Development of a Saline Reservoir Carbon Sequestration Demonstration Project at Decatur, Illinois USA

Finley, R.J., Leetaru, H.E., Frailey, S.M., Greenberg, S.E.
Illinois State Geological Survey,
University of Illinois
Marsteller, S., Senel, O.
Schlumberger Carbon Services
and McKaskle, R.
Trimeric Corporation
finley@isgs.illinois.edu

The Midwest Geological Sequestration Consortium (MGSC), a regional carbon sequestration partnership funded by the U.S. Department of Energy (DOE), with additional funding from the Illinois Office of Coal Development, is developing a one million-tonne test injection of carbon dioxide (CO_2) into the Mount Simon Sandstone at Decatur, Illinois USA. The Mount Simon reservoir at the Illinois Basin-Decatur project (IBDP) site is a 493 m (1,620 ft)-thick braided fluvial to nearshore marine/tidal flat system overlain by 152 m (500 ft) of black shale, siltstone, and tight carbonates of the Eau Claire Shale acting as a reservoir seal. Injection will begin in mid-2011 at a depth of about 2,130 m (7,000 ft) at a nominal rate of 1,000 metric tonnes/day of supercritical CO_2. One million tonnes will be injected over three years. The CO_2 source is from the ethanol fermentation units at Archer Daniels Midland Company (ADM), a global processor of agricultural products with a major facility in Decatur. This work was initiated with baseline data collection (2D seismic) in 2007 and will extend through post-injection monitoring into 2016. Permitting was carried out with ADM as the permit holder, and the site holds a Class I Nonhazardous permit under US Underground Injection Control (UIC) rules, but will be repermitted under the new UIC Class VI rules in 2012.

Drilling, logging, casing (February-May 2009) and completing (January 2010) of the injection well is an example of a team effort requiring coordination and expertise that varies through each step of test site implementation. Schlumberger Carbon Services was engaged by MGSC from project initiation, not just to bring oil field services and expertise to the test site as needed, in sequence, for well work, but also to serve as an integrating subcontractor for operations, data collection, and aspects of data analysis. Schlumberger Carbon Services provided a well design and completion plan, deployed innovative microseismic sensors, developed health and safety plans and procedures, implemented a digital data collection and archiving system, and is fully involved with MGSC in data interpretation and modeling. Schlumberger also placed a full-time coordinator and additional staff within ISGS offices beginning about a year before the drilling of the injection well to support ISGS geologists, engineers, and management in planning and developing the injection site. ISGS staff defined the site geology, interpreted pre-drilling geophysics, picked core points, characterized the Mt. Simon, and developed initial depositional, geologic, and reservoir models.

A second well drilled to 1,067 m (3,500 ft) now holds a permanently cemented geophone array consisting of 31 levels of multicomponent sensors. This well was used for collecting a 3D vertical seismic profile (VSP) that actually showed greater resolution of bed geometry near the injection well than the surface 3D seismic survey of January 2010. Repeat VSPs will provide data during injection to monitor the CO_2

plume distribution and to calibrate reservoir models to predict the long-term fate of CO_2. The third well at the IBDP, for observation and verification of pressure and fluid chemistry responses to injection, was drilled 330 m (1,000 ft) from the injection well in October-November 2010 to a depth of 2,214 m (7,264 ft). Seven zones within the Mount Simon at and above the injection level and three in porous zones above the Eau Claire Shale seal will be perforated and isolated by packers such that pressure data and fluid samples can be taken through tubing ports using wireline tools with the Schlumberger Westbay System. Fluid sampling will occur pre-, during, and post-injection. Modeling indicates CO_2 arrival at this well about 18 months after start of injection, but the modeling does not yet take into account directional depositional heterogeneities inherited from the braided fluvial deposition. With only a small fraction (16.7 m [65 ft]) of the lowermost Mount Simon perforated for initial injection, vertical migration within the reservoir will be monitored and permeability ratios (k_v vs. k_h) and the role of internal flow baffles assessed using well log, geophysical, and fluid sampling data. About 108 m (360 ft) of the lowermost Mount Simon was cored in the observation well.

While the injection and monitoring infrastructure were put in place (2009-11) a compression facility was constructed to take the 99+ percent pure CO_2 from the fermentation units and deliver supercritical CO_2 to the wellhead. To supply the well, dual four-stage compressors with glycol dehydration fed by a single blower and followed by a variable speed pump were determined to be most cost effective from a capital and operating cost perspective for a three-year demonstration.

Much of what has been accomplished, and will continue through 2016, at the Illinois Basin-Decatur test site is independent of size of the injection volume. Scaling of this effort to several million tonnes per year would involve a similar level of team effort with the major difference being on the source end, or “upstream” end, of the project with respect to pipeline capacity and CO_2 supply. This upstream source could be multiple ethanol facilities or multiple coal- or gas-fired power plants. Larger, commercial projects will likely require more than one injection well and would require adaptation of the permitting, environmental monitoring, and geophysical programs to a larger site and plume footprint. All field activities are being documented in detail using time-lapse photography, video, and in written documentation as an aid in scaling up of future geological sequestration projects and in support of outreach, education, and technology transfer. The project web site, www.sequestration.org, may be accessed for more information.