NATIONAL ENERGY TECHNOLOGY LABORATORY
OIL & GAS

DOE Award No.: ESD12011

Quarterly Research Performance Progress Report)

(Period Ending 12/31/2017)

PROPERTIES OF SEDIMENTS CONTAINING METHANE HYDRATE, WATER, AND GAS SUBJECTED TO CHANGING GAS COMPOSITIONS

Project Period (April 1, 2012 to open)

Submitted by:
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Office of Fossil Energy

RESEARCH PERFORMANCE PROGRESS REPORT

DISCLAIMER

ACCOMPLISHMENTS:

Task 11. Assessment of thermal gradient modification methods and Investigation of the effect of thermal gradient and gradient oscillation on hydrate behavior –

Accomplishments: Although some preliminary work on layered systems with approximately a factor of 10 difference in particle sized have been performed, more work in needed in developing consistent and controllable thermal gradients (task 11Accomplishments: Using both the current and newly manufactured hydrate pressure vessel, methods of temperature gradient application were applied to investigate effects of thermal gradient and temperature oscillation. Techniques employed included the use of viscosity adjustment for the confining fluid, the use of different heating/cooling coils, and the use of different heating/cooling techniques.

External heating with heat tape proved only slightly effective and difficult to control. (see Figure 1). This experiment setup consisted of a sand sample in the pressure vessel, gelatin mixed with water was used as the confining fluid, and a cooling jacked was placed around the sample set to 12C. A heating tape was wound around one end of the vessel to create the temperature gradient. Figure 1 below show measurements taken along the length of the vessel in the confining fluid at 0.5 and 1 hr.

Internal wire type heating devices placed in heat wells did not provide sufficient heading to produce a measureable gradient. The current working design uses an x-ray transparent Al tubing coil to allow fluid to flow through to increase or decrease the temperature on the inlet. Fluid in the coil is provided by a controlled water bath capable of heating and cooling. Increased viscosity of the confining fluid by adding gelatin (1 – 3% by mass) will reduce the effects of convection. Once the temperature control system is well understood we will form methane hydrate and alter the thermal gradient.

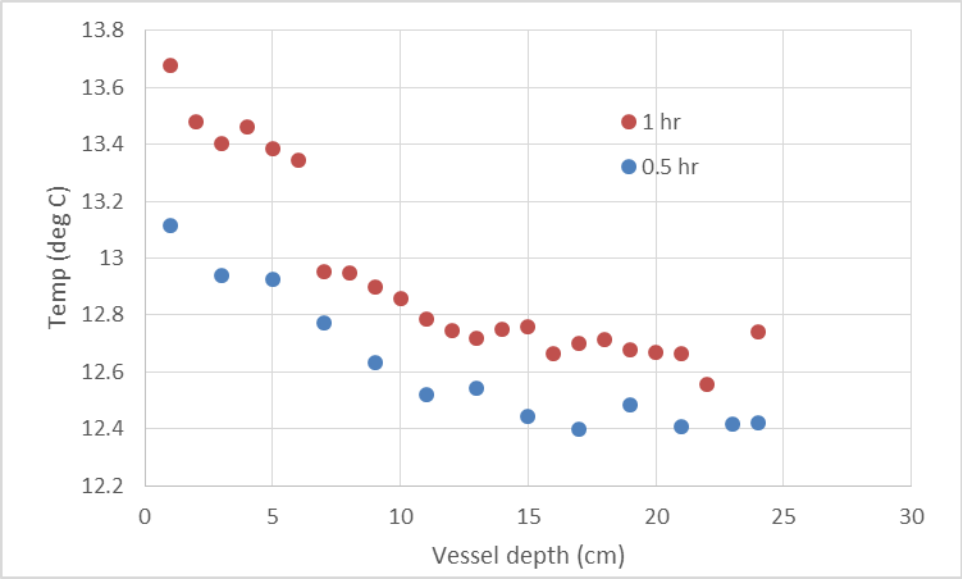

Figure 1. Temperature gradients in vessel using external heating.

