Novel Materials for Robust Repair of Leaky Wellbores in CO_2 Storage Formations

Award Number: DE-FE0009299

Prime Performer:
University of Texas at Austin

Principal Investigator:
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Project Duration:
10/01/2012 – 01/31/2016

Performer Location:
Austin, Texas

Program:
Carbon Transport & Storage

Project Summary:

The project objective was to develop a novel application of a pH-triggered polymer gelant to seal leakage pathways associated with existing wellbores. The effort tested gelant formulations under a variety of conditions relevant to field applications and determining which is optimal for stopping the flow of brine, brine containing dissolved carbon dioxide (CO_2), or bulk phase CO_2. The modeling objective was to develop simple models of the key processes involved in this application, including the transport and reaction of a low-pH fluid (the gelant) through fractures in strongly alkaline materials (cement and earth formations), the rheology of the gelant and gel, and the coupled flow/transport/reaction before, during and after gelant placement in the leaking formation/leakage pathway/ recipient formation system. Researchers validated the components of the models against the laboratory experiments and applied the coupled model at the wellbore scale to analyze possible leakage remediation strategies and to design the placement of gelant to achieve those strategies.

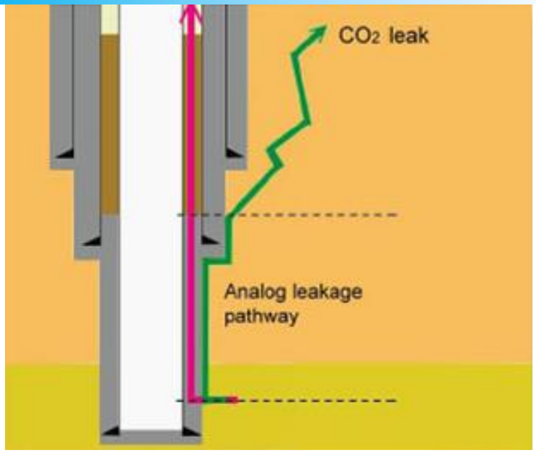

Figure 1: An illustration of a CO_2 leakage pathway within a wellbore that could be encountered during CCS operations. The proposed gelant could fill small aperture microannuli that may be present after well completion operations.

Project Outcomes:

This study focused on understanding the development of polymer viscosity and identifying the main components of syneresis. Several chemicals were studied and selected based on not only their ability to eliminate syneresis, but also their reaction with polymer during injection and subsequent development of gel yield stress in cement fractures. The ease of polymer injection and the resulting gel strength were the key metrics for determining the feasibility of the application. Cores pretreated with a chelating agent, sodium triphosphate ($Na_5P_3O_{10}$), showed good injectivity during polymer placement and improved sealing performance during water breakthrough tests. In addition, the pretreatment procedure greatly reduced the calcium content in the cement and prevented polymer syneresis of the sealing gel. The simulation model was used to study the gelant flow through the fracture. The model was validated against laboratory experiments. The resulting gel-in-place using pretreated cores provided longer periods of effective seal and held pressure gradients orders of magnitude higher compared to gel placed in untreated cores. Although harsher reservoir conditions had not yet been extensively tested, the lab-scale testing showed promising application for field-scale tests in shallow wells. The performer recommended future studies that focus on lab-scale corefloods at reservoir conditions, and field-scale applications in shallow wells to improve the performance and feasibility of this sealant technology.

Presentations, Papers, and Publications

Final Report: AREA 2: Novel Materials for Robust Repair of Leaky Wellbores in CO_2 Storage Formations (January 2016) – Matthew Balhoff, Shayan Tavassoli, Jostine Fei Ho.