Semiclathrate hydrate process for pre-combustion capture of CO2 at near ambient temperatures

By: Zheng, JJ; Zhang, Junjie; Zhang, P; Peng, Linga, P; Linga, Praveen

Abstract

CO2 capture has become an important part in building a sustainable energy system featuring the clean use of fossil fuels with low carbon footprint. Hydrate-based gas separation (HBGS) is one of the potential technologies to capture carbon dioxide from pre-combustion (fuel gas) stream. Promoters are often employed to moderate the formation conditions of hydrates. Tetra-n-butylammonium fluoride (TBAF) exhibits great thermodynamic promotion on hydrate formation. In this study the kinetic performance of the formation process of CO2-H2-TBAF semiclathrate hydrate was evaluated under different experimental pressures (6 MPa, 4 MPa and 2 MPa) and temperatures (298 K, 292 K and 286 K), with the stoichiometric TBAF concentration (3.38 mol%). Gas uptake measurement and visual observations showed that at a given pressure, the total gas uptake decreased with the decrease of experimental temperature due to high mass transfer resistance caused by rapid concentration (3.38 mol%). Gas uptake measurement and visual observations showed that at a given pressure, the total gas uptake decreased with the decrease of experimental temperature due to high mass transfer resistance caused by rapid

Keywords

Author Keywords: Gas hydrates; CO2 capture; TBAF; Semiclathrate; Pre-combustion capture; CCS

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Abstract

CO\(_2\) capture has become an important part in building a sustainable energy system featuring the clean use of fossil fuels with low carbon footprint. Hydro-based gas separation (HBGS) is one of the potential technologies to capture carbon dioxide from pre-combustion (fuel gas) stream. Promoters are often employed to moderate the formation conditions of hydrates. Tetra-n-butylammonium fluoride (TBAF) exhibits great thermodynamic promotion on hydrate formation. In this study the kinetic performance of the formation process of CO\(_2\)-H\(_2\)-TBAF semiclathrate hydrate was evaluated under different experimental pressures (8 MPa, 4 MPa and 2 MPa) and temperatures (298 K, 292 K and 286 K) with the stoichiometric TBAF concentration (3.38 mol%). Gas uptake measurement and visual observations showed that at a given pressure, the total gas uptake decreased with the decrease of experimental temperature due to high mass transfer resistance caused by rapid growth of TBAF hydrate. The highest gas uptake was achieved by experiments conducted at 6.0 MPa and 298.0 K. It was the highest among semiclathrate promoters with stoichiometric concentraion, but lower compared with THF. The major advantage of the use of TBAF is that the HBGS process can be operated at near ambient temperatures compared to other promoters. The CO\(_2\) composition in the hydrate phase was between 65.2 and 93.1 mol%, highly dependent on the experimental conditions.

Keywords

Gas hydrates; CO\(_2\) capture; TBAF; Semiclathrate; Pre-combustion capture; CCS

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Abstract
CO2 capture has become an important part in building a sustainable energy system featuring the clean use of fossil fuels with low carbon footprint. Hydro-based gas separation (HBGS) is one of the potential technologies to capture carbon dioxide from pre-combustion (fuel gas) stream. Promoters are often employed to moderate the formation conditions of hydrates. Tetra-n-butylammonium fluoride (TBAF) exhibits great thermodynamic promotion on hydrate formation. In this study the kinetic performance of the formation process of CO2-H-2-TBAF semiclathrate hydrate was evaluated under different experimental pressures (6 MPa, 4 MPa and 2 MPa) and temperatures (298 K, 292 K and 286 K), with the stoichiometric TBAF concentration (3.38 mol%). Gas uptake measurement and visual observations showed that at a given pressure, the total gas uptake is highest at 6.0 MPa and 298.0 K. It was the highest among semiclathrate promoters with stoichiometric concentration, but lower compared with THF. The major advantage of the use of TBAF is that the HBGS process can be operated at near ambient temperatures compared to other promoters. The CO2 composition in the hydrate phase was between 65.2 and 93.1 mol%, highly dependent on the experimental conditions.

Variance analysis was employed to evaluate the impact of pressure and temperature on gas uptake. Gas solubility composition in the hydrate phase was between 65.2 and 93.1 mol%, highly dependent on the experimental conditions.

Keywords
Gas hydrates; CO2 capture; TBAF; Semiclathrate; Pre-combustion capture; CCS

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