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Amino Acids Based CO₂/N₂ Capture and Storage under High Pressure & Low Temperature Geological Conditions

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Abstract

Geological sequestration of CO₂-rich gas as a CO₂ capture and storage technology has a lower technical and cost barrier compared to industrial scale-up. In this study, we proposed CO₂ capture and storage via hydrates in geological formations within the hydrate stability zone as a novel technique to contribute to global warming mitigation strategies, including carbon capture, utilization, and storage (CCUS), and to prevent large methane release to the atmosphere caused by hydrate melting.

A trapping mechanism via the CO₂ hydrate layer at the base of the gas hydrate stability zone can be used to prevent upward migration of CO₂ for long-term storage. CO₂ capture and sequestration into the geological formation within the hydrate stability zone can be enhanced in the presence of hydrate promoters, including surfactants and amino acids. [†]

Improved formation kinetics are observed in the presence of surfactants (1000-3000 ppm) and hydrophobic amino acids (3000 ppm) at 120 bar and 1 °C experimental conditions. We report an induction time in the range of 7-170 min and a CO₂ split fraction (0.60-0.90) in the hydrate for 120 bar initial injection pressure. The CO₂ split fraction can be improved by reducing the sand particle size or increasing the CO₂ mole percent in the incoming feed gas for a given injection pressure. The injection pressure requirements for CO₂ gas hydrate formation (CGHF) are too high to be implemented on an industrial scale. Therefore, hydrophobic amino acids as kinetic promoters together with thermodynamic promoters such as THF and tetra-n-butylammonium bromide (TBAB) could enable a more environmentally friendly solution for CO₂ capture via CGHF with modest operational requirements.

Keywords: Hydrate based CO₂ capture and storage, Green chemicals, CO₂ hydrate seal

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