Hawaiʻi Natural Energy Institute Research Highlights

Alternative Fuels

Methane Dissolution Rates in the Deep Ocean

OBJECTIVE AND SIGNIFICANCE: Japan has begun offshore pre-production activities to recover methane gas from hydrate reservoirs in seafloor sediments south of Tokyo. Prior to commercial production, the associated environmental consequences need to be carefully assessed. HNEI was contracted to employ its unique laboratory-scale deep ocean simulator facility to measure the dissolution rate and hydrodynamic behavior of methane bubbles at conditions in the ocean down to 1000 m depth. These data will be employed for model development by colleagues in Japan to predict possible impacts to the marine environment near production sites.

BACKGROUND: Methane hydrate (MH) in deep ocean sediments represents one of the few conventional (i.e., fossil) energy resources found in Japan. Japan has led the world in R&D investments in MH exploration and science. In 2013, a Japanese consortium conducted the world's first offshore MH gas production test in the Eastern Nankai Trough at a water depth of about 1000 m. A hydrate reservoir located 200-300 m below the seafloor was de-pressurized, causing the hydrate to decompose into its constituent methane gas and water components. The released gas flowed through a conduit to the ocean surface. A 2nd longer duration test was performed in 2017 at a location near the 2013 site. A recent HNEI publication summarizes Japan's MH R&D activities and strategy in the context of the country's overall energy policy (2017, A. Oyama, S.M. Masutani, **A Review of the Methane Hydrate Program in Japan**, Energies, Vol. 10, Issue 10, Paper 1447. (Open Access: **PDF**)).

As part of HNEI's past CO_2 ocean sequestration and deep oil spills research activities, and its ongoing MH program, we have developed unique laboratory facilities to simulate conditions in the deep ocean. In late 2018, Japan NUS Co., Ltd., with funding from METI, contracted HNEI to conduct experiments in our facilities to investigate the behavior of rising, buoyant methane bubbles released in the deep ocean as a consequence of gas production activities.

Figure 1 presents a schematic diagram of the high-pressure water tunnel system employed in the present study. The clear acrylic test section (gray insert in the figure) is enclosed in the vessel shown in Figure 2, which is filled with chilled synthetic seawater pressurized to approximate conditions in the ocean at depths down to 1000 m. The steady downward flow of seawater pumped through the water tunnel can be adjusted to exactly offset the buoyancy of a methane bubble in the test section so that the bubble stays fixed in space and can be observed with a video camera. The rate of shrinkage of the bubble can then be used to determine dissolution rates of the methane into seawater under dynamic condition similar to those experienced by bubbles rising in the ocean.

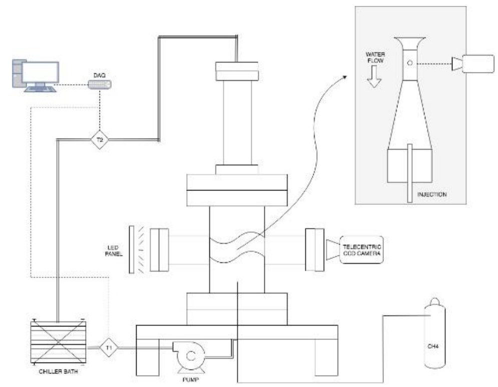

Figure 1. Schematic diagram of the water tunnel.

Figure 2. Photograph of the deep ocean simulator.

PROJECT STATUS/RESULTS: This project was completed in 2019 and results currently are under review by the funding agency.

Funding Source: Japan NUS Co., Ltd. (JANUS)

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Last Updated: October 2019