

Phase Equilibria and Spectroscopic Observation of Alcohol Hydrates with Methane Gas

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Low alcohols such as methanol and ethanol are known to play an inhibitor role in forming clathrate hydrate. However, recent multiple researches report that alcohols with preferential structures can be enclosed in the cages of structure-II or structure-H clathrate hydrates formed with the aid of help gases such as methane and carbon dioxide. These alcohol-based clathrate hydrates tend to possess better structure stability than pure sI clathrate hydrates not containing alcohol guests. Moreover, such a polar guest molecule as tert-butyl methyl ether greatly affects the clathrate hydrate formation kinetics due to its high solubility. The active participation of highly water-soluble alcohol guests in transforming cage lattices with small gaseous guest molecules make the formed clathrate hydrates to be stabilized in more favorable temperature and pressure conditions. Amyl alcohol molecules are the organic compounds having the molecular formula $C_5H_{11}OH$. Even though, amyl alcohol seems like oils because of phase separation between water and alcohols due to low solubility in water, still they exhibit polar relative to hydrocarbons. These two distinct trends in amyl alcohol might play an essential part in interpreting a complex behavior of clathrate hydrates. In this study, in order to examine the effects of alcohol guest molecules on clathrate hydrates, we attempt to (1) analyze the types of hydrate structure by introducing the methane gas into amyl alcohols + H_2O systems through solid-state NMR and PXRD; (2) check the existence of a 'free' OH bonding of amyl alcohol hydrate former through Raman; and finally (3) suggest the possibilities of semi-clathrate hydrate formation formed from the alcohol guest molecules with gaseous methane. These findings are expected to be good for a fine understanding of the relations between the size of guest molecules and the types of hydrate structure in alcohol hydrates with gaseous methane.