Geochemical Modeling of Acid Gas (H_2S and CO_2) EOR/Storage at Zama, Alberta, Canada

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ABSTRACT
The Energy & Environmental Research Center (EERC), through the Plains CO_2 Reduction (PCOR) Partnership, one of the U.S. Department of Energy (DOE) National Energy Technology Laboratory's Regional Carbon Sequestration Partnerships, is working with Apache Canada Ltd. to determine the effect of acid gas (H_2S and CO_2) injection for the simultaneous purpose of disposal, sequestration of CO_2, and enhanced oil recovery (EOR). The injection process and subsequent hydrocarbon recovery are being carried out by Apache Canada Ltd., while the EERC and its contractors are conducting monitoring, verification, and accounting activities at the site.

Acid gas injection takes place into the top of a pinnacle reef structure (a process referred to as "top-down" injection), in use since the mid-1960s, which has been depleted of oil through primary and secondary (water flood) production techniques. Incremental oil is produced from a second well in the reservoir completed near the base of the reservoir. Since December 2006, more than 90,000 tons of acid gas, approximately 74% of which was CO_2, has been injected into the Zama oil field approximately 4900 feet (1500 meters) below the ground surface. To date, more than 50,000 incremental barrels of oil have been recovered as a result of the injection.

In previous studies of Zama geochemistry, the detailed mineralogical analysis of core from the Slave Point and Keg River Formations was performed with various analytical tools, such as x-ray diffraction, x-ray fluorescence, QEMSCAN, and inductively coupled plasma–mass spectroscopy. Also, the 2-D physical and chemical modeling of the gas flow was developed. This work is focusing on further development and expansion of the geochemical reservoir model and correlation of modeling results with laboratory experiments, which were performed with the high-pressure and high-temperature batch reactor at the EERC. Zama core plug samples taken from the Keg River and Slave Point Formations were exposed to a supercritical mixture of CO_2 and H_2S and synthetic brine at the Zama reservoir pressure and temperature conditions. The numerical modeling was performed using several software packages, such as PHREEQC, Geochemist Workbench, the Computer Modelling Group's GEM, and others.