

Thermodynamic and kinetic formation behaviors of CO₂ + N₂ hydrates in saline water and their significance for CO₂ separation and sequestration

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Geological sequestration of CO₂ is considered as a promising carbon storage option. When flue gas is injected into natural gas hydrate layer, both CO₂ sequestration and natural gas production can be achieved simultaneously through guest replacement. During the flue gas injection, mixed gas hydrates can be additionally formed with residual water in marine sediments. In this study, thermodynamic and kinetic formation behaviors of CO₂ + N₂ hydrates in NaCl solution were investigated to see the effect of NaCl on the CO₂ + N₂ hydrate formation. In NaCl solution, hydrate equilibrium conditions were shifted to harsher regions. In NaCl 3.5wt% solution, the hydrate conversion was decreased, but the CO₂ selectivity in the hydrate phase was increased. The time-dependent formation behavior of CO₂ + N₂ hydrates was observed via in-situ Raman spectroscopy. The high CO₂ selectivity in the hydrate phase was confirmed at the early stage of the hydrate growth in pure water, and this tendency was more pronounced in NaCl solution. The results provide valuable insights into the formation behavior of CO₂ + N₂ hydrates in real marine sediment conditions.