Well Integrity - Response from Storage and EOR Operators

FEW0191 – Task 7

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Motivation

To define well integrity research needs based on input from CO$_2$ storage projects
Projects span small demonstrations to commercial operations across the globe.
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Accomplishments

– Survey has been vetted by Industry and DOE
– Sent to the operators of 52 sites
– Responses are anonymous
– 16 responses 23Aug2019
Preliminary Survey Results

- Most projects are on shore
  - Saline reservoirs and CO$_2$-EOR operations
  - More than 1000 meters deep
  - Less than 70°C
  - At or below hydrostatic pressure

- CO$_2$ injection
  - 1 to more than 9 years
  - Less than 10,000 to more than 1,000,000 tonnes
  - 10,000 to 1,000,000 tonnes/year

- Most wells are vertical

- Number of wells
  - 1 to more than 100 injection wells
  - 1 to 100 legacy wells
Survey suggests that most integrity issues are manageable

- We will highlight issues that could benefit from additional information
  - Construction
  - Operations
  - Material Degradation
  - Risk factors leading to leakage
  - Leakage Monitoring
Construction - Impacts

- Casing deformation/instumentation
- Loss of circulation
- Drillpipe failures
- Cement displacement
- Stuck pipe
- Borehole Instability
- Mud contamination
- Hole deviation during drilling

Legend:
- none
- low
- medium
- major

0 2 4 6 8 10 12 14 16
Construction

• Research Recommendations
  – Better characterization of stress state and geology near the well bore
  – Well designs that accommodate the state of stress and local geology
Operations - Impacts

The chart illustrates various operational impacts, categorized by the severity of their effects:

- **Instrument Failure**: Low impact
- **Hydrate Formation**: Low and medium impacts
- **Caprock Fracturing**: Low to major impacts
- **Wax/Asphaltene**: Low and medium impacts
- **Pressure Cycling**: Low and medium impacts
- **Chemicals**: Low to major impacts
- **Sustained Casing Pressure**: Low and medium impacts
- **Scale**: Low to major impacts
- **Thermal Cycling**: Low to major impacts
- **Salt Precipitation**: Low to major impacts
- **Water**: Low impact

The severity levels are indicated by different colors: none, low, medium, and major.
Operations

• Research Recommendations
  – Robust instrumentation
  – Improved understanding between injection, pressure, and materials and caprock performance
  – Improved understanding between fluid chemistry, temperature and pressure on hydrate/organic solids formation
Impacts: Acute degradation of wellbore materials
Impacts: Chronic degradation of wellbore materials

Injection wells – Results for legacy and monitoring wells are similar
Degradation of Well Materials

• Research Recommendations
  – Corrosion of steel components
Risk Factors for Well Leakage
Risk Factors

• Research Recommendations
  – Standards for cemented interval needed to avoid leakage
  – Standards to evaluate the health of pre-existing wells
Cost effective and useful monitoring methods

- Mechanical integrity pressure tests
- Wellhead pressure
- Wellhead temperature
- Wellhead flowrate sensors
- Cement bond log
- Groundwater chemistry
- Packer isolation test
- Downhole temperature sensors
- Downhole pressure sensors
- Supervisory control and data acquisition...
- Multi-finger caliper
- Groundwater pressure
- Pulsed neutron log
- Ultrasonic imaging tool
- Soil gas flux sampling
- Active seismic
- Cross well electrical resistance tomography
- Electrical resistance tomography
- Magnetotellurics
- Sidewall coring tool

Legend:
- Cost effective
- Useful
- Critical
Monitoring

• Research Recommendations
  – Improved methods to evaluate pre-existing wells
  – Improved methods to detect leakage
Project Summary

– Well integrity survey will result in a unique data set to guide future research investments on well integrity.

Next Steps

– Collect and evaluate additional responses to the survey
  • Contact Jaisree Iyer for survey
    – iyer5@llnl.gov
– Vet research recommendations with literature and experts
– Publish findings as research needs document
Appendix
Problem Statement
- Our objective is to develop a *Well Integrity Research Needs* document that reports issues and insights from carbon storage projects. The report will provide a field-based assessment to better understand past incidents, to prevent them from happening in the future, to define for future research needs for successful commercialization of geologic CO₂ storage.
- Target CO₂ storage projects include DOE US Partnerships and international commercial projects.

Research Partners: LLNL, NETL and SINTEF

Research needs will be based on survey response from industry and literature.

This work contributes to several Priority Research Directions for storage recommended in the Mission Innovation CCUS Workshop report.
- Optimizing injection of CO₂ by control of the near-well environment
- Locating, evaluating, and remediating existing and abandoned wells
- Establishing, demonstrating and forecasting well integrity
Task 7: Well Integrity Atlas

Milestones
1. Document completion, injection, and abandonment issues
2. Document risk assessment of legacy wells
3. Document monitoring methods to support accounting methodologies
4. Summarize research and monitoring needs to lower leakage risk through well bores

Key Accomplishments/Deliverables

**2018:** Field based assessment of monitoring and research needs to lower leakage through well bores.

Value Delivered
- Guiding document for future operators on how to avoid well integrity risks during and post injection.