

Formation of gas hydrates composed of methane and helium

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Because helium is one of the components of natural gas, it is possible that helium molecules are enclathrated in natural gas hydrates. Actually, helium is detected in natural gas where gas hydrates exist. However, direct detection of helium in gas hydrates is not reported yet. Maekawa (2004) reported that equilibrium pressure of mixed-gas (methane + helium) hydrate increased with composition of helium. In this study, we formed methane and helium mixed-gas hydrate and measured composition of helium in GH and residual gases. Fine ice powder was put into a pressure cell (42 mL) and pressurized methane and helium. Gas hydrate formed at around 273 K, and residual gas in the cell was sampled and the rest of residual gas was evacuated at the temperature of liquid nitrogen (77 K). After completion of evacuation, hydrate remained in the cell was dissociated at a room temperature. Molecular composition of GH and residual gases were measured using a portable gas chromatograph (CP-4900, Varian). Some hydrate samples were retrieved at 77 K and determined their crystallographic properties by a PXRD (powder X-ray diffraction) and Raman spectroscopy. The gas hydrate samples were close to be normal methane hydrate from the results by PXRD pattern and Raman spectra. Methane preferred to be encaged in hydrate phase rather than helium. The maximum concentration of helium in hydrate was about 6% (the rest 94% was methane) when the initial partial pressures of methane and helium were about 3 and 15 MPa, respectively. Concentration of helium in hydrate increased with the partial pressure of helium in the initial gas. Because helium cannot be trapped and is difficult to adsorb to sample surface at 77 K, We can conclude that helium molecules can be enclathrated slightly into hydrate cages.

Reference

Maekawa T (2003) Gas hydrate formation for mixtures of methane + helium and ethane + helium. J Chem Eng Data 48: 1283-1285, doi:10.1021/je0301592

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