Hiroyuki KOMATSU, Ph.D.

Assistant Professor

Program: Advanced Materials Science and Technology

Area: Applied Chemistry and Chemical Engineering

Undergraduate: Dept. of Engineering

Professional Expertise

Dr. Komatsu has expertise in developing environmentally sustainable technologies with inclusion compounds. Presently, he is studying semi-clathrate hydrates, as these are new promising materials that are formed mainly from water and can be used at conditions near room temperature for technologically important gas separations (e.g. CO_2/H_2). Inclusion compounds allow selective separations because they have the property of trapping gases according to their van der Waals' radius that must be less than the hydrate cage size (Fig.1). In applications of hydrates, it is important that hydrate formation in solid-liquid interface and gas inclusion in vapor-solid interface are controlled. In his laboratory, the characteristics of hydrates about those phenomena are investigated.

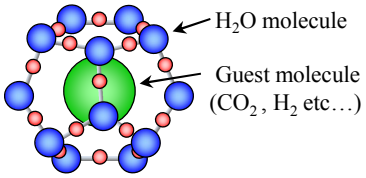

Fig.1 Gas enclosing cage of hydrate

Research Fields of Interest

Dr. Komatsu's group focuses gas separation processes that can be used in distributed energy systems to supply hydrogen or separate biogas. Target gases are carbon dioxide, hydrogen and methane as these are commonly produced in energy systems. He proposed a fluidized gas separation process with hydrate slurry (Fig.2). Properties relating to viscosity and gas inclusion of hydrate slurry change dynamically with CO_2 concentration. Therefore the control of these properties is important to increase efficiencies of the process. The following research topics that are related to hydrate slurries are presently being considered.

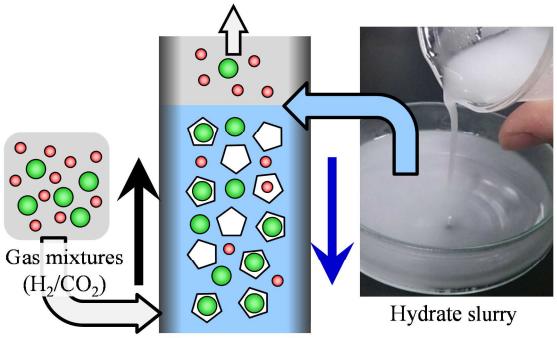

Fig.2 Fluidizer gas separation process with hydrate slurry

1. Rheological characteristics

Hydrate particle size, viscosity and aggregability of hydrate slurries at atmospheric pressure or under CO_2 pressure are presently unknown and not well studied. In this regard, the influence of hydrate solid fraction and dispersants are being investigated.

2. Gas inclusion characteristics

The CO_2 partial pressure influences hydrate solid fraction in a slurry. Equilibrium inclusion amount and inclusion kinetics of gases in a bubbling fluidized system are being studied.

3. Gas separation characteristics and process design

Gas compositions in vapor phase at the time of gases inclusion and slurry regeneration are important for practical use. It is necessary to design contact methods between gases and hydrate slurry, and also to study how the hydrate slurry can be recycled.

Education

2014: Ph.D. (Environmental Studies), Graduate School of Environmental Studies, Tohoku University, Japan

2011: Master Environmental Studies, Graduate School of Environmental Studies, Tohoku University, Japan

2009: Bachelor Eng., Department of Applied Chemistry, Chemical Engineering and Biomolecular Engineering, Tohoku University, Japan

Professional Societies and Activities

1. Member of the Society of Chemical Engineers, Japan
2. Member of the Japan Institute of Energy

Awards

1. Best student Paper Award of 2010 Symposium (Taiwan) on Methane Hydrate Recovery and CO_2 Sequestration

Major Publications

Papers

[1] M. Abe, S. Hirata, H. Komatsu, K. Yamagiwa, H. Tajima, "Thermodynamic selection of effective additives to improve the cloud point of biodiesel fuels", *Fuel*, vol.171, pp.94-100, 2016

[2] H. Komatsu, M. Ota, Y. Sato, M. Watanabe, R. L. Smith Jr., "Hydrogen and Carbon Dioxide Adsorption with Tetra-*n*-Butyl Ammonium Semi-Clatrate Hydrates for Gas Separations", *AIChE J.*, vol.61, no.3, pp.992 -1003, 2015

[3] H. Komatsu, M. Ota, Y. Sato, M. Watanabe, R. L. Smith Jr., "Multiple adsorption resistance model for constituent molecular effects in hydrogen clathration kinetics in clathrate hydrate particles", *Chem. Eng. Sci.*, vol.108, pp.270-282, 2014

[4] H. Komatsu, A. Hayasaka, M. Ota, Y. Sato, M. Watanabe, R. L. Smith Jr., "Measurement of pure hydrogen and pure carbon dioxide adsorption equilibria for THF clathrate hydrate and tetra-n-butyl ammonium bromide semi-clathrate hydrate", *Fluid Phase Equilib*. vol.357, pp.80-85, 2013

[5] H. Komatsu, M. Ota, R. L. Smith Jr., H. Inomata, "Review of CO2-CH4 clathrate hydrate replacement reaction laboratory studies – Properties and kinetics", *J. Taiwan Inst. Chem. Eng*., vol.44, pp.517-537, 2013

[6] H. Komatsu, H. Yoshioka, M. Ota, Y. Sato, M. Watanabe, R. L. Smith Jr., C. J. Peters, "Phase Equilibrium Measurements of Hydrogen-Tetrahydrofuran and Hydrogen-Cyclopentane Binary Clathrate Hydrate Systems", *J. Chem. Eng. Data*, vol.55, pp.2214-2218, 2010

Proceedings (International)

[1] H. Komatsu, M. Ota, M. Watanabe, Y. Sato, R. L. Smith, Jr., "Analysis of semi-clatharte hydrate formation kinetics in the presence of H_2 or CO_2 gas phases", *International Symposium for 70th Anniversary of the Tohoku Branch of the Chemical Society of Japan*, Sept. 2013

[2] H. Komatsu, A. Hayasaka, M. Ota, Y. Sato, M. Watanabe, R. L. Smith Jr., "Measurement of the adsorption equilibria of hydrogen and carbon dioxide in clathrate and semi-clathrate hydrates", *6th International Symposium on Molecular Thermodynamics and Molecular Simulation*, Sept.2012

[3] H. Komatsu, "Two stage adsorption model for formation kinetics of hydrogen binary clathrate hydrate", *6th International Symposium on Chemical Environmental Biomedical Technology*, Sept. 2011

[4] H. Komatsu, M. Ota, M. Watanabe, Y. Sato, R. L. Smith Jr., "Constituent molecular effects on phase equilibria and hydrogen adsorption kinetics in clathrate hydrates", *7th International Conference on Gas Hydrates*, Jul. 2011

[5] H. Komatsu, M. Ota, R. L. Smith Jr., "Phase equilibrium measurements and fundamental models for clathrate hydrates", *2010 Symposium on Methane Hydrate Recovery and CO_2 Sequestration*, Mar. 2010

[6] H. Komatsu, H. Yoshioka, M. Ota, Y. Sato, H. Inomata, R. L. Smith Jr., "Analysis of hydrogen-tetrahydrofuran and hydrogen-cyclopentane binary clathrate hydrate phase equilibria", *5th International Symposium of Molecular Thermodynamics and Molecular Simulation*, Oct. 2009