Oil & Natural Gas Technology

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Quarterly Progress Report
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Comparative Assessment of Advanced Gas Hydrate Production Methods

Submitted by:
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Gas Hydrates Assessment
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Quarterly Report – Q1 (FY2009)

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

Project management activities were minimal during the quarter consisting of tracking technical progress and spending, and quarterly reporting.

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: Reservoir Simulation

Work is in progress conducting numerical simulations of gas hydrate production using CO_2 injection for the four classes of natural gas hydrate accumulations:

- Class 1 - Hydrate bearing zone above a free-gas (mobile-gas) zone within a permeable formation, where the lower hydrate stability boundary occurs at the hydrate-gas boundary and the upper hydrate stability boundary occurs above the permeable formation;
- Class 2 - Hydrate bearing zone overlying a free-aqueous (mobile-aqueous) zone within a permeable formation;
- Class 3 - Hydrate bearing zone occupying the entire permeable formation, thus without either a free-gas or -aqueous (mobile-gas or -aqueous) zone;
- Class 4 - Disperse, low saturation accumulations of gas hydrates without confining overburden and underburden strata (e.g., suboceanic deposits).

During the first quarter of FY2009, a series of simulations was completed that investigated the production of natural gas hydrates, using CO_2 injection, from a Class 1 gas hydrate

accumulation. Results from this preliminary investigation were published[1] at the GHGT-9 conference in Washington, D.C. Whereas, these simulations investigated injecting CO_2 in several forms (i.e., pure CO_2, micro-emulsions, and dissolved CO_2), the simulation suite was not complete. One critical finding from this investigation has been that the formation of secondary CO_2 hydrate has the potential to halt the production process by inhibiting fluid migration. Laboratory experiments conducted by ConocoPhillips have suggested that complete exchange of CO_2 and CH_4 is possible without forming excessive secondary hydrate and while maintaining elevated hydrate saturations. To explore the differences between the numerical simulation results and the experimental observations of ConocoPhillips, a scientific team from ConocoPhillips visited Battelle during the first quarter of FY2009. The key finding from this meeting was that pore-water salinity may play a strong role in the inhibition of secondary hydrate formation beyond certain saturation levels, which agree with recently published experimental results (McGrail et al. 2007). To complete the Class 1 investigations, a suite of 216 simulations is being conducted for the upcoming Mount Elbert special edition to be published in the *Journal of Marine and Petroleum Geology*. The objective of this paper will be to describe a suite of production simulations that consider a matrix of production options:

- 3 depressurization pressures (4 MPa, 6MPa, 8MPa)
- 2 depressurization periods (6 months, 12 months)
- 2 injection scenarios (full screen, partial screen)
- 3 injection pressures (+2MPa, +4MPa, +6MPa)
- 2 injection temperature (20°C, 50°C)
- 3 injection forms (pure CO_2, 50% volume micro-emulsion, dissolved CO_2)

and to report on both the pitfalls and advantageous of injecting CO_2.

Significant Issues and Corrective Action

None.

Publications and Presentations

White, M.D. and B.P. McGrail. 2008. "Designing a pilot-scale experiment for the production of natural gas hydrates and sequestration of CO_2 in Class 1 hydrate accumulations," Presented at the 9th International Greenhouse Gas Control Technologies Conference, November 18, 2008, Washington, D.C.

References

McGrail BP, S Ahmed, HT Schaef, AT Owen, PF Martin, and T Zhu. 2007. "Gas Hydrate Property Measurements in Porous Sediments with Resonant Ultrasound Spectroscopy." *Journal of Geophysical Research - Solid Earth* **112(B05202)**.

[1] White M. D, and B. P. McGrail. 2008. "Designing a Pilot-Scale Experiment for the Production of Natural Gas Hydrates and Sequestration of CO2 in Class 1 Hydrate Accumulations." In Proceedings of the 9th International Conference on Greenhouse Gas Control Technologies. PNWD-SA-8374, Battelle—Pacific Northwest Division, Richland, WA.

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