

Testing efficiency of storage in the subsurface: Frio Brine Pilot Experiment

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Abstract:

Can we demonstrate that subsurface storage is an effective method of reducing emissions of CO₂ to the atmosphere? The Frio Brine Pilot Experiment is designed to test storage performance of a typical subsurface environment in an area where large-volume sources and sinks are abundant, near Houston, Texas, USA. We employed extensive pre-experiment characterization and modeling to identify significant factors that increase or decrease risk of leakage from the injection zone. We then designed the experiment to focus on those factors, as well as to test for presence or absence of events that are not expected. A fully developed reservoir model of heterogeneous reworked fluvial sandstones of the Frio Formation documents three-dimensional compartmentalization of the injection horizon by faulting associated with salt-dome intrusion and growth. Modeling using the TOUGH2 simulator showed that a significant source of uncertainty for subsurface performance of injected CO₂ is residual CO₂ saturation during storage. If initial displacement of water during injection is efficient and capillary effects create the expected residual saturation of 30 percent CO₂, the volume occupied by the plume will be limited, and long-term storage can be expected even in an open system. If, however, during injection, CO₂ moves out from the injection well along high-permeability pathways, it may not contact most pores, and residual saturation will have a smaller effect on storage. Our experiment is therefore designed to monitor plume geometry and CO₂ saturation near the injection well and closely spaced observation well. Leakage out of the injection zone as a result of well engineering or other flaws in the seal is also monitored in the sandstone immediately overlying the injection zone and at the surface using multiple techniques. Permitting strategies include cooperation among two State agencies, as well as Federal NEPA assessment, because of the innovative aspects of the experiment.

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