Abstract
A series of laboratory experiments, field observations, and numerical modeling of geochemical reactions have been conducted to determine the chemical kinetics of potential mineral dissolution and/or precipitation caused by the injection of carbon dioxide (CO2) and sour gas. Kinetic experiments were conducted using core samples from potential Williston Basin storage formations and pure mineral samples (e.g., calcite, dolomite, siderite, etc.) obtained from vendors. Samples were analyzed using x-ray diffraction (XRD) and QEMSCAN® techniques. Two sample sets consisting of 16 samples each, under the same experimental conditions, were “soaked” for a period of 4 weeks at 2500 psi (172 bar) and 176°F (80°C) in synthetic hydrated brine. Over that time period, one set was exposed to pure carbon dioxide and the other to a mixture of CO2 (88 mol%) and H2S (12 mol%). The initial XRD mineralogical analysis of selected samples indicates the presence of the following minerals: anhydrite, calcite, dolomite, forsterite, halite, illece, magnetite, and quartz. The main objectives of this work were 1) to determine possible mineral reactions of the Madison Group, Broom Creek Formations, and Tyler Formations of Williston Basin, North Dakota with CO2 and sour gas; 2) to identify potential operational concerns; 3) to compare differences in mineral reactions between pure CO2 and sour gas injection scenarios; and 4) to adjust kinetic reaction rates for geochemical modeling tools with experimental observations. This work was performed by the Energy & Environmental Research Center through the Plains CO2 Reduction Partnership, one of the U.S. Department of Energy National Energy Technology Laboratory’s Regional Carbon Sequestration Partnerships.

Experimental Setup and Conditions

CO2 Partial Pressure 2250 psi/155 bar
Temperature 158°F/70°C
Gas Mixture 1) CO2 – 100 mol%
2) CO2 – 67.3 mol%
3) CO2 (88 mol%) and H2S (12 mol%)
Mass of Sample 10-15 g
Type of Sample Core plugs
Saturation Conditions Synthetic brine NaCl 10% by weight
Time of Exposure 4 weeks