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Investigating calcite dissolution and relative effects on Underground Hydrogen Storage (UHS) through pore-scale reactive transport model and reservoir simulation

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Underground Hydrogen Storage (UHS), as an emerging large-scale energy storage technology with great compatibility with hydrogen economy, is at the centre of research attention in recent years. To investigate the feasibility of implementing UHS in porous reservoir such as aquifer or depleted hydrocarbon reservoirs, geochemical reactions brought by the presence of hydrogen in subsurface and their influence on hydrogen loss and reservoir integrity is heat-debated by many researchers. Among these geochemical reactions, calcite dissolution is one of the most important as it can not only affect the petrophysical properties of rocks, bring about substantial hydrogen loss, but also raise the pH value and release CO2 which trigger more biotic and abiotic reactions. There are already many experiment and modelling studies focusing on this topic. However, none of these studies succuss to model this reaction in a physical dynamic setting, leading knowledge gap between simulation results and experiment observation. This is because the current models describing fluids-solid reactions are using ad-hoc surface area parameters during the reaction process. The influence from ion movement raised by surface charge and convection pressure gradient are also ignored. Herein, we use a novel pore-scale reactive transport solver by coupling fluid flow with geochemical reaction. The governing equations includes: (1) Poisson equation, (2) Nernst-Planck equation, and (3) Navier-Stokes equation. These equations were solved using the lattice Boltzmann method within X-ray computed microtomography images for a sandstone reservoir containing 10 vol% calcite, where Phreeqc is used to simulate geochemical reaction. By doing so, the effects from real-time pore morphology and mineral surface charge on the calcite dissolution kinetics, for the first time, are investigated under a transient condition. This study provides fundamental information on UHS in reservoirs containing sensitive minerals and facilitate the screening of potential UHS sites.

Participation

In-Person

References

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