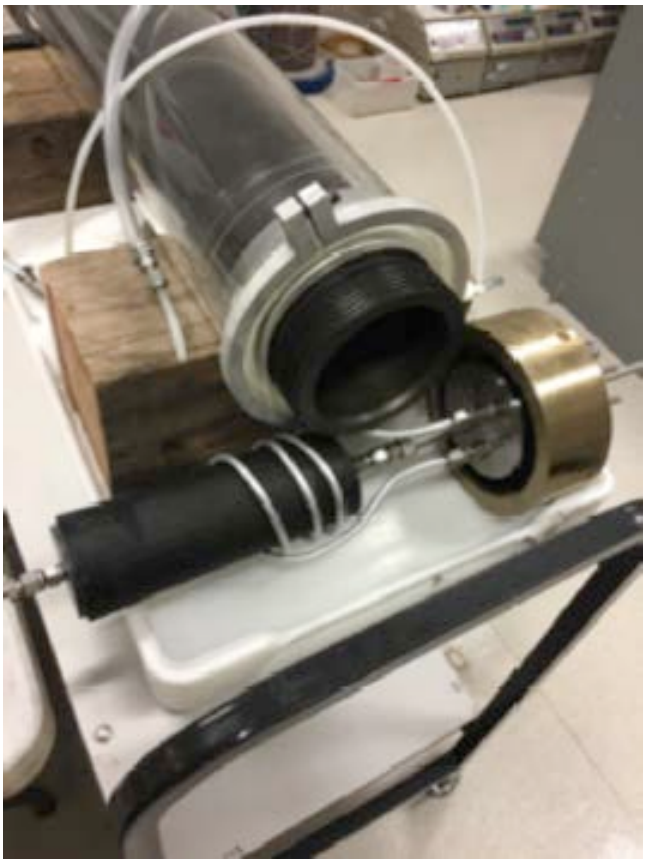

Figure 2. X-ray transparent internal heating coil.

Focus next quarter: Improve thermal gradients in new vessel while observing hydrate formation/dissociation.

Task 13. Continued Studies of Hydrate-Bearing Layered Systems

This task was put on hold until the new vessel was fitted out and will be initiated in Q1. Some of the materials needed have been obtained for use in the tests.

Status: Initiated but incomplete. Discussions with modelers will improve experiment direction.

Focus next quarter: Initiate hydrate tests in the new vessel.

Task 14. Continued Computational Rock Mechanics

Status: Initiated but incomplete. No change from Q3.

Focus next quarter: Diversify pool of researchers available to perform task and run simulations on permeability while reexamining geomechanical behavior.

Task 15. Experimental work in response to current challenges

Accomplishments: Participation in overseeing the hydrate geomechanics code comparision study.

Focus next quarter: Continue focus on layered systems. Future focus on varying brine composition in layered and non-layered systems. Continued participation in managing code comparison study.

Task 16. Continued investigation of layered systems

Accomplishments: Although some preliminary work on layered systems with approximately a factor of 10 difference in particle sized has been performed, more work in needed in developing consistent and controllable thermal gradients (Task 11)

Focus next quarter: Hydrate tests to begin.

Task 17. Comparison of the effect of vertical and horizontal wells for gas production in a layered hydrate-bearing system

Layered systems have been studied both with and without hydrate formation. Although proposed the outlet designated to be 1/8", experiments demonstrated that the sand was easily plugging up this tubing so the simulated well diameter was increased to a ¼ inch OD, 0.18 inch ID tubing which when not plugged to restrict flow, allowed for movement of sand from the sample. Results show that sand production is most evident in systems where there is fluid (water) flow, rather than in experiments when only the effective stressed was increased. The simulated well was located either at the endcap of the sample or midway up the sample. Currently only horizontal positioning has been completed.

