near-critical region. It has been demonstrated that the proposed EOS describes adequately the experimental data in one- and two-phase region of the mixtures.