Viscosity and Density Measurement Equipment for Mixtures with Carbon Dioxide

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Binary mixtures of carbon dioxide are found in industrial applications like Enhanced Oil Recovery, polymer processing, and coolant technologies. In order to optimize and utilize the enhancing effects of carbon dioxide to the designated process, it is necessary to determine, analyze and describe the dissolution behavior and its influences on the physical properties of the mixture. Due to the pressure- and temperature-dependent dissolution behavior of carbon dioxide into the representative liquid, the experimental investigation, including the necessary equipment, is rather elaborate.

In order to acquire equilibrated mixtures with carbon dioxide, a capillary rheometer, a rotational rheometer, and a densimeter have been upgraded with additional equipment to allow the equilibration and measurement of the designated mixtures. The capillary rheometer can be utilized for shear rate dependent viscosity measurements of binary mixtures up to pressures of 30 MPa and temperatures of up to 353 K. The rotational rheometer system is based on a Haake Rheostress RS75, which includes a pressure cell for pressures of up to 40 MPa and temperatures up to 373 K. Both systems contain a continuously working saturation pump and an additional pressure containing mixing cell. The density is measured by utilizing an Anton Paar DMA HPM vibrating tube densimeter. In order to measure the density and the viscosity simultaneously and to guarantee equivalent fluid composition of the mixture, the densimeter system can be attached to either of the rheometer systems.

Since the capillary rheometer allows accurate rheological measurements, it is preferably used. For rather great scopes of data, the rotational rheometer is selected since the overall volume and the needed saturation time is minor than for the capillary rheometer system.
This work presents three experimental setups and improvements. Viscosity and density measurements of carbon dioxide saturated squalane and PEG600 are presented, including the uncertainty evaluation according to the Guide to the expression of uncertainty in Measurement (GUM), to give an insight into the devices' performance.