Measurement of Interfacial Tension of Liquids with Dissolved Gases by the Pendant-Drop Method up to 573 K and 10 MPa

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The interfacial tension of gas-liquid systems plays an important role in many technical applications since it can strongly affect, for instance, wetting and foaming behavior, separation processes, and heat and mass transfer performance. For process-relevant conditions including elevated temperatures and pressures as well as the presence of different gas atmospheres, however, the availability of reliable interfacial tension data required for the efficient design of processes and apparatus is limited.

For improving this situation, a new experimental setup based on the pendant-drop method allowing the determination of the interfacial tension of liquids with dissolved gases at temperatures up to 573 K and pressures up to 10 MPa has been developed. To equilibrate the liquid with the gas before the generation of pendant drops, a corresponding vessel supplying the capillary with liquid was installed. For evaluation of the drop images, custom-made software based on the principle of axisymmetric drop-shape analysis was developed, where an optimized calibration procedure is included. Measurements with various fluids, for which accurate reference data covering a wide range of interfacial tensions are available, were performed to validate the setup together with the evaluation software. These measurements indicate a conservatively estimated expanded relative uncertainty (k = 2) of 2% when reliable density data for the liquid and the gas phase are available.

The new setup was applied to investigate the effect of dissolved hydrogen on the interfacial tension of a reference liquid organic hydrogen carrier (LOHC) system based on diphenylmethane, its fully hydrogenated counterpart dicyclohexylmethane, and their mixtures with and without the partially hydrogenated (cyclohexylmethyl)benzene at temperatures up to 523 K and pressures up to 7 MPa. Furthermore, various mixtures of these compounds were studied in argon atmosphere to analyze the influence of the degree of hydrogenation and the presence of (cyclohexylmethyl)benzene on the interfacial tension.