Re-evaluation of Viscosity Measurements on Natural Gas

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Thermophysical property data of low uncertainty are urgently needed for industrially important fluids and fluid mixtures to develop energy efficient components like compressors, gas turbines, and pipelines as well as chemical processes. Transport properties are not known with the same low uncertainty as thermodynamic properties. Earlier viscosity measurements often used reference viscosity values for the calibration of the applied instrument and calculation methods that were accepted at the time of the measurements to be reliable to evaluate the measured values. For viscosity, this concerns both the calibration and the use of density values required for the evaluation. With application of improved reference viscosity values and of upgraded equations of state for computing the needed density values, the originally published viscosity data can be revisedand their uncertainty improved. Then, they should be comparable with recent experimental data of other authors.

In this work, previous experimental viscosity data for two natural gas samples H (high caloric) and L (low caloric), published by Schley et al. (2004) and originally obtained using a vibrating-wire viscometer in the temperature range between 260 K and 320 K, were re-evaluated after an improved re-calibration. For this purpose, a new reference value for the viscosity of argon at 298.15 K and at zero density, proposed by Vogel et al. (2010) and further updated by Hellmann (2020), was applied to newly determine the wire radius. The re-evaluation also concerns the density computation. In this work, the density is calculated using the equation of state by Kunz and Wagner (2012) using REFPROP 10.0 of Lemmon et al. (2018) instead of employing a calculation according to the International Standard ISO 12213 (1997), nowadays out of date.

The re-evaluated experimental data of each nominal isotherm for the two natural gas samples H and L were correlated as a function of the reduced density by a power-series representation restricted to the fourth power. Finally, the re-evaluated viscosity data were discussed in comparison with values calculated using the ECS model by Ely and Hanley (1981) via its implementation in REFPROP (Lemmon et al., 2018).

The re-evaluated data of this work are reported as $\eta\rho pT$ values and can be used, together with other viscosity data for natural gas which became available during and since the investigation by Schley et al. (2004), to update the database for natural gases. Moreover, several mixture models using the current database for natural gases should enable future generation of a viscosity correlation for natural gases.