Integrated Wellbore Integrity Program: Results on Testing CO₂ Wells for Defects

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OBJECTIVES
- During a typical life cycle, wells may develop a combination of defects, which may be exacerbated by subsurface CO₂ exposure.
- Defects may include cement degradation, casing corrosion, mechanical breaks, micro-annulus, cracks, porous cement, incomplete cement, and more.
- What can be learned from direct tests on existing wells that have been exposed to CO₂ in the subsurface for 20-50+ years?
- To better understand the condition of oil and gas wells subjected to CO₂, 3 sites were investigated with wellhead sustained casing pressure testing and well history review.

METHODS
- ~1,500 wells at three field sites were reviewed, and a sampling of 53 CO₂ wells were measured for casing pressure.
- 23 wells were tested with a methodology developed to diagnose wellbore defects based on testing sustained casing pressure buildup curves directly at the wellhead.
- Testing provided a direct measurement of well conditions thru a non-invasive method to assess the nature, severity, and general location of well defects. (Method has limitations, requires defect leading to gas migration to the wellhead).
- The test data was compared to well records (well repairs, workovers, inspections, bond logs) to better define well history/construction.
- Together, this information was analyzed to better understand the risks that legacy boreholes may pose for CO₂ storage.

FIELD SITES
- Michigan Basin site- high natural CO₂ in a relatively shallow (350 m) shale gas play, & deeper (1850 m) carbonate CO₂ EOR field.
- 5-30% CO₂ in Antrim Shale, 300-500 m
- 95-99% CO₂ in EOR zone at 1,500-2000 m

RESULTS
- Overall, sustained casing pressure was not a common problem for the tested wells.
- The tested wells had minor casing pressure (1<MPa) related to thermal effects or shallow gas. Pressure buildup was insufficient for analysis.
- Meta models developed based on PHREEQC geochemical analysis and applied to 4 test study areas.
- 1,500 wells were reviewed, 53 CO₂ wells were measured for SCP, and 23 wells were tested for SCP at three field sites.
- The wells exhibited zonal isolation with no indication of significant well defects.
- Well construction and/or cement carbonation sealing may have contributed to well integrity.

Field Test Sites

Well Records
Sustained Casing Pressure Test
Well Integrity Rating

Williston Basin site
Appalachian Basin site
Michigan Basin site