Model Development of the Aquistore CO_2 Storage Project

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Abstract

The Plains CO_2 Reduction (PCOR) Partnership, through the Energy & Environmental Research Center, is collaborating with Petroleum Technology Research Centre (PTRC) in site characterization; risk assessment; public outreach; and monitoring, verification, and accounting activities at the Aquistore project. The Aquistore project is a carbon capture, utilization and storage (CCUS) project situated near the town of Estevan, Saskatchewan, Canada, and the United States–Canada border. This project is managed by the PTRC and will be receiving CO_2 from the SaskPower Boundary Dam CCUS project and will serve as buffer storage of CO_2 for the world's first commercial postcombustion CCUS project from a coal-fired electric generating facility. To date, an injection well and an observation research well (150 meters apart) have been drilled and completed at the Aquistore site with injection anticipated to begin in 2014. Using a combination of site characterization data provided by PTRC and independently acquired information, the PCOR Partnership has constructed a static geological model to assess the potential storage capacity of the Aquistore site and provide the foundation for dynamic simulation. The geologic model and the results of the predictive simulations will be used in the risk assessment process to help define an overall monitoring plan for the project and to assure stakeholders that the injected CO_2 will remain safely stored at the Aquistore site.

The deep saline system targeted for storage comprises the Deadwood and Winnipeg Formations, the deepest sedimentary units in the Williston Basin. At nearly 3550 meters below the surface, this saline system is situated below all oil production and potash-bearing formations in the region and provides a secure location for the storage of CO_2. Characterization data acquired from the Aquistore wells for these formations include a seismic 3-D survey, petrophysical core data, and a comprehensive logging suite.

The geocellular model, centered on the injection and observation wells, is built on a coarse-scale regional extent encompassing 9507 km^2, with a smaller, finer-scaled area of 34 km^2 corresponding to the 3-D seismic survey area with higher structural resolution. Because of the extreme depth of the injection formations and lack of economic incentive,

relatively few wells in the area extend into or through the target horizon. This lack of well control locally was the premise of the regional model to determine the stratigraphic zones of reservoir and nonreservoir not captured by the 3-D seismic survey. Regionally, six flow zones (sandstone-dominated) and five intermediate low-/no-flow zones were identified in logs along with the capping shale of the Ice Box Formation.

The structural model was then populated geostatistically with petrophysical properties, including Vshale (shale volume), total porosity, temperature, and pressure. These properties are essential in determining the effective pore volume and CO_2 density at reservoir conditions. Based on the total effective pore space for the saline system in the local scale model and an in situ density value for CO_2, a storage resource of approximately 13.4 Mt was calculated at a 14% efficiency factor as defined by the U.S. Department of Energy (DOE) for saline reservoirs.

In order to run dynamic CO_2 injection simulations, it was necessary to upscale the geocellular model. This was accomplished by creating a local grid refinement in close proximity to the injection and monitoring wells where the effects of CO_2 injection will be strongest. Implementing two grid sizes allowed the overall cell count of the model to be reduced (to ensure optimum performance of the simulation software), while still honoring the geologic properties of the reservoir and representing a realistic prediction of how the injected CO_2 will behave. The dynamic simulation scenarios were designed based on the site-specific factors involved in the injection and storage of CO_2 at the Aquistore site, such as maximum bottomhole pressure, injectivity, pressure effects, the length of time for CO_2 to reach the monitoring well, laboratory relative permeability tests, and the ultimate fate of the injected CO_2. The simulation results will be presented to demonstrate how they could be used to conduct the monitoring, verification, and accounting activities for such commercial-scale CCUS projects.

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