Density Measurements of Binary Gas Mixtures Containing Hydrogen over the Temperature Range from (253 to 453) K with Pressures up to 20 MPa

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In the course of the current German energy policy, temporal flexibility of renewable energy is gaining more and more importance. One opportunity to obtain this flexibility is the conversion of excess renewable energy to hydrogen, which could be either methanized to substitute for natural gas or could directly be added to the existing natural gas grid. In this context, existing equations of state for natural gas and other relevant mixtures have to be validated for increased hydrogen content. If required, they have to be further improved by developing new models for not yet well described binary subsystems containing hydrogen. The basis of accurate empirical models are accurate and reliable thermodynamic property data. Therefore, our goal was to screen the (p, ρ, T) behavior of different binary systems (such as hydrogen + carbon dioxide and hydrogen + nitrogen) over wide ranges of pressure and temperature. The targeted relative combined expanded uncertainty (k = 2) in density was 0.1 % or less, including the uncertainty in mixture composition. Density measurements were carried out in the temperature range from (253 to 453) K with pressures up to 20 MPa utilizing the well-established single-sinker density measurement technique (Archimedean buoyancy principle) in conjunction with a magnetic-suspension coupling. Achieving overall uncertainties of about 0.1 % in the present work was a challenge as sorption effects are known to confound the density. Thus, appropriate sample handling was required to obtain reproducible and reliable data sets. Here, we present our recent results with comparisons to equations of state. Thereby, we primarily focused on the GERG-2008 and the AGA8-DC92 equations but also considered widely used cubic equations of state.