Clathrate hydrate-based CO_2 capture and storage technologies

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Clathrate hydrates are solid inclusion compounds formed by the hydrogen bonding of water molecules at high pressure and low temperature conditions. The host water molecules form cage frameworks of clathrate hydrates, whereas the small gas molecules are captured in the empty cages. Clathrate-based gas separation has attracted increasing attention and could be an alternative to the existing post-combustion or pre-combustion gas separation technologies. In this study, semi-clathrates formed by tetra n-butyl ammonium chloride (TBAC) were used for capturing CO_2 from post-combustion flue gas and pre-combustion fuel gas mixtures. The thermodynamic stability, gas uptakes, and CO_2 compositions for TBAC semi-clathrates were closely investigated to confirm the separation efficiency of clathrate-based CO_2 capture. In this study, the CH_4 - CO_2 replacement occurring in different gas hydrate structures for energy production and CO_2 sequestration was also examined with a primary focus on phase behaviors and structural transformation. The initial and replaced hydrates were analyzed via ^{13}C NMR and PXRD to examine cage-dependent guest distributions and possible structural transition.