Acid Gas Injection and Monitoring at the Zama Oil Field in Alberta, Canada: A Case Study in Demonstration-Scale Carbon Dioxide Sequestration

Steven A. Smith,[1]* James A. Sorensen,[1] W.A. (Bill) Jackson,[2] Doug Nimchuk,[2] Edward N. Steadman,[1] and John A. Harju[1]

[1]Energy & Environmental Research Center (EERC)
15 North 23rd Street, Stop 9018, Grand Forks, ND 58202-9018

[2]Apache Canada, Ltd.

Abstract

A comprehensive, monitoring, mitigation, and verification (MMV) plan is critical to the success of any geological carbon sequestration project utilized as a method of reducing CO_2 emissions to the atmosphere. From October 2005 through September 2009, the Zama oil field in northwestern Alberta, Canada, has been the site of acid gas (approximately 70% CO_2 and 30% H_2S) injection for the simultaneous purpose of enhanced oil recovery (EOR), H_2S disposal, and sequestration of CO_2. The Plains CO_2 Reduction (PCOR) Partnership is conducting MMV activities at the site throughout this period while Apache Canada, Ltd., is undertaking the injection and hydrocarbon recovery processes. This project is being conducted as part of the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Regional Carbon Sequestration Partnership Program.

Acid gas is being obtained as a by-product of oil production in the Zama Field and subsequent fluid separation process at the on-site facilities. During the separation process, oil and gas are sent to market, while acid gas is redirected back to the field for utilization in EOR operations. Previously, CO_2 was vented to the atmosphere and sulfur was separated from the H_2S and stockpiled in solid form on-site. This project has enabled the simultaneous beneficial use of each of these "waste" products and effective mitigation of two environmental concerns.

The Zama project was designed to address the issue of monitoring CO_2 sequestration at EOR sites, in this case utilizing H_2S-rich acid gas as the sweep mechanism, in a cost-effective and reliable manner. The primary issues that are being addressed include 1) determination of CO_2 and/or H_2S leakage, or lack thereof, from the pinnacle; 2) development of reliable predictions regarding long-term fate of injected acid gas; 3) generation of data sets that will support the development and monetization of carbon credits associated with the geologic sequestration of CO_2 at the Zama oil field.

To address these issues, a variety of research activities are being conducted at multiple scales of investigation in an effort to fully understand the ultimate fate of the injected gas. Geological, geomechanical, geochemical, and engineering work is being used to fully describe the injection zone and adjacent strata in an effort to predict the long-term storage potential of this site. Through these activities, confidence in the ability of the Zama oil field to provide long-term containment of injected gas will be achieved. While this project has been focused on one of the hundreds of pinnacles that exist in the Zama Field, many of the results obtained can be applied not only to additional pinnacles in the Alberta Basin, but to similar structures throughout the world.

Keywords: Acid Gas, CO_2 Sequestration, EOR, MMV