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Thermo-chemical processes, salt precipitation, and porosity-permeability dynamics During CO_2 Injection

By A.Abdollahi, B.Hosseinzadeh and H.Nick, Technical University of Denmark, Danish Offshore Technology Centre, Elektrovej 375, 2800, Kgs. Lyngby, Denmark.

Abstract

During CO2 injection into underground formations, a series of phenomena may happen, including pressure increase, variation in formation temperature, water vaporization, salinity enrichments, CO2 dissolution, chemical reactions, salt precipitation (salt-out), formation permeability and changes in capillary pressure and enhanced water re-imbibition.

The impact of the mentioned complex interactions is reflected in this study through the proposed methodology of commercial simulators. Simulation results show significant permeability reductions (up to 75% in lower injection rates or total injectivity loss), significantly impacting long-term storage performance. Additionally, the study provides a foundation to account for possible chemical reactions between CO2, water, and minerals, resulting in changes in formations' porosity and permeability. A novel method is proposed, introducing a dynamic approach to account for changes in capillary pressure to ensure capturing changes in water re-imbibition, which is not addressed in existing simulators, in addition to a simplified yet effective approach to track changes in well and perforation performance reduction. Although the simulation model is complex and computationally expensive, the insights gained will significantly aid future planning and development of CO_2 storage sites.

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