Oil & Natural Gas Technology

DOE Award No.: DE-FC26-06NT42666

Quarterly Progress Report
(July – September 2007)

Comparative Assessment of Advanced Gas Hydrate Production Methods

Submitted by:
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Prepared for:
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National Energy Technology Laboratory

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Award No. DE-FC26-05NT42666
Battelle Pacific Northwest Division

Gas Hydrates Assessment
B. Peter McGrail, Principal Investigator

Quarterly Report – Q4 (FY2007)

Executive Summary

This project will compare and contrast, through numerical simulation, conventional and innovative approaches to producing methane from gas hydrate-bearing geologic reservoirs. Initially, the project will investigate the production of gas hydrates from idealized reservoir configurations. If the initial investigation shows promise for the innovative approaches, additional simulation studies will be conducted using actual gas hydrate reservoir data from the Alaska North Slope (ANS) region. Work this quarter focused on establishing a subcontract with the University of Alaska and in conducting additional production simulations in preparation for a Merit Review meeting.

Results of Work During Reporting Period

Phase I

Task 1: Project Management

A subcontract proposal was prepared and sent to the University of Alaska – Fairbanks to conduct their planned experimental work under Task 3. Battelle contracts is awaiting a response from the University before the subcontract can be issued.

A revision to the Research Management Plan will be issued next quarter to reflect changes in spending plan and schedule.

Task 2: Technology Status Assessment

This task was completed in the third quarter of this year with the submission of the summary report.

Task 3: Basic reservoir Simulation

The STOMP-HYD simulator was applied to a series of one- and two-dimensional simulations that investigated the production of CH_4 hydrates in geologic media using CO_2 injection. The petrophysical parameters for the simulations were based on those determined from the MDT flow and recovery tests in the C Unit of the Mount Elbert Well and the subsequent simulations of those experiments using STOMP-HYD. These simulations results were reported at the NETL Merit Review meeting in Golden, Colorado in September, 2007. Effectively there are two approaches to producing CH_4 hydrate in geologic media using CO_2 injection: 1) hydrate dissociation and reformation, and 2) direct molecular exchange. In the hydrate dissociation and reformation approach, the injected CO_2 first dissociates CH_4 hydrate. This stage is followed by reformation of a mixed gas hydrate, which is predominately comprises

CO_2. In the direct molecular exchange approach, the injected CO_2 exchanges with the CH_4 in the hydrate structure, maintaining the hydrate integrity. The dissociation-reformation approach has the advantage of releasing CH_4 in both the small and large cages. In the direct-exchange approach only the CH_4 in the large cages is released. Co-injection of CO_2 and N_2 has been shown to allow molecular exchange of CH_4 in both the small and large cages. Because the STOMP-HYD simulator does not track small- and large-cage occupancies, it is not currently capable of limiting CO_2 exchange with CH_4 to large cages. The principal conclusion from this series of simulations was that both CO_2 exchange approaches yielded faster production times, but lower CH_4 recoveries over pure water injections. Without consideration of the cage occupancies, the direct-exchange yielded faster production times over the dissociation-reformation approach, with nearly equivalent CH_4 recoveries. CO_2 to water ratios in the injectant primarily affected production rates, with higher ratios yielding faster productions.

A contract between Battelle and the Korea Institute for Geoscience and Mineral Resources (KIGAM) was completed. That work principally involves the application and verification of the STOMP-HYD simulator to a CH_4 hydrate production experiment, using the direct-exchange approach. A full verification of the simulator will not be possible as the production experiments conducted at KIGAM involved co-injection of CO_2 and N_2. This work was initiated with a visit to the laboratory by Dr. Won Suk Lee from KIGAM. During this visit, Dr. Lee worked with the STOMP-HYD simulator and provided Battelle with data from the exchange experiments. In working with the simulator on these experiments, a new primary variable switching scheme was developed that uses hydrate saturation as a principal unknown. The KIGAM contract is supporting the investigation of this new scheme for its computational efficiency.

