
 [JJ] Evening Poster | M (Multidisciplinary and Interdisciplinary) | M-IS Intersection

[M-IS17] Gas hydrates in environmental-resource sciences

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An increasing number of researches focusing on natural gas hydrates has recently been conducted from the environmental, material, and resource scientific viewpoints. This session aims to share and discuss the latest research results to understand and examine the nature and potential of gas hydrates in the past-present-future of the Earth. Because the researches on gas hydrates are interdisciplinary, broad topics from field and experimental researches, modeling, etc. will be presented in this session.

[MIS17-P07] Effect of temperature on the C–H symmetric stretching vibrational frequencies of methane in structure H and I clathrate hydrates

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Clathrate hydrates are crystalline inclusion compounds that consist of guest molecules of suitable sizes and shapes trapped in well-defined cages formed by water molecules. Both synthetic and naturally occurring clathrate hydrates with natural gases as guest molecules are commonly known as gas hydrates. Gas hydrates with enclathrated hydrocarbon gases that exist in sea/lake bottom sediments and permafrost layers have attracted considerable interest as a potential source of unconventional natural gas.

Three typical crystal structures of clathrate hydrates have been identified on Earth: cubic structure I (sI), cubic structure II (sII), and hexagonal structure H (sH). Small guest molecules such as methane (CH_4) or ethane form sI-type hydrates, whereas larger molecules like propane or 2-methylpropane (C_4H_{10}) form sII hydrates. sH hydrates are obtained from even larger molecules, e.g., 2-methylbutane (C_5H_{12}) or 2,2-dimethylbutane (C_6H_{14}), in the presence of a help gas as CH_4 . In this study, the Raman spectra of the C–H symmetric stretch region of CH_4 enclathrated within various sH hydrates and structure I CH_4 hydrates were analyzed in the temperature range of 83–183 K. Thermal expansions of these sH hydrate samples were also measured using powder X-ray diffraction. Symmetric stretch vibrational frequencies of CH_4 in host water cages increased because of varying temperature, and the sizes of host water cages also increased; variation of CH_4 in small cages was less than in larger cages. Comparing the variations of the C–H symmetric stretching frequencies of CH_4 in gas hydrates with varying pressure and temperature, we suggest that the observed trend is caused by thermal vibrations of the CH_4 molecule in water cages.

Reference

Sloan and Koh (2008) Clathrate Hydrates of Natural Gases, 3rd ed., CRC Press: Boca Raton, FL, USA