

Project Title: Kinetic Parameters for the Exchange of Hydrate Formers

Award Number: 65213

Submitting Official: Mark D. White, Research Engineer, PNNL

Project Period: Begin: 07/01/2013 End: open

Reporting Period: Begin: 01/01/2014 End: 03/31/2014

Report Term: Quarterly

Executive Summary

Through the funding support of the U.S. Department of Energy under this Field Work Proposal the Pacific Northwest National Laboratory (PNNL) will investigate numerically and experimentally an unconventional technology for producing geologic accumulations of natural gas hydrates. The guest-molecule-exchange technology involves replacing methane molecules with the clathrate structure with alternative guest molecules, such as carbon dioxide and nitrogen. The alternative guest molecules are selected to maintain the original hydrate structure and be thermodynamically preferred under the reservoir temperature and pressure conditions. The numerical component of the proposed work will investigate the Iñik Sikumi Gas Hydrate Field Trial, a collaborative project conducted by the U.S. DOE National Energy Technology Laboratory, ConocoPhillips, and the Japan Oil, Gas, and Metals National Corporation on the Alaska North Slope. The experimental component of the proposed research will provide supporting kinetic exchange data, needed by the numerical simulations. Both the numerical and experimental elements are preliminary investigations due to the limited scope of the proposed work.

Goals and Objectives

This project will investigate the kinetics of exchanging CO₂ and N₂ with clathrated CH₄ in hydrate bearing geologic media. The project comprises two distinct components: 1) numerical investigation of the 2012 Iñik Sikumi gas hydrate field trial, and 2) experimental investigation of kinetic exchange processes in laboratory-scale hydrate bearing unconsolidated sands. The principal objective of the numerical component will be to provide an interpretation of the data gathered at Iñik Sikumi Well #1. The experiment component of this project is designed to provide kinetic exchange parameters needed in the numerical simulation. The principal objective of the two experiments is to provide an order of magnitude value to the kinetic exchange parameters for the field-scale simulations of the Iñik Sikumi gas hydrate field trial.

Technical Highlights, Results and Discussion

This project comprises three distinct tasks; one numerical simulation and two experimental.

Ignik Sikumi History Match

The paper for the 2014 Offshore Technology Conference, entitled “Guest Molecule Exchange Kinetics for the 2012 Ignik Sikumi Gas Hydrate Field Trial,” was completed and submitted. Contributions to the paper for the International Conference on Gas Hydrates (ICGH8-2014) to be held in Beijing, China, 28 July – 1 August, 2014, entitled “Review of the findings of the Ignik Sikumi CO₂-CH₄ gas hydrate exchange field trial,” was submitted to Brian Anderson at West Virginia University. Both of these papers document the simulations conducted under this project with the STOMP-HYDT-KE simulator on the Ignik Sikumi #1 Field Trial.

CH₄-CO₂-N₂ Exchange Study

There is no progress to report, as work on the project was delayed until we learn whether supplemental funding will be granted in FY2014 for this study.

Pressurized X-Ray Diffraction Study

There is no progress to report, as work on the project was delayed until we learn whether supplemental funding will be granted in FY2014 for this study.

Risk Analysis

As both the numerical and experimental work on the project was delayed to the start of FY14, the risks associated with this project are those described in the Project Management Plan.

Schedule/Milestone Status

Ignik Sikumi History Match

Title: Review Archived Data

This milestone was completed in preparing for the numerical simulations of the Ignik Sikumi #1 Field Trial. This work is documented in the OTC 2014 paper (White and Lee, 2014).

Title: Simulate Ignik Sikumi Field Trial

This milestone was completed in conducting the numerical simulations of the Ignik Sikumi #1 Field Trial. This work is documented in the OTC 2014 paper (White and Lee, 2014).

Title: Compare Simulation Results

This milestone was completed in writing the contribution to the ICGH8-2014 paper with Brian Anderson (Anderson et al., 2014).

