Experimental Results of Hydrate Reservoir Destabilization Through Heating.

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Gas clathrate reservoirs have been considered as possible sources of energy, as hazards to deep water drilling operations, and as contributors to global climate change. Clathrate destabilization may occur through depressurization of the reservoir, addition of chemical inhibitors, or heating the reservoir.

Meso-scale heat conduction experiments were conducted in the Seafloor Process Simulator (SPS) at Oak Ridge National Laboratory in an attempt to apply experimental constraints to purely numerical models of heat transfer within a nearly isobaric reservoir. A column of saturated sediment was place inside the pressure vessel and pressurized to conditions sufficient to form methane clathrate at seafloor temperatures, while the system remained at room temperature (298K). Once pressurized, the temperature of the vessel was then lowered to approximately 275K, forming pore filling clathrate in the sediment column. Following hydrate formation, heat was supplied to the center of the clathrate reservoir through a hot fluid heat exchanger embedded in the sediment column to dissociate the methane hydrate.

Relative changes in temperature within the hydrate-sediment column were monitored with a fiber optic quasi-distributed sensing system (DSS), along with temperature and pressure within the vessel headspace. Using the DSS Plotter analysis software, it was determined that an axis-symmetric section of clathrate was dissociated around the heat exchanger. Clathrate dissociation was accompanied by a small rise in vessel headspace pressure in addition to the expected thermal expansion of the headspace gas. The quantity of heat input to the system was calculated from the drop in fluid temperature as it flowed through the heat exchanger. Increased heat input resulted in an increase in the volume of hydrate dissociated. Clathrate rapidly reformed immediately upon the removal of the heat energy.

A simple numerical model has been developed to simulate the heat flow in the system. Early results are promising and with further refinement the gap between the volume of hydrate dissociation predicted from the model and the experimental data observed on the LUNA DSS system will close. Much of the thermal energy is used to counter the heat of dissociation and heat input from the cold room the vessel is in. Some thermal energy was also lost in the pipelines inside the vessel.