Geomechanical Investigations at an Acid Gas EOR Pilot Project in the Zama Oil Field, Alberta, Canada

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Abstract

Since December 2006, a stream of acid gas (approximately 70% CO_2 and 30% H_2S) has been injected into a Devonian pinnacle reef structure in Apache Canada's Zama oil field in northwestern Alberta, Canada. The injection has been conducted at an average rate of approximately 25,000 m^3 of acid gas per day, which includes approximately 45 tons of CO_2 per day. This project includes a variety of efforts focused on examining the effects that high concentrations of H_2S can have on enhanced oil recovery and carbon sequestration operations, particularly with respect to monitoring, mitigation, and verification.

As geological sequestration comes to the forefront of technologies aimed at reducing anthropogenic CO_2 emitted to the atmosphere, storage sink integrity becomes a paramount issue to address. One such research activity in the Zama project has been to investigate the geomechanical properties and in situ stresses in the Keg River Formation reservoir and the Muskeg Formation cap rock. Geomechanical testing in the laboratory, log analysis, and numerical modeling will help establish injection pressure thresholds and, hence, the overall integrity of the system. Laboratory tests have been conducted on core samples taken from the Zama Field, including uniaxial and triaxial compressive strength tests, static and dynamic elastic properties, pore volume compressibility, stress-dependent permeability, and compressional and shear wave velocities at varying stress levels. These data sets, along with new information being obtained in ongoing field and laboratory programs, will ultimately form the basis for developing a numerical geomechanical model of the F-Pool pinnacle reef that will be used to assess the long-term integrity of the reservoir/cap rock system.

Numerical and analytical geomechanical modeling have also been used to examine perturbations in the reservoir pressure and, hence, the in situ regimes in the reservoir and cap rock throughout the history of the field's initial oil production, water flooding and, most recently, acid gas injection. Knowledge gained and recommendations for monitoring and modeling carbon storage operations in this geological environment will be described. Initial results from this integrated investigative program in the Zama Field indicate that both the dolomite reservoir and its overlying anhydrite cap rock are generally characterized by high mechanical strength, high stiffness, low compressibility, and very low permeability.

Keywords: Geomechanics, CO_2 Sequestration, Acid Gas, Enhanced Oil Recovery, MMV