Multiphase Flows Simulation of CO2 Storage in Saline Aquifers

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Numerical simulation of multiphase flow plays an important role to the assessment of the reliability and safety of CO_2 geological storage. As expected, the calculated results can provide meaningful and scientific information for management purposes. The big challenge to the numerical simulation of multiphase flow in saline aquifers is to accurately capture the mass interface and to deal with the geological heterogeneity.

In this study CO_2 storage in saline aquifers in Jilin oil field in Sunlong basin has been investigated. The inertial and quadratic effects were taken into account in the momentum equation. The improved CE/SE method was applied to discretize the different equations, and the particle level-set method was extended to capture the interface between CO2 and saline water. The CO_2 temperature and pressure for this field site fall in the supercritical region. The state for CO_2 has been employed to take into account realistic reservoir conditions for CO_2 geological sequestration. The geological heterogeneity has been sufficiently realized by using the geostochastic model.

It is found that the Rayleigh-Taylor instability phenomenon, which is associated with the penetration of saline fluid into CO_2 fluid in the direction of gravity, has been observed in CO_2 storage in saline aquifers in Jilin oil field. Development of a mushroom-type spike is a strong indication of the formation of Kelvin-Helmholtz instability due to the developed short wavelength perturbations present along the interface and parallel to the bulk flow. Additional key findings: the geological heterogeneity can distort the flow convection. The ascending of CO_2 can induce the persistent flow cycling effects. It is confirmed that the proposed method and numerical model has the reliability to simulate the process of the hydrodynamic trapping, which is the controlling mechanism for the initial period of CO_2 storage at

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time scale of 100 years.
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