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Management of salt precipitation for large-scale CO2 storage projects

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CO_2 storage at climate-relevant scales will involve rapid deployment of projects worldwide in diverse geological settings, with each involving several millions of tons injection per annum. CO_2 transport also can be varied, with pipeline transport being supplemented by direct injection from ship or other land-based transport. Successful projects should have low risk of injectivity loss to be cost-effective for commercial implementation. Salt precipitation has been identified as a mechanism for injectivity reduction in the near wellbore region, especially for saline aquifer storage. Salt crystals can accumulate in pore throats as injected CO_2 evaporates residual water, which reduces permeability and blocks flow. Although salt precipitation can be treated effectively, poor management can lead to unwanted well shut-in and additional costs to industrial projects.

Salt precipitation has been documented to some extent in the field and has been extensively studied in experimental and numerical studies. Industry-standard simulation tools, both commercial and open-source codes, have the capabilities to model permeability reduction due to salt precipitation. Although the phenomenon does not appear to be a showstopper, one main challenge is to understand under what circumstances salt precipitation will require potentially costly intervention. First, CO_2 storage projects in saline aquifers to date have injected relatively small volumes of CO_2 and therefore negligible salt precipitation. Secondly, little is known about the impact of hysteresis under cycling CO_2 injection (e.g. direct injection from ships) that could enhance the risk of salt precipitation. Another challenge is understanding the correct laboratory protocols for experimental studies, which has been shown to have a significant impact on conclusions related to permeability reduction. Finally, it is often not clear how to translate lab observations in simple idealized systems to predictions at the field scale where geology, wellbore construction and multiphase flow behavior is significantly more complex.

In this study we perform a comprehensive review and analysis of knowledge, data and simulation capabilities related to salt precipitation and the realistic impacts for CO_2 storage injectivity. Using benchmarked simulation tools, we extend current analysis from small, pilot-scale injection in idealized settings to large-scale commercial deployment, particularly under cyclical injection conditions and heterogeneous flow conditions. We propose directions for future experimental and simulation studies to close remaining knowledge gaps. We also suggest guidelines for assessing and managing salt precipitation for large-scale CO_2 storage in realistic settings.

Participation

In-Person

References

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