Results from continuous downhole monitoring (PDG) at a field-scale CO_2 demonstration project, Cranfield, MS

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Abstract:

Elevated formation fluid pressure resulting from large-volume carbon dioxide (CO_2) injection for sequestration is a key factor affecting storage integrity (seal and well performance) and ultimate capacity. Monitoring pressure dynamics (buildup and falloff) is a fundamental and pragmatic reservoir surveillance technique for monitoring sequestration performance. The Southeast Regional Carbon Sequestration Partnership (SECARB) field project conducted by the Gulf Coast Carbon Center with support from the National Energy Technology Laboratory (NETL) and the U.S. Department of Energy (DOE) and managed by the Southern States Energy Board (SSEB) at Denbury Resources' Cranfield Field in southwest Mississippi provides a unique opportunity to monitor large-scale (>10^6 tons) CO_2 injection on the flank of an anticline at 3 km depth. Prior to large-scale CO_2 injection, the reservoir has been shut-in for decades and was near hydrostatic pressures when injection commenced. Thus, the initial pressure buildup prior to production is similar to what would be expected for many brine sequestration projects. The evolving CO_2 distribution and pressure perturbation has been monitored continuously for over one year. This paper presents the monitoring well design, including a novel dual completion for above-zone monitoring, and presents real-time pressure data recorded in the injection interval. Correlation of changes in CO_2 injection rates from eleven injection wells throughout the field with observed pressure response at the observation well are used to demonstrate the sensitivity of this monitoring technique for quantifying CO_2 fluxes within the reservoir, and to illustrate the sealing nature of a reservoir-scale fault in the field during CO_2 injection. At Cranfield, subsurface pressure monitoring is capable of detecting CO_2 fluxes (injection rate changes) corresponding to as little as hundreds of tons per day at distances up to 1 km. The reservoir appears to have a predictable response of the rate of pressure change at the observation well for injection perturbations of variable rates and distances, suggesting that rates of observed pressure change that are uncorrelated with injection changes could be used to detect, quantify, and locate unanticipated migration of CO_2 out of the injection zone.

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