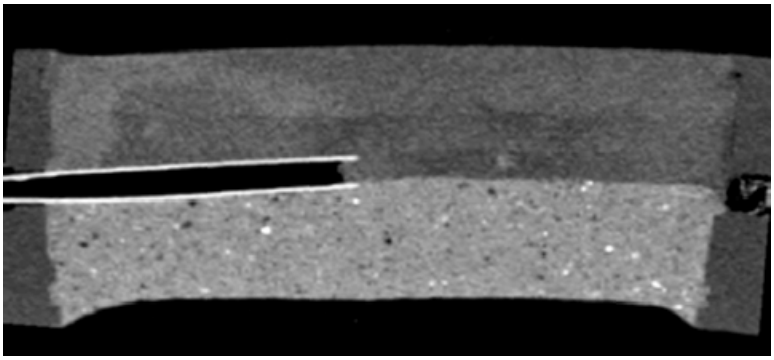

Figure 3. CT image showing location of simulated borehole in a layered sample. The top layer is a packed sand, and the bottom is a mixture of silt and clay.

Focus next quarter: Experiments are expected to begin in FY18Q2.

Milestone Table

Milestone Title	Milestone Description	Planned Completion Date	Actual Completion Date	Status / Results
Report on Layered Hydrate	A report describing the data collected in our first layered hydrate test will be submitted.	January 31, 2015 Delayed – expected by September 30, 2015	Included with quarterly update 5/05/16	Complete
Go/NoGo on vessel	A brief letter report will be submitted following Task 10a to inform the DOE of the go/no go decision on vessel remanufacture. (Tasks 10).	September 30, 2015	Informally contained in update 11/16	Complete
Topical Report	A report documenting the results of laboratory tests examining the effects of thermal gradients and gradient oscillation on hydrate behavior will be submitted. (Task11)	March 31, 2016	Delayed	Will resume in new vessel in Q4
Topical Report	A report documenting the results of laboratory tests investigating the gas hydrate equilibrium point versus the gas production rate will be submitted. (Task 12)	June 30, 2016	June 30, 2016	Laboratory work complete and powerpoint presentation assembled. Letter report in preparation.
Topical Report	A report documenting the results of laboratory tests on layered systems.	July 31, 2017	Delayed	Work will resume in Q4
Grain-scale Computation of Hydrate-Bearing Sand Properties Based on microCT Sample Description	A report documenting the results of numerical simulations on multigrain scale flow and mechanical simulations.	May 31, 2017	Delayed, data fields generated and shared with NETL	Simulations will resume in Q4
Topical Report	A report documenting the results of current challenge laboratory tests and their interpretation.	July 31, 2017	Delayed	Experimental work will resume in Q4 with new vessel

Topical Report	A report adding to the observations on layered systems	January 31, 2018	March 31, 2018	Work is under way in a number of projects to support this.
Topical Report	An experiment report documenting the results of gas production from laboratory-simulated vertical and horizontal wells.	July 31, 2018		
Conference Papers/ Proceedings/ Articles	Documents include conference papers, proceedings, presentations, journal articles, and press releases.	Minimum of 7 business days prior to submission		

PRODUCTS:

None to report this quarter.

CHANGES/PROBLEMS:
We are integrating a new student, Bin Wang, into our laboratory group. In addition to Bin, Chun Chang, a post-doctoral researcher with experience in controlled pressure/temperature core flood work is providing assistance to broaden his experience.

SPECIAL REPORTING REQUIREMENTS:

NA
BUDGETARY INFORMATION:

BP6 = July 2017 - June 2018	Actual Cost (this quarter)	Actual Cost (cumulative for BP)	Funds available (for the BP)	Balance of unspent funds (for the BP)	Actual Cost (cumulative for the full FWP)	Funds available (for the full FWP)	Balance of unspent funds (for the full FWP)
Jul-Sep 2017	$29,402	$29,402	$125,000	$95,598	$457,399	$685,000	$227,601
Oct-Dec 2017	$43,189	$72,591		$23,007	$500,588		$184,412

*This chart does NOT include Jan 2018 costs

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