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Heterogeneity effects on the Solubility-trapping during CO2 Geological Sequestration

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In the CO2 sequestration process, the solubility-trapping mechanism is one of the key mechanisms, which contributes to the safe eradication of injected supercritical CO2 (ScCO2). When ScCO2 is injected into the reservoir domain, it will start migrating upwards due to its low density as compared to reservoir water. During this migration, some amount of CO2 will be dissolved into the reservoir water. This process of CO2 dissolving in the reservoir water and getting trapped in the reservoir domain is known as Solubility-trapping. The dissolution of CO2 in the reservoir domain can also occur due to the solubility fingering phenomenon. This solubility fingering phenomenon takes place due to the density differences between the CO2 dissolved water and connate reservoir water. Further, it will cause instability in the domain, which activates the diffusive convection process, which will increase the solubility-trapping efficiency gradually [1].

The objective of this paper is to conduct a study on solubility-trapping mechanisms during the CO2 sequestration process. The solubility-trapping mechanism has a greater influence on the mineral-trapping mechanism, where the harmful CO2 can be permanently eliminated by mineral dissolution and precipitation reactions [2]. In this research, an effort is made to study the influences of petrophysical properties, geomorphological structures, and other CO2 sequestration parameters on the solubility-trapping mechanism over a long geological time scale. The reactive transport modelling technique is used to perform this numerical analysis. It has the ability to predict the geochemical reactions in both spatial and temporal directions along with the fluid flow [3]. In the current numerical analysis, necessary assumptions are made so that only the solubility reactions are considered by neglecting the mineral reaction.
Firstly, the evidence of solubility-trapping due to the instability created by density differences in the reservoir domain is evaluated. Then the initiation of density-driven convective mixing is evaluated with the help of the Rayleigh-Darcy number for an observable domain over a geological time scale. Secondly, the parametric analysis is carried out by analyzing the solubility-trapping percentage at different injection points with a fixed injection rate so that the optimal injection point for CO2 sequestration is evaluated. Then the influences of petrophysical properties and geomorphological structure on the solubility-trapping mechanism are studied by modelling individual synthetic domains.

Further, the analysis is carried out to study the trapping efficiency, storage capacity, and structural integrity. These simulation analyses are carried out based on the cumulative aqueous CO2 concentrations, average reservoir pressure, and reservoir temperature. The outcome of these results provide insights into the selection of the suitable range of petrophysical properties and optimal injection points for the safe and efficient implementation of CO2 sequestration.

Time Block Preference

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

References

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