Paper Number: 510

Geologic Carbon Storage at a One Million Tonne Demonstration Project: Lessons Learned from the Illinois Basin – Decatur Project, USA

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Demonstration of geologic storage of carbon dioxide (CO_2) at the near commercial-scale is essential to gaining understanding of the work flow needed to go from regional characterization to post-injection site care and closure. The Illinois Basin – Decatur Project (IBDP), located in Decatur, Illinois USA, is a one million tonne deep saline geologic CO_2 storage project led by the Midwest Geologic Sequestration Consortium (MGSC), one of the United States Department of Energy (US DOE) – National Energy Technology Laboratory's Regional Carbon Sequestration Partnerships. IBDP is a fully integrated demonstration project in the largest-capacity saline reservoir in the Illinois Basin. Stored CO_2 is derived from biofuel production at the Archer Daniels Midland (ADM) hosted test site. The MGSC, lead by the Illinois, Indiana, and Kentucky Geological Surveys, was funded in 2003 to conduct geologic sequestration assessments and demonstrations throughout the Illinois Basin in the Midwestern region of the USA. IBDP is currently in the post-injection monitoring phase and is linked to the Illinois Industrial Sources CCS Project through scientific and permitting-related activities. These projects hold the first-ever Underground Injection Control permits for Class VI, specifically developed for the subsurface storage of CO_2, in the United States.

IBDP began in 2007 with a three-year pre-injection characterization and design period, followed by three years of injection, and three years of scheduled post-injection monitoring. Injection was successfully completed in November 2014 with over 999,000 tonnes of CO_2 injected at a nominal rate of 1,000 tonnes/day into the Mt. Simon Sandstone, a Cambrian formation. The project infrastructure includes more than 5,000 m of drilled wells (three deep wells, 17 shallow wells), microseismic monitoring with downhole 4-component sensors in the injection well, in-well geophysical monitoring array for repeat plume monitoring via Vertical Seismic Profile (VSP), a compression/dehydration facility and 1.9 km pipeline capable of taking wet CO_2 at atmospheric pressure from ethanol fermentation units to delivering dry supercritical CO_2 to wellhead. A rigorous and extensive monitoring, verification, and accounting (MVA) program includes 3D seismic (2 surveys), 3D VSP (6 surveys), soil flux, atmospheric monitoring, shallow groundwater monitoring, and a deep verification well for pressure/temperature and fluid sampling. MVA data includes 18 months of pre-injection baseline, 36 months of injection, and 12 months of the 36-month post-injection period. Outreach and education programs, in place since 2007, continue to engage local, regional and international stakeholders through print materials, open houses, presentations, model demonstrations, school visits, teacher professional development, stakeholder meetings, briefings, and public hearings.

IBDP has demonstrated the safety, effectiveness, and efficiency of the process of isolating the CO_2 stream from the atmosphere. Geologic assessment and controls have proven essential to understanding reservoir conditions and predicting CO_2 behaviour. The injectivity and capacity of the Mt. Simon have been confirmed. Cased-hole logging shows that CO_2 volumes injected remain stored in the lower Mt. Simon. Significant geologic characterization of more than 385 m of whole core and 371 sidewall cores has provided significant insights into reservoir heterogentiy and the impact on CO_2 movement through the reservoir, such as internal tight zones that act as baffles to CO_2 movement. Reservoir simulation shows the sealing capacity of the Mt. Simon-Eau Claire Shale interface to be secure more than 100 years after the cease of injection. The integrated compression/dehydration, pipeline, and injection well system operated as planned with ADM carrying out 24/7 injection operations fully integrated with their ethanol production facility. Intensive MVA of the near-surface environment above the CO_2 plume shows no effects on air, water, soil, or structural uplift during injection and none are expected. Further findings show that the 1 million tonne volume is essential to address geophysical plume detection, modelling of a regulatory Area of Review, deployment of downhole data collection systems suitable to meet regulatory requirements, and to monitor and verify microseismic events as tied to pressure perturbations.