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Relative Permeability in Reactive Carbonate Rock

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Geologic carbon storage at scales needed to reduce anthropogenic CO2 emissions will require sequestration in numerous rock formations. The injection of CO2 into carbonates has promise due to the high porosity, permeability and ubiquity of these rocks. Unlike sandstones, carbonates present a unique challenge in the form of high reactivity when exposed to the CO2-acidified brine. CO2-acidified brine, or carbonic acid, is the result of injected CO2 and native brines mixing. The alteration of carbonate pore structures due to interactions with CO2-acidified brine results in a changing porosity and permeability in the formation as injections proceed. The dynamicity of the formation flow properties during injection means that readily used methodologies for parameterizing relative permeability behavior and CO2 migration do not describe the system effectively.

We present a method to capture the evolution of relative permeability of a carbonate system using an unsteady-state relative permeability technique combined with computed tomography (CT) scanning. Samples were saturated with a CT-contrasting brine to simulate in-situ connate conditions within the carbonate samples, at which point absolute permeability was also determined. Supercritical CO2 was then injected into the samples until residual brine saturation was achieved to determine relative permeability at a given flow rate. The sample was then re-saturated with brine to remove any residual CO2, and the newly evolved absolute permeability was measured. Intermediate CT scans taken during the flow tests were used to determine how much porosity was gained from dissolution, which was extracted from the images and utilized to calculate the new pore volume of the rock. The updated porosity and absolute permeability at each flow rate facilitated determination of new updated relative permeability curves for the sample.

The prevalence of carbonates worldwide and their favorable storage characteristics, including high porosity and permeability, make these lithologies essential in large-scale carbon storage planning. It is therefore essential to characterize how CO2 flow properties evolve during active injection in carbonates. In this work, we present a methodology for characterizing relative permeability in formations where worm-hole formation and dissolution are dominant processes during CO2 injection.

Time Block Preference

Time Block C (18:00-21:00 CET)

References

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