A New Reference Quality Equation of State for Sulfur Hexafluoride

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A new formulation for the thermodynamic properties of sulfur hexafluoride in the form of a fundamental equation explicit in the Helmholtz energy is presented. The functional form of the residual part was developed using state-of-the-art linear and nonlinear optimization algorithms. It contains 36 coefficients which were fitted to selected data of the following properties: thermal properties of the single phase and the vapor-liquid saturation curve, speeds of sound, isochoric and isobaric heat capacities, and second and third virial coefficients.

High precision data that redefine the pvT surface of gaseous, liquid, and supercritical sulfur hexafluoride, including the vapor-liquid phase boundary, have recently been measured in our group with single- and two-sinker apparatuses. Additionally, a very extensive set of pvT data was measured in the critical region with a multicell apparatus. For the first time, the critical region is described by experimental data of very high quality.

The new equation of state describes the pvT surface of sulfur hexafluoride with an uncertainty in density of less than 0.02 to 0.03 % from the melting line up to temperatures of 490 K and pressures of 30 MPa. In the critical region, the uncertainty is less than 0.005 % in pressure. It is for the first time that a wide-range equation of state describes both very accurate data sets in the gaseous, liquid, and supercritical regions and highly accurate data in the critical region within their experimental uncertainties. The data that the equation was fitted to cover the fluid region from the melting line to a temperature of 650 K and a pressure of 150 MPa. Beyond this range, the equation yields a reasonable extrapolation behavior up to very high temperatures and pressures.