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主催：慶應義塾大学理工学部機械工学科

Department of Mechanical Engineering, Keio University

日時 (Date)

2018年1月11日(金) (January 11, 2019 (Fri.)) 11:00~12:00

場所 (Venue)

12棟2階12-211 (12-211, Building 12)

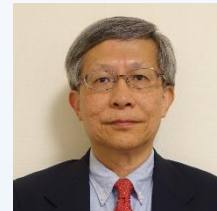
講演題目 (Title)

Development of Thermodynamic Model for Phase Boundary of Gas Hydrates and Kinetic Effect of Ethanol on Gas Hydrate Formation and Dissociation

講演者 (Speaker)

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ABSTRACT:

Gas hydrates are ice-like crystalline solids in which water molecules form a three-dimensional structure that is stabilized by the encapsulation of small gas molecule like methane, ethane and carbon dioxide. In this talk, I will cover two topics: (1) a predictive thermodynamic model to describe the phase behavior of gas hydrates and (2) a proposed experimental method to speed up the rate of hydrate formation for gas storage and transportation.

The Peng-Robinson-Stryjek-Vera equation of state combined with the COSMO-SAC activity coefficient liquid model through the modified Huron-Vidal mixing rule are chosen to describe the vapor and liquid phases. The van der Waals and Platteeuw (vdW-P) model is applied to describe the hydrate phase. In the vdW-P model, the Langmuir adsorption constant is pressure- and temperature-dependent and designed to produce a reduced free volume available to the encapsulated gas molecules as the pressure increases. It is found that three- phase-coexisting conditions of gas hydrates, from vapor-ice-hydrate equilibrium at low temperatures, to vapor-liquid-hydrate equilibrium at higher temperatures, and even to liquid-liquid-hydrate equilibrium at high pressures, can be well described by this predictive model. In addition, this proposed model is able to predict the phase boundary of gas hydrates in the presence of organic inhibitors, electrolytes and ionic liquids.

Clathrate hydrate is considered to be a potential material for gas storage and transportation. Slow kinetics of hydrate formation is the challenge impeding the commercialized process development of such applications. Ethanol is used as a kinetic promoter to improve the efficiency of methane hydrate formation via gas (methane)-solid (ice powder) reaction at a fixed methane pressure and temperature. It is found that amount of ice powder converted into methane hydrate with ethanol added is consistently larger than that without ethanol added. The methane hydrate conversion rate is independent of reaction temperature. Furthermore, small quantities of ethanol could also substantially enhance the dissociation rate of methane hydrate by suppressing the self-preservation effect in the dissociation process operated at 1 atm and temperatures below the ice melting point. Ethanol effect on the CO₂ hydrate formation will also be discussed.