Oil & Natural Gas Technology

DOE Award No.: DE-FC26-06NT42666

Quarterly Progress Report
(April – June 2008)

Comparative Assessment of Advanced Gas Hydrate Production Methods

Submitted by:
Battelle Pacific Northwest Division
Richland , WA

Prepared for:
United States Department of Energy
National Energy Technology Laboratory

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Office of Fossil Energy

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

Gas Hydrates Assessment
B. Peter McGrail, Principal Investigator

Quarterly Report – Q3 (FY2008)

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.

Results of Work During Reporting Period

Phase I

Task 1: Project Management

Battelle was advised of a project review scheduled to be held in Morgantown on August 25, 2008. Arrangements have been made for at least one task leader to attend and represent the project.

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

Hydrate production simulations generally involve complex phase appearances, disappearances and transitions. Because of the lengthy compute times involved in solving large multidimensional domains with injection of CO2 and CO2-water mixtures for gas hydrate production, work this quarter mainly focused on focused on techniques to make these computations more numerically efficient, through the development of innovative solution schemes and algorithms. Three distinct kernels of the simulator were written and tested for computational efficiency. The most efficient kernel is now being implemented in the latest version of STOMP-HYD. These improvements have greatly decreased simulation times for production-type problems, using both conventional and the CO_2 exchange processes, but the numerical simulation of hydrate production problems remains numerically challenging. Besides developing new solution approaches and algorithms, an alternative for reducing simulation times for production problems is executing on parallel computers. There are several alternatives for converting a simulator from sequential to parallel form (parallelization). For STOMP-HYD, parallelization will be through the use of a PNNL developed toolkit called Global Arrays (GA).

Implementing GA into STOMP-HYD was initiated, with the bulk of the work going to implementing the parallel linear system solver toolkit, PETSc, developed at Argonne National Laboratory. During the next quarter, the GA function calls will be incorporated into the simulator in a structured fashion that will allow component-wise parallelization of STOMP-HYD. The parallelization work will be first targeted at the linear-systemsolver first, the Jacobian matrix assembly second, the flux calculations third, the field property calculations forth.

Task 4: Reservoir Simulation with ANS Field Data

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

**Significant Issues and Corrective Action**

None.

Publications and Presentations

The paper OTC 19458, "Numerical Simulation of Methane Hydrate Production from Geologic Formations via Carbon Dioxide Injection," by M. D. White and B. P. McGrail was presented at the OTC 2008 Conference in Houston, Texas.

References

48984 Gas Hydrates Assessment
Planned and Actual Cumulative Spending Curve   Apr-June 2008
(DOLLARS IN THOUSANDS)
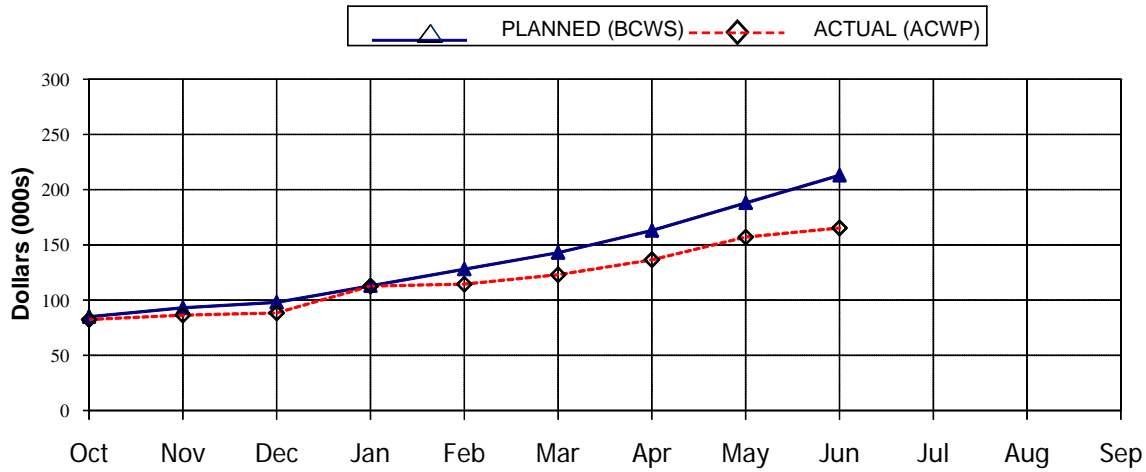
($K)	FY07 TD	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	FY08
Planned Cost	80.00	5.00	8.00	5.00	15.00	15.00	15.00	20.00	25.00	25.00	25.00	25.00	30.00	293.0
Actual Cost by Month	79.1	3.3	4.0	2.0	24.2	1.8	8.5	13.6	20.5	8.3	0.0	0.0	0.0	165.3
Variance Cost	0.9	1.7	4.0	3.0	-9.2	13.2	6.5	6.4	4.5	16.7	0.0	0.0	0.0	
Cumulative Planned	80.0	85.0	93.0	98.0	113.0	128.0	143.0	163.0	188.0	213.0	238.0	263.0	293.0	
Cumulative Actual	79.1	82.4	86.4	88.4	112.6	114.4	122.9	136.5	157.0	165.3	0.0	0.0	0.0	
Cumulative Variance	0.9	2.6	6.6	9.6	0.4	13.6	20.1	26.5	31.0	47.7	0.0	0.0	0.0	

MILESTONES		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	FY08
Complete Task 3 Simulations													△	
Quarterly Reports			☆				☆			☆				

LEGEND

SCHEDULED △   DEVIATION ▭   COMPLETED ☆

TIME LINE —   ELIMINATED BY REDUCTION ◌

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