Gas Hydrate Field Experiments on the Alaska North Slope: Project Status

Ray Boswell on behalf of ANS Gas Hydrate Project R&D Committee

Methane Hydrate Federal Advisory Committee Meeting

December 1, 2020













Background



Effort to Establish an Alaska North Slope Reservoir Response Field Experiment



- Prior gas hydrate testing has confirmed the technical viability of production based on reservoir depressurization
- Insufficient test duration and quantity complicate assessment of fundamental processes.... Or well designs and testing strategies to determine commercial potential
- ANS greater PBU region provides the most viable known location for the needed long-term scientific testing.
 - Known accumulations, available infrastructure, a history of effective R&D field projects in partnership with Alaska industry and agencies (2007, 2011, 2018)
- Objectives of current ANS initiative are to establish a project that can
 - 1) assess reservoir response beyond near-wellbore and transient phenomena,
 - 2) evaluate effective well design and operational procedures to support sustained productivity, and
 - 3) use 1 and 2 to design subsequent tests intended to test potential for commercial viability.

Review of geology: western PBU

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SE

NW





PBU 7-11-12 location





- Working Interest Owners agreed to consider a test that could be conducted with no interference to ongoing operations
- 7-11-12 gravel pad selected based on limited log data and proprietary seismic data provided by PBU
- Stratigraphic Test Well (Dec. 2018) confirmed viable test location
- Effort ongoing to determine legal structure for desired 3rd-Party operations from the site
- Detailed planning underway in advance of initial engagement with Operator



STW





Hydrate-01 Well House





STW Reporting







three-well program designed to conduct an extended duration test of the response of gas hydrate reservoirs to controlled depressurization. Micro-CT Visualization of Hydrate ring Sediments to Aid I

Efforts

Reported: STW Sidewall Core Analysis



Measured at AIST, Sapporo Japan





Project Context



Statement of Intent (6/2008)



AIST

Memorandum of Understanding (4/2013)



PHASE 1 (Completed): Stratigraphic Test Well

Memorandum of Understanding (11/2014) CRADA (12/2018)



JOGMEC









Drilling Services Agreement with BPXA







Project Structure

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Jointly managed and jointly (but separately) funded





Reservoir Response Issues



In addition to an accurate assessment of the starting condition

- Sustainability and values for production rates over time (water and gas)
- Geomechanics and dynamic petrophysics (reduction in K with grain mobilization and consolidation)
- Interaction with reservoir across all boundaries (heat transfer, water influx, gas loss?)





Well Completion Design Issues



In addition to determining most effective production strategy

- 1. Sand Control
- 2. Reservoir subsidence related casing stresses
- 3. Hydraulic isolation (to maximize ability to depressurize reservoir)
- Flow Assurance (all times – particularly during shutins)

Cement Water Heat Grains 330000000000 Water Fi Gas Heat Water Water 3 Gas hydrate Sand Clay Silt

Very generic well completion and reservoir condition



Specific Data Acquisition Objectives



Science

Full characterization of GH systems → Physical Properties, Geomechanics, Petrophysics

- Sidewall pressure coring (STW)
- Whole core pressure coring (GDW)
- Full suite LWD (all wells) and wireline logs (GDW and as needed)

Observation of controlled perturbation \rightarrow Dynamic Geomechanics, Petrophysics, Heat Flow

- Fiber-optic Strain, Acoustic, and Temperature Monitoring
- Pressure and Temperature monitoring (gauges)
- Monitoring inside (PTW) and outside (PTW, STW, GDW) casing

Time Series VSP via DAS \rightarrow Reservoir System Response

Technology

Assessment of mitigations to emergent production challenges (heat flow, permeability, geomechanics)

- Sand control/completion/stimulation/shut-in
- Artificial lift; Hydraulic isolation

Improved evaluation/prediction of productivity and potential

• Numerical simulation (needed validation/calibration datasets)







Examples of tools under consideration



Current Testing Plan



Addition to the plan of a second PTW to mitigate risk/expand test flexibility





Draft GDW Coring Plan





Display is MD from STW. NOTE: GDW with slightly less inclination could result in slightly compressed apparent unit thicknesses. Color bars are nominal <u>11'</u> HPTC-III core runs.

GDW: On Site Pressure Core Processing







PTWs Facilities Plan



Recommendations prior to engagement with Operator



• Drilling Support

- Accurate metering of low/variable flow rates
- OBM handling, Mud Chilling, other standard drilling support.
- Mud logging, geochemistry, pressure core handling, sensor interfaces, etc.
- Well intervention including injectant storage and use

• Solids disposal

• Trucking to PBU grind and inject facilities

• Water handling and disposal

- Planning targets \rightarrow 3000 bbl/d
- On site temporary storage
- Trucking to PBU water injection facilities
- On-site evaporation

• Gas disposal

- On site consumption
- Emergency flaring



Modeling: NETL/JOGMEC



Code Comparison - Constraint on max gas and water rates to guide surface facility design





PTWs Technical Plans





- <u>Highest priority</u>: safety; reg. compliance; no disturbance to PBU Ops
 - Water/Sand: local storage w/ sufficient excess. Trucking and disposal in unit facilities
 - Gas: local consumption
- Focus: data interpretability step-wise and controlled depressurization
 - Single driving force 2 MPa steps
- Focus: monitoring reservoir response
 - Periodic VSPs to assess system response (geometry/scale)
 - DTS/DSS/DAS and P-gauges in 3 wells to monitor dissociation reaction and impacts in 4D, with additional DTS/DAS deployment in a 4th well.....
- Focus: well design & survivability
 - Artificial lift: robust, viable across expected flow range
 - Flow assurance; pre-staged intervention: downhole heater, heat trace, chemical injection lines
 - Completion to optimize sand control/hydraulic isolation
 - Staged shut-in and restart procedures
- NOTE: all plans developed to-date by JOGMEC, USGS, DOE ... will be reviewed/revised with TPO and PBU WIOs once testing program is authorized to proceed and TPO selected



PTWs Intervention Plan

Ongoing

Flow Assurance: Shut-in & remediate

Gas Rate (low, declining, erratic, persistently flat)

- Hydrate formation \rightarrow P drop and monitor
- Ice formation \rightarrow P drop and monitor: hot methanol
- Sand/fines blockage \rightarrow P cycling: acid?: re-perf
- Gas-Water block \rightarrow P cycling
- Reservoir Limitation \rightarrow stimulation... TBD
