

Viscosity and Density of Decane and Hexylbenzene with Dissolved Carbon Dioxide and/or Methane

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Transport properties play a key role in both geological carbon storage in depleted hydrocarbon reservoirs and CO₂-enhanced oil recovery. A thorough understanding of the viscosity and density of live reservoir fluids is necessary as these properties strongly influence fluid mobility, thereby affecting convective flows of fluids in porous geological formations.

In this study, a bespoke vibrating wire viscometer and a commercial vibrating-tube densimeter were used for the simultaneous measurements of viscosity and density at temperatures between (298 to 423) K and pressures up to 75 MPa. The estimated expanded relative uncertainties are 2 % for viscosity and 0.2 % for density with a coverage factor of 2. The experiments were conducted on binary and ternary mixtures containing either decane or hexylbenzene with dissolved CO₂ and/or CH₄. The measurements were made in the single-phase compressed fluid region at various mole fractions of the dissolved gas, which was CO₂, CH₄, or an equimolar mixture of the two. Subsequently, the results were correlated using the modified Tait equation for density and the Tait-Andrade and Vogel–Fulcher–Tammann equations for viscosity as functions of temperature and pressure. The data were precisely captured by both correlations, with deviations within the estimated experimental uncertainties.

The predictive capabilities of the residual entropy scaling approach were assessed by extending the universal correlation developed by Binti Mohd Taib and Trusler [1] which maps the scaled reduced viscosity onto a hypothesised mono-variant function of scaled residual entropy by means of two substance-dependent scaling factors. The performance of this approach was assessed for the mixtures studied using both predictive mixing rules for scaling parameters and fitting. The multi-parameter Helmholtz energy equations of state and the multi-fluid Helmholtz Energy approximations were used to calculate residual entropy for pure substances and mixtures, respectively. The effects of using less accurate thermodynamic models will also be considered.

References

1. M. Binti Mohd Taib, J.P.M. Trusler, *J. Chem. Phys.* **152**, 164104 (2020). <https://doi.org/10.1063/5.0002242>