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Simulation Study of Combining Carbon Dioxide Storage and Geothermal Energy in Saline Aquifers

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The safety issue is the first priority in carbon geological storage while injecting CO_2 into saline aquifers. With the effect of buoyancy, injected supercritical CO_2 will migrate upward and accumulate under the caprock, the possibility of leakage from the caprock to the overburden might happen consequently. From the literatures and field experiments we understand that the solubility mechanism, i.e. making the CO_2 dissolved into the brine, offers benefits in terms of highly safety because the CO_2-saturated water has a heavier density and tends to sink to the bottom of the storage formation. Another challenge for the carbon geological storage is the cost. The storage process is a job with energy consumption. Once we can have electricity from renewable energies, such as geothermal, the energy consumption issue can be solved. The purpose of this study is to combine the geothermal energy and the CO_2 storage to make a cheaper and safer feasible CO_2 storage engineering.

Combining CO_2 storage and geothermal energy production was presented as an approach to make CCS economically feasible. Hot brine is produced from a deep aquifer for energy production. After the energy use for the electricity, the used water will be re-injected into a shallow aquifer with dissolved CO_2. The process of combining energy use and CO_2 dissolution will be performed by a numerical simulation, and the feasibility of this concept is analyzed.

The saline aquifers in the Y-field in northwestern Taiwan is studied. A commercial simulator which had often been used to build up numerical models for the CO_2 geological storage is used in this study. We setup a pilot test project for this combination study. The production and injection wells are set in deep and shallow saline aquifers, respectively. The production well is used to pump high temperature water, for energy extraction, from the deep aquifer of the study field and the injection well is used to inject CO_2 saturated water into the shallow aquifer. The CO_2 saturated water is formed on the ground by mixing the CO_2 and the pumping water in a chamber. The solubility mechanism is performed before the water re-injection.

Our simulation results show that the deep saline aquifer in this field is feasible to provide certain amounts of high-temperature brine for energy use and then for the CO_2 dissolution. The behaviors of CO_2 saturated water injected into the shallow aquifer, the storage reservoir, are observed. The injection fluid with dissolved CO_2 can be permanently stored in this geological structure. The sensitivity analysis is also performed in this study to understand the key geological and engineering parameters for this combination engineering of geothermal energy and dissolved CO_2 storage. The benefits of a safer CO_2 storage with lower cost are concluded based on our simulation results.