<u>Task 4: Reservoir Simulation with ANS Field Data</u>

This task is not scheduled to start until Task 3 scope has been completed.

Significant Issues and Corrective Action

None.

Conference Presentations

An abstract was submitted for acceptance in an upcoming conference:

White, M.D., and B.P. McGrail. 2008. "Numerical Simulation of Methane Hydrate Production from Geologic Formations via Carbon Dioxide Injection," Paper Proposal for the Special Session on Gas Production From Hydrates for the 2008 Offshore Technology Conference.

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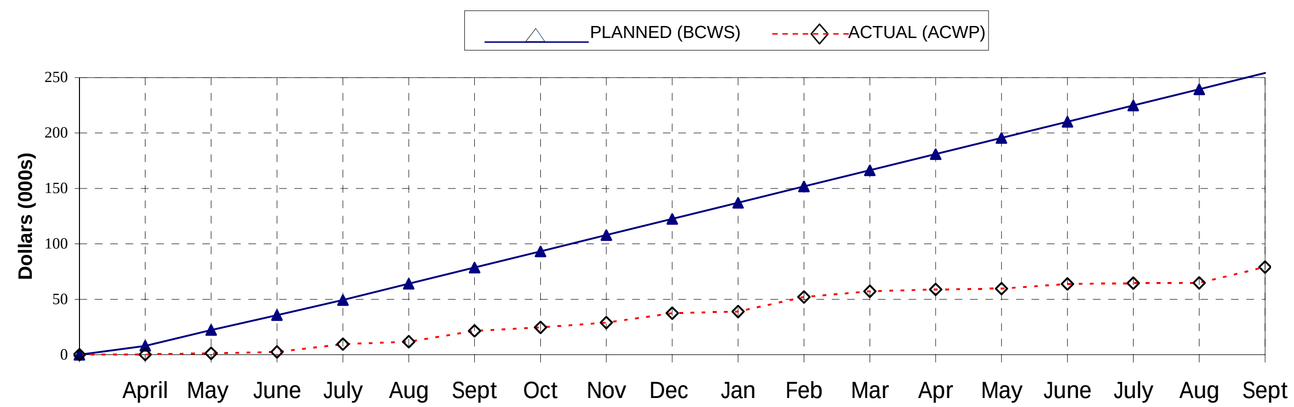
Planned and Actual Cumulative Spending Curve **July-Sept 2007**

(DOLLARS IN THOUSANDS)



($K)	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	FY07
Planned Cost	7.97	14.33	13.37	13.70	14.64	14.64	14.60	14.60	14.64	14.60	14.64	14.60	14.60	14.60	14.64	14.64	14.64	14.64	254.1
Actual Cost by Month	0.2	1.1	1.2	7.1	2.2	9.7	3.2	4.3	8.5	1.4	13.2	5.1	1.7	0.7	4.2	0.7	0.2	14.3	79.0
Variance Cost	7.8	13.2	12.2	6.6	12.4	4.9	11.4	10.3	6.1	13.2	1.4	9.5	12.9	13.9	10.4	13.9	14.4	0.3	
Cumulative Planned	8.0	22.3	35.7	49.4	64.0	78.7	93.3	107.9	122.5	137.1	151.7	166.3	180.9	195.5	210.2	224.8	239.5	254.1	
Cumulative Actual	0.2	1.3	2.5	9.6	11.8	21.5	24.7	29.0	37.5	38.9	52.1	57.2	58.9	59.6	63.8	64.5	64.7	79.0	
Cumulative Variance	7.8	21.0	33.2	39.8	52.2	57.2	68.6	78.9	85.0	98.2	99.6	109.1	122.0	135.9	146.4	160.3	174.7	175.1	

MILESTONES	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	FY07
Task 1. Prepare a Research Development Plan					☆														
Task 2. Prepare a technology Status Assessment											☆								
Project Kickoff Meeting				☆															
Complete Research Management Plann						☆													
Quarterly Reports			☆			☆			☆			☆			☆				

LEGEND

SCHEDULED △ DEVIATION COMPLETED ☆

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