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Mineral composition and concrete gradation of sandy clay on CO₂ hydrates formation

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Sandy clay is the main porous medium for the occurrence of gas hydrates in nature. Hydrate-based technology for CO₂ sequestration in marine and permafrost layers is a promising and potential technique. To investigate the influence of formation properties on CO₂ sequestration, experiments were conducted under an initial pressure of 5.5 MPa and temperature of 1.27 °C. The influence of different mineral compositions and concrete gradation of sandy clay for CO₂ hydrate formation were analyzed. The pressure-temperature changes, CO₂ hydrate average formation rate, CO₂ consumption, and phase saturation were calculated during the CO₂ hydrate formation process. The results show that the CO₂ hydrate average formation rate decelerated with the increase of coarse sand proportion due to the reduction of specific surface area, and the CO₂ hydrate average formation rate is the smallest when the ratio of fine-grained sand to coarse-grained sand particle sizes (mass ratio of each component, the same below) is 1.0: 2.0, which is 12.60 mmol/min. Montmorillonite is not conducive to CO₂ hydrate formation; the CO₂ hydrate average formation rate of the sand group (contains fine-grained sand and coarse-grained sand) is higher than that of the sandy clay group (contains fine-grained sand and montmorillonite clay). The experiments in the sand group are more likely to achieve high hydrate saturation and CO₂ consumption, making it more suitable for CO₂ sequestration in areas with mineral compositions containing fine-grained sand and coarse-grained sand. The CO₂ consumption rates for the ratio of fine-grained sand to coarse-grained sand and clay mineral particle sizes of 1.0: 0.5 are 0.86 mol and 0.77 mol, respectively. With the increase in the proportion of coarse-grained sand and clay minerals, both the hydrate saturation and CO₂ consumption gradually decrease. The ratio of fine-grained sand to coarse-grained sand and clay mineral particle sizes of 1.0:0.5 is suitable for CO₂ sequestration using the hydrate-based technology.

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