Interfacial Tensions of Systems Comprising Carbon Dioxide, Decane and Iododecane at High Pressures and High Temperatures: Experimental Measurements and Modeling with Volume Translated Peng Robinson EOS and Square-Gradient Theory

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In X-ray CT imaging, oil phase is commonly doped with iododecane to enhance the contrast between fluids. Experimental measurements and modeling were performed to investigate the effect of introducing iododecane on the interfacial tension between CO_2 and decane-iododecane mixture. Interfacial tensions under geological conditions were measured by applying the pendant drop method. The densities of the decane-iododecane mixtures over the entire range of temperatures and pressures were measured by a vibrating tube densimeter and the saturated densities were obtained by volume translated Peng Robinson EOS. The deviations caused by the refractive index changes during the interfacial tension measurement were compensated by a newly established optical model.

In this work, we report the interfacial tension of systems comprising CO_2 and decane-iododecane mixtures with iododecane mass fraction of 0, 50%, 70%, 90% and 100%, at temperatures from 298 K to 353 K and pressures up to 10 MPa. The expanded relative uncertainty at 95% confidence is about 1.2%. Empirical equations were developed to correlate all of the measured data in terms of temperature, pressure and iododecane mass fraction.

Calculations of the interfacial tension were performed based on the van der Waals Square Gradient Theory (SGT) coupled with the volume translated Peng Robinson EOS (VTPR), which was extended to mixtures by using quadratic mixing rule. The VTPR + SGT approach is found to provide a good correlation of the interfacial tensions of the systems comprising CO_2, decane and iododecane. The interfacial molar density profile of each component and the relative Gibbs adsorption were also determined.

The interfacial tension data obtained in this work can support and assist the interpretation of multiphase flow in porous media during hydrocarbon exploitation and carbon geological storage processes.