NEW FORMULATION FOR THE VISCOSITY OF ISOBUTANE

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Thermophysical property data of high standard are urgently requested for industrially important fluids to design more accurately compressors, gas turbines, and gas pipelines as well as cooling cycles and chemical processes. Transport properties, generally and particularly in the region near the critical point, are not known with sufficient accuracy, if compared with thermodynamic properties. For isobutane, the current NIST standard data base REFPROP 9.1 of Lemmon et al. (2013) recommends the viscosity correlation of Vogel et al. (2000) characterized by uncertainties of (3-4)% in its range of validity. This correlation was predicated on an outdated equation of state (EoS) of Younglove and Ely (1987), whereas REFPROP 9.1 recommends the reference EoS of Bücker and Wagner (2006) for the thermodynamic properties of isobutane.

In 2015, a vibrating-wire viscometer combined with a single-sinker densimeter was applied by Herrmann et al. to perform very accurate viscosity measurements on isobutane, including the near-critical region. The standard uncertainty of the data was conservatively estimated to be 0.3% so that they could be considered as primary data.

The contradiction between the new reference EoS and the outdated EoS and the improved data situation in the dense-gas region prompted us to generate a new viscosity formulation for isobutane using a state-of-the-art structure-optimisation method. The concept of the new formulation incorporates four contributions concerning the limit of zero density, the initial-density dependence, the near-critical and the higher-density regions. The first two contributions were separately treated, in which the second benefitted from the kinetic theory. Whereas the critical-enhancement contribution was partly pre-treated, the thermodynamic scaling approach was used for the very high-density region. Computed values for the new formulation were compared with the primary data sets employed when generating the formulation, but also with values calculated for the previous viscosity correlation of Vogel et al. (2000).