the ENERGY lab

PROJECT FACTS

Carbon Sequestration

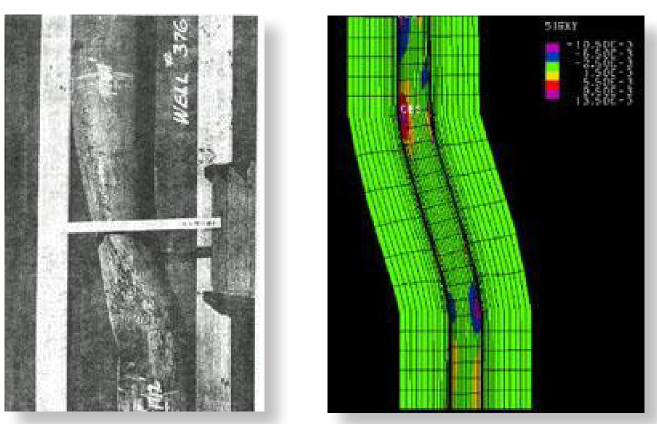
Proof-of-Feasibility of Using Wellbore Deformation as a Diagnostic Tool to Improve CO_2 Sequestration

Background

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) is currently funding research leading to state-of-the-art advanced technologies that address geologic storage of carbon dioxide (CO_2) in multiple formation types and across all phases of CO_2 geologic storage operations.

Geologic storage involves the injection of CO_2 into underground formations that have the ability to securely contain it over long periods of time. Research efforts are currently focused on several geologic storage formation types: several clastic and carbonate types, coal, organic rich shale, and basalt formations. These formations contain different fluids such as saline water, oil and natural gas. A principal element of DOE's Carbon Sequestration Program is Core Research and Development (R&D), and one of the R&D focus areas—geologic storage—is aimed at addressing the challenges of CO_2 storage in these formations.

Critical challenges identified in the geologic storage focus area include CO_2 well bore integrity, geochemical and mechanical responses, fluid flow and containment, and development of mitigation technologies. Integrity of the wellbore and storage formation are key components in the retention of CO_2 both during and after injection operations. More research is needed to further evaluate the role that wellbore and storage formation integrity plays in the geologic sequestration of CO_2.



Images of a well casing deforming due to changes in applied loads. Measuring the deformation can be used to infer loads, formation properties and structure, completion performance. http://www.terralog.com/casing_damage_analysis.asp

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PARTNERS

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PROJECT DURATION

Start Date

10/1/2010

End Date

09/30/2013

COST

Total Project Value

$561,501

DOE/Non-DOE Share

$449,209 / $112,292

U.S. DEPARTMENT OF ENERGY

Project Description

Researchers at Clemson University and its partners are evaluating the feasibility of using wellbore deformations to assess the changing conditions of geologic storage formations, storage formation caprock, and well boreholes. Wellbores tend to deform in response to the injection or recovery of fluid. In extreme cases, the deformation is catastrophic and the well can be compromised. In routine cases, the small elastic deformation that accompanies injection or recovery has the potential to be an important diagnostic tool that improves the efficiency and safety of CO_2 sequestration. Wellbores also tend to deform during sequestration operations, and effective monitoring of this process has the potential to be used to detect the early precursors to hydraulic fracturing, induced faulting, and failure of wellbore seals so they can be addressed before becoming catastrophic. These results will improve the characterization of geologic storage formations, caprock compressibility, and pressure-dependent permeability, in addition to the distribution of structural deformation and other stratigraphic or structural differences in multiple geologic formation types. The results will improve well borehole characterization, including improvements in our understanding of the bond and integrity between the well casing, the cemented or grouted well annulus (the space between the well casing and the perimeter of the borehole), and the geologic formation itself.

Goals/Objectives

The objective of this project is to evaluate the feasibility of measuring and interpreting wellbore deformations under conditions anticipated for CO_2 sequestration, with the ultimate goal of establishing the necessary background for a field demonstration. This will be accomplished by developing the knowledge required to anticipate the mechanical response, interpret the results of deformation measurements,and develop the equipment to take the required field measurements.

The project will consist of three primary goals:

- Characterization of wellbore deformation under conditions anticipated for use in geologic CO_2 sequestration.
- Development of identification and evaluation techniques for interpreting the results of simultaneous measurements of displacement and pressures during well testing or operation.
- Evaluation of the capabilities of downhole instruments.

The project will be conducted by applying a broad range of expertise in theoretical and applied aspects of hydromechanical well testing, geomechanics, model inversion, and instrumentation. Deliverables will include reports and journal papers describing simulation, interpretation, and instrumentation required for the proposed technique.

Benefits

This project will benefit CO_2 sequestration in geologic formations by developing a new technique that will improve both geologic formation characterization and in situ monitoring. This new technique could also improve the characterization of geologic storage formation, caprock compressibility, and pressure-driven permeability, as well as the distribution of structural deformation (i.e., fractures) and other heterogeneities in a wide range of geologic formation types.

Moreover, it will improve the understanding and mechanical characterization of the well bore itself, including the bonds between the well casing, grout or cement, and the geologic formation. If used during CO_2 sequestration operations, wellbore deformation has the potential to detect the precursors to hydraulic fractures in either the geologic storage formation or the wellbore annulus. This research will demonstrate the ability to monitor and interpret well bore displacements and thus will improve the safety and effectiveness of CO_2 sequestration while reducing its costs.

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