

Viscosity and Density of NaCl(aq), CaCl₂(aq), MgCl₂(aq) with dissolved CO₂ at Temperatures from (274 to 449) K and at Pressures up to 100 MPa

Claudio Calabrese^S, Geoffrey Maitland and Martin Trusler^C

Department of Chemical Engineering, Imperial College London, London, United Kingdom

m.trusler@imperial.ac.uk

We report the viscosity and density of sodium chloride, calcium chloride and magnesium chloride aqueous solutions with and without dissolved CO₂. The measurements were made in the single-phase compressed liquid region at temperatures between (274 and 449) K at pressures up to 100 MPa. The viscosity was measured with a vibrating-wire viscometer while the density was measured by means of a vibrating U-tube densimeter. The initial results with the vibrating-wire viscometer for NaCl solutions without dissolved CO₂ were found to exhibit a systematic error that increased with the electrical conductivity of the brine and hence was worst at high temperatures and high salt concentrations. This issue has been addressed with a semi-empirical modification of the working equation for the vibrating-wire viscometer. Measurements of the viscosity and density in the brines under CO₂ addition were made at salt molalities of up to 5 mol·kg⁻¹ and are associated with relative uncertainties of 0.1 % for density and 2 % for viscosity. The results for both properties have been correlated as functions of temperature, pressure, salt molality and the mole fraction of dissolved CO₂. For viscosity, we used a simple modification of the Vogel-Fulcher-Tammann equation while, for the densities, a modified Tammann-Tait equation, incorporating a correlation of the partial molar volume of dissolved CO₂, was employed.