## Thermodynamic Phase Equilibria and Formation Kinetics of Cyclopentane, Cyclopentanone and Cyclopentanol Hydrates in the Presence of Gaseous Guest Molecules including Methane and Carbon Dioxide

Authors : Sujin Hong, Seokyoon Moon, Heejoong Kim, Yunseok Lee, Youngjune Park

Abstract : Gas hydrate is an inclusion compound in which a low-molecular-weight gas or organic molecule is trapped inside a three-dimensional lattice structure created by water-molecule via intermolecular hydrogen bonding. It is generally formed at low temperature and high pressure, and exists as crystal structures of cubic systems - structure I, structure II, and hexagonal system - structure H. Many efforts have been made to apply them to various energy and environmental fields such as gas transportation and storage, CO<sub>2</sub> capture and separation, and desalination of seawater. Particularly, studies on the behavior of gas hydrates by new organic materials for CO<sub>2</sub> storage and various applications are underway. In this study, thermodynamic and spectroscopic analyses of the gas hydrate system were performed focusing on cyclopentanol, an organic molecule that forms gas hydrate at relatively low pressure. The thermodynamic equilibria of CH<sub>4</sub> and CO<sub>2</sub> hydrate systems including cyclopentanol were measured and spectroscopic analyses of XRD and Raman were performed. The differences in thermodynamic systems and formation kinetics of CO<sub>2</sub> added cyclopentane, cyclopentanol and cyclopentanone hydrate systems were compared. From the thermodynamic point of view, cyclopentanol was found to be a hydrate promotor. Spectroscopic analyses showed that cyclopentanol formed a hydrate crystal structure of cubic structure II in the presence of CH<sub>4</sub> and CO<sub>2</sub>. It was found that the differences in the functional groups among the organic guest molecules significantly affected the rate of hydrate formation and the total amounts of  $CO_2$  stored in the hydrate systems. The total amount of  $CO_2$  stored in the cyclopentanone hydrate was found to be twice that of the amount of CO<sub>2</sub> stored in the cyclopentane and the cyclopentanol hydrates. The findings are expected to open up new opportunity to develop the gas hydrate based wastewater desalination technology.

Keywords : gas hydrate, CO<sub>2</sub>, separation, desalination, formation kinetics, thermodynamic equilibria

**Conference Title :** ICCDUSD 2018 : International Conference on Carbon Dioxide Utilization and Sustainable Development **Conference Location :** London, United Kingdom

Conference Dates : January 18-19, 2018

1