Methane Hydrate Formation and Dissociation in a Partially Saturated Sand – Measurements and Observations

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In order to efficiently produce natural gas from hydrate reservoirs, an understanding of how hydrate and porous media behave upon dissociation is needed. This understanding must be gained using large samples; and in addition to temperature and pressure measurements, detailed imaging techniques such as x-ray computed tomography (CT) imaging are required to visualize and quantify changes. We formed and dissociated methane hydrate in a partially saturated sand, while using x-ray CT to observe the test. In this first-of-its-kind experiment, the large partially saturated sand sample (7.6 cm in diameter and 25.4 cm long) was packed in an x-ray transparent vessel to an average porosity (percentage of space between sand grains) of about 36%, and had an average water saturation (percentage of porespace occupied by water) of about 56%. Temperature measurements were gathered at four locations in the sample, and system pressure was measured.

The set of tests included the initial formation of the hydrate, two thermal dissociation steps, a second hydrate formation, and final dissociation by depressurization. Hydrate was initially formed at pressures between 5.5 and 6.2 MPa with a temperature of 1.3°C. Thermal dissociation was induced by increasing the boundary (vessel wall) temperature in steps to 6.8 and 8.4°C, causing expected increases in pressure in the system. Hydrate reformation occurred when the temperature was lowered to 3.7°C, after which depressurization to about 2.8 MPa induced dissociation at temperatures from 0.4° to 3.7°C.

Data to be discussed include temperature and pressure responses of the tests, and CT data showing regions of interest including where dissociation is occurring, and where mechanical forces are causing density of the porous medium to increase. This and data from other tests will be used to determine kinetic parameters for dissociation.