Densities of Brines and CO_2-Saturated Brines

Saif Al Ghafri [C, S]

Qatar Carbonates and Carbon Storage Research Centre (QCCSRC),
Imperial College London, Department of Chemical Engineering, London, United Kingdom
sa1806@ic.ac.uk

We report the densities of $MgCl_2$(aq), $CaCl_2$(aq), KI(aq), NaCl(aq), KCl(aq), $AlCl_3$(aq), and the mixed salt system [(1 – *x*)NaCl + *x*KCl](aq), where *x* denotes mole fraction of KCl, at temperatures between (283 and 472) K and pressures up to 68.5 MPa. We also report the densities of some of these brines when saturated with CO_2 at temperatures between (298 and 473) K and at pressures up to 70 MPa. The brines were studied over a range of molalities typically extending up to values close to saturation at ambient conditions; exceptions were KI(aq) and $AlCl_3$(aq) where the molalities were limited to (1.06 and 2.00) $mol \cdot kg^{-1}$ respectively. The measurements of the density of the brines were performed with a vibrating-tube densimeter coupled with a high-pressure syringe pump. A similar apparatus, incorporating a stirred equilibrium vessel, was used for the CO_2-saturated brines. In both cases, calibrations were performed under vacuum and with pure water over the full ranges of pressure and temperature investigated. An analysis of uncertainties shows that the relative uncertainty of density varies from 0.03 % to 0.05 % depending upon the salt and the molality of the solution. An empirical correlation is reported that represent the density for each brine system as a function of temperature, pressure and molality with absolute average relative deviations of approximately 0.02 %. The model also compares favourably with a large database of results gathered from the literature. The model can be used to calculate density, apparent molar volume and isothermal compressibility over the full ranges of temperature, pressure and molality studied in this work. An ideal mixing rule for the density of a mixed electrolyte solution was tested against our mixed salt data and was found to offer good predictions at all conditions studied with an absolute average relative deviation of 0.05 %. The important effect of dissolved CO_2 on brine density is discussed.

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