Hawaiʻi Natural Energy Institute Research Highlights

Alternative Fuels

Methane Hydrates

<u>OBJECTIVES AND SIGNIFICANCE</u>: Methane hydrates in deep ocean sediments and arctic permafrost constitute an enormous energy reservoir that is estimated to exceed the energy content of all known coal, oil, and conventional natural gas resources. The primary goals of this project that has been ongoing since 2001 are to 1) support exploration of hydrate reservoirs in seafloor sediments and arctic permafrost; 2) support the development of safe and practicable methods to destabilize hydrates to produce methane fuel; and 3) advance our understanding of the environmental impacts of natural seeps and accidental releases of methane and other hydrocarbons in the ocean. HNEI has also investigated engineering applications of hydrates including desalination and H_2 storage, and promoted many international R&D collaborations.

<u>BACKGROUND</u>: Research on CO_2 hydrates at HNEI began in the 1990's as part of an international collaboration on CO_2 ocean sequestration. The research scope was expanded to include methane hydrates when HNEI was asked by the Minerals Management Service (MMS) of the Department of the Interior to participate in a study on deep oil spills. Over time, we have conducted a host of laboratory investigations on a wide range of topics related to hydrates and participated in numerous oceanographic research cruises to offshore hydrate zones.

At present, our activities are focused on the following three areas: 1) chemical destabilization of hydrates; 2) biogeochemistry of seafloor methane hydrates; and 3) the biodegradation of methane in the ocean.

Methane hydrates can be destabilized by application of heat, depressurization, or contact with chemical reagents known as thermodynamic inhibitors. Destabilization results in melting of the solid hydrate, which releases liquid water and methane gas. Many conventional inhibitors are expensive and/or toxic. Our laboratory experiments evaluate the effectiveness of various inhibitors with the goal of identifying safe and inexpensive alternatives. Figure 1 shows a novel facility developed by HNEI researchers to investigate the thermochemistry of hydrates. This facility employs a fiberoptic probe coupled into a high pressure calorimetry test cell to permit Raman spectra to be sampled as hydrates form and decompose. The Raman calorimeter has provided valuable data to assess inhibitor effectiveness.

Figure 1. Photo of the Raman calorimetry facility.

<u>PROJECT STATUS/RESULTS</u>: Experimental work under this project is nearing completion. Key results of recent work include: analysis of seismic data of hydrate reservoirs in the Nankai Trough offshore of Japan and determination of the effectiveness of alternative inhibitors such as salts that occur naturally in seawater and glycerol to dissociate hydrates. An investigation of methane hydrate kinetics within a sand substrate is nearing completion.

This project has produced the following publications:

- 2017, J.T. Weissman, et al., **Hydrogen Storage Capacity of Tetrahydrofuran and Tetra-N-Butylammonium Bromide Hydrates Under Favorable Thermodynamic Conditions**, Energies, Vol. 10, Issue 8, Paper 1225.
- 2017, K. Taladay, et al., **Gas-In-Place Estimate for Potential Gas Hydrate Concentrated Zone in the Kumano Basin, Nankai Trough Forearc, Japan**, Energies, Vol. 10, Issue 10, Paper 1552.
- 2016, T.Y. Sylva, et al., **Inhibiting Effects of Transition Metal Salts on Methane Hydrate Stability**, Chemical Engineering Science, Vol. 155, pp. 10-15.
- 2016, T.H. Ching, et al., **Biodegradation of biodiesel and microbiologically induced corrosion of 1018 steel by Moniliella wahieum Y12**, International Biodeterioration & Biodegradation, Vol. 108, pp. 122-126.

Funding Source: Office of Naval Research

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Last Updated: October 2020