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Impure CO_2 Solubility Trapping in Deep Saline Aquifers: Role of Operating Conditions

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Abstract : Injection of impurities along with CO_2 into saline aquifers provides an exceptional prospect for low-cost carbon capture and storage technologies and can potentially accelerate large-scale implementation of geological storage of CO_2. We have conducted linear stability analyses and numerical simulations to investigate the effects of permitted impurities in CO_2 streams on the onset of natural convection and dynamics of subsequent convective mixing. We have shown that the rate of dissolution of an impure CO_2 stream with H_2S highly depends on the operating conditions such as temperature, pressure, and composition of impurity. Contrary to findings of previous studies, our results show that an impurity such as H_2S can potentially reduce the onset time of natural convection and can accelerate the subsequent convective mixing. However, at the later times, the rate of convective dissolution is adversely affected by the impurities. Therefore, the injection of an impure CO_2 stream can be engineered to improve the rate of dissolution of CO_2, which leads to higher storage security and efficiency. Accordingly, we have identified the most favorable CO_2 stream compositions based on the geophysical properties of target aquifers. Information related to the onset of natural convection such as the scaling relations and the most favorable operating conditions for CO_2 storage developed in this study are important in proper design, site screening, characterization and safety of geological storage. This information can be used to either identify future geological candidates for acid gas disposal or reviewing the current operating conditions of licensed injection sites.

Keywords : CO_2 storage, solubility trapping, convective dissolution, storage efficiency
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