Improvements in the Measurement and Modeling of CO2-Brine Properties

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Carbon capture and storage (CCS) and geothermal energy extraction are alternative approaches to fossil fuels exploitation considered to effectively reduce CO_2 emissions in the atmosphere. One possibility is to store CO_2 in depleted petroleum reservoirs or saline aquifers. Another approach is to use CO_2 as a working fluid to enhance heat transfer from depth to surface in geothermal reservoirs. The correct prediction of the phase equilibrium conditions of CO_2 + brine mixtures and the long-term trapping of CO_2 in the saline aquifer require the accurate knowledge of the *P-T-x* properties of these fluids at reservoir conditions.

While the majority of experimental and modeling works have used NaCl as the only salt component in the brine, the presence of other salts can affect the brine properties differently. Therefore, it is important to obtain new datasets for the thermophysical properties of CO_2 + brines containing multiple salts. The objective of this work is to review new improvements for the experimental determination of the volumetric and transport properties of CO_2-brine solutions at conditions of temperature and pressure relevant to carbon storage and geothermal energy production.

The solubility of CO_2 in brine solutions containing NaCl, $CaCl_2$, $MgCl_2$, $SrCl_2$, KCl, $NaHCO_3$, $BaCl_2$ and Na_2SO_4 were measured by using an experimental gravimetric method, at 303, 333 and 373 K, from 5 to 40 MPa, and for salinities up to 2 $mol \cdot kg^{-1}$. A vibrating U-tube densimeter and a capillary viscometer were used to measure the density and viscosity of brines loaded with controlled amounts of CO_2 at the same conditions. The geochemical simulator PHREEQC was used to predict the solubility of CO_2 in multi-component brines. In addition, attempts were made to generalize the Søreide-Whitson model to calculate the solubility of CO_2 in brines containing NaCl, KCl, $MgCl_2$, $CaCl_2$ and Na_2SO_4 for temperatures between 273 and 473 K, pressures up to 200 MPa and salinities up to 6 $mol \cdot L^{-1}$. The results of our study showed that the modified model considerably improves the description of the individual salt brines and calculates the CO_2 solubility in a large variety of brine solutions, including our measurements, with good accuracy when compared with previous parameterizations. The apparent molar volume approach was used for the density modeling.