Hydrate Phase Equilibria and Structure Identification of the CH_4 + CO_2 + Thermodynamic Hydrate Promoter Systems for Application to CO_2 Capture from Natural Gas

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Some natural gas fields located in Southeast Asia contain high levels of CO_2 content which can reduce energy density and increase production cost. Gas hydrate-based separation can be a good candidate for capturing CO_2 from natural gas because the gas is obtained from high pressure reserviors. In this study, thermodynamic and structural analyses of the CH_4 + CO_2 hydrate were conducted in the presence of various thermodynamic hydrate promoters (THPs) such as tetrahydrofuran (THF), neohexane (NH), and tetra-n-butyl ammonium chloride (TBAC) in order to investigate CO_2 capture characteristics depending on the structure. Three-phase (H-LW-V) or four-phase (H-LW-LNH-V) equilibria of the CH_4 (50%) + CO_2 (50%) + THP hydrates were measured to determine hydrate stability conditions. The phase equilibrium results showed that the addition of TBAC to the system resulted in the most significant thermodynamic promotion. Powder X-ray diffraction (PXRD) and Raman spectroscopy revealed that for the CH_4 (50%) + CO_2 (50%) gas mixture the addition of TBAC, THF, and NH induced the formation of semiclathrate, sII, and sH hydrate, respectively.