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Prediction of CO₂ Injectivity into Low-temperature Water Zones below Natural Gas Hydrate Reservoirs for Non-Leaking Storage

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Abstract

The potential leakage of carbon dioxide (CO₂) from traditional underground carbon storage reservoirs has become a growing concern. This study suggests a novel approach —injecting CO₂ into subsea water zones situated under natural gas hydrate reservoirs. The objective is to store CO₂ within the water zones in hydrate form, thereby minimizing the risk of future CO₂ leaks. Assuming a sufficiently rapid flow of CO₂ during injection to prevent hydrate formation, an analytical model was developed to predict well's CO₂ injectivity. The case study utilizing data from the natural gas hydrate reservoir in the Shenhu area, Northern South China Sea, indicates that the CO₂ injectivity of a water zone underlying a natural gas hydrate reservoir is significantly influenced by the transmissibility of the water zone. With water zone transmissibility values varying within a range of -50% to +50% around the mean value of 15.79 Darcy-cm, well injectivity is projected to be nearly proportional to water zone transmissibility, ranging from 6 tons/day to 16 tons/day. Interestingly, CO₂ injectivity in the water zone exhibits minimal sensitivity to the permeability of the natural gas hydrate reservoir. In the examined case, the anticipated CO₂ injection rate is expected to vary only slightly, ranging from 10.5 tons/day to 11.5 tons/day, even with a permeability uncertainty of the gas hydrate reservoir ranging from 1 md to 3 md. The injectivity of a well completed in the water zone aligns with that of a well completed with frac-packing in the natural gas hydrate reservoir. Both types of wells are anticipated to inject CO₂ at a flow rate ranging from 6 tons/day to 16~17 tons/day, contingent upon the transmissibility of the water zone and the transmissibility of the hydraulic fracture. Notably, injecting CO₂ into water zones, as opposed to frac-packed natural gas hydrate reservoirs, offers the advantage of cost savings by eliminating the need for hydraulic fracturing.

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References

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