Title: Report Interpretations

This milestone was completed by writing two papers documenting the comparison of the STOMP-HYDT-KE simulations against the field observations from the Ignik Sikumi #1 Field Trial (White and Lee, 2014; Anderson et al., 2014).

Cost Status

This quarter concluded with a cost variance of about \$32.5k, mostly due to project staff being occupied with other project work. The cost status spreadsheet is shown on the following page.

Conclusion

The start of this project was delayed to allow for completion of other FY13 projects, giving researchers a block of time to start the project.

References

White, M.D. and W.S. Lee. 2014. "Guest molecule exchange kinetics for the 2012 Ignik Sikumi Gas Hydrate Field Trial," *Proceedings of the Offshore Technology Conference held in Houston, Texas, USA, 5-8 May 2014, OTC-25374-MS*.

Anderson, B., R. Boswell, T. S. Collett, H. Farrell, S. Ohtsuka, and M. White. 2014. "Review of the findings of the Ignik Sikumi CO₂-CH₄ gas hydrate exchange field trial," *Proceedings of the 8th International Conference on Gas Hydrates (ICGH8-2014), Beijing, China, 28 July - 1 August, 2014*.

Baseline Reporting Quarter		FY2013 Start: 10/01/2012 End: 09/30/2013				FY2014 Start: 10/01/2013 End: 09/30/2014			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Baseline Cost Plan									
Federal Share	Task 1.0				\$1,250	\$1,250	\$1,250	\$1,250	\$1,250
	Task 2.0				\$11,250	\$11,250	\$11,250	\$11,250	\$11,250
	Task 3.0				\$10,000	\$10,000	\$0	\$0	\$0
	Task 4.0				\$10,000	\$10,000	\$0	\$0	\$0
Non-Federal Share									
Total Planned Cost (Federal and Non-Federal)					\$32,500	\$32,500	\$12,500	\$12,500	\$12,500
Cumulative Planned Cost					\$32,500	\$65,000	\$77,500	\$90,000	\$90,000
Actual Incurred Costs									
Federal Share	Task 1.0				\$0	\$0	\$0	\$0	\$0
	Task 2.0				\$0	\$21,876	\$19,014	\$19,014	\$19,014
	Task 3.0				\$0	\$418	\$2,925	\$2,925	\$2,925
	Task 4.0				\$0	\$0	\$0	\$0	\$0
Non-Federal Share									
Total Actual Cost (Federal and Non-Federal)					\$0	\$22,294	\$21,939	\$21,939	\$21,939
Cumulative Actual Cost					\$0	\$22,294	\$44,233	\$44,233	\$44,233
Variance									
Federal Share	Task 1.0				\$1,250	\$1,250	\$1,250	\$1,250	\$1,250
	Task 2.0				\$11,250	(\$10,626)	(\$7,764)	(\$7,764)	(\$7,764)
	Task 3.0				\$10,000	\$9,582	(\$2,925)	(\$2,925)	(\$2,925)
	Task 4.0				\$10,000	\$10,000	\$0	\$0	\$0
Non-Federal Share					\$0	\$0	\$0	\$0	\$0
Total Cost Variance (Federal and Non-Federal)					\$32,500	\$10,206	(\$9,439)	(\$9,439)	(\$9,439)
Cumulative Cost Variance					\$32,500	\$42,706	\$33,267	\$33,267	\$33,267

Task	Milestone Description	FY2013 Start: 10/1/2012 End: 09/30/2013				FY2014 Start: 10/01/2013 End: 09/30/2014				Actual End Date	Comments	
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
Task 2	Review archived data									7/1/13	10/28/13	
Task 2	Simulate Igmik Sikumi field trial									10/1/13	12/31/13	
Task 2	Compare simulation results									1/1/14	3/31/14	
Task 2	Report interpretations									4/1/14	6/30/14	
Task 3	Conduct Kinetic Exchange Exp.									10/1/13	12/31/13	
Task 4	Conduct Hydrate Structure Exp.									10/1/13	12/31/13	