Contribution ID: **489** Type: **Oral Presentation**

Effects of Thermal Shocks on Cement for CCS under Confined and Unconfined Conditions

Wednesday, 24 May 2023 10:00 (15 minutes)

In wells for carbon capture and storage (CCS), fractures can develop in the cement due to strong thermal shocks upon pressurized CO2 injection into the subsurface. The network of these fractures forms leakage pathways that can impair well integrity, and thus impede successful geological storage of CO2. In this study, we investigate how thermal shocks affect cement integrity under unconfined and confined conditions. Solid cylindrical samples (Φ3 x 7 cm) and samples of the same size but with a hole (Φ4 mm) in the middle are used. All samples are prepared using class G cement with 35% BWOC silica flour by Halliburton AS Norway, in accordance with API specification 10B-2. In unconfined experiments, we either quench the solid sample into cold water or inject cold water through the hollow-cylindrical sample to induce thermal shocks. In confined experiments, we mount the hollow-cylindrical sample in a triaxial deformation setup with confining pressure and axial stress, then inject cold water to induce the shocks. Before the shocks in all experiments, samples have been heated to 130℃. The temperature of the water is 5℃ to achieve a strong thermal shock as possible. We produce eight cycles of thermal shock in all experiments. To study the extent of cracking, we use a micro-computed tomography (μ-CT) scanner to characterize the network of pores and fractures in the cement before and after experiments.

Under unconfined conditions, fractures develop in cement after thermal shocks in both quenching and injecting-through experiments. Both experiments generate sufficient thermal stresses to cause cracking in cement. In quenching, multiple fractures are initiated at different orientations. However, by injecting cold water through the sample, only one longitudinal fracture is created. This fracture is intersected with the injecting hole, where most thermal stresses are built up. The volume ratio of pores and fractures in samples increases to 2.74% by quenching and 1.84% by injecting through respectively, from 0.38%. Compressive strength decreases from 97.9 MPa for intact samples to 53.9 MPa after quenching, and 83.6 MPa after the injecting-through experiment. Under confined conditions, we carry out injecting-through experiments to bring about thermal shocks under 1.5 and 10 MPa confining pressure. We haven't observed any failure in cement integrity under either confinement. Instead, compressive strength increases by 6.2% and 7.2%, and the volume ratio of pores and fractures decreases by 7.7% and 18.2% after the experiment under the confinement of 1.5 and 10 MPa, respectively. This means the presence of confining pressure not only hinders the adverse effects of thermal stresses on cement integrity but also compacts the samples. Higher confining pressure causes more compression to the sample, then resulting in greater strength.

Participation

In-Person

References

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

Netherlands

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

This abstract is related to Energy Transition

Primary authors: Dr LI, Kai (Delft University of Technology); Dr PLUYMAKERS, Anne (Delft University of Technology)

Presenter: Dr LI, Kai (Delft University of Technology)

Session Classification: MS01

Track Classification: (MS01) Porous Media for a Green World: Energy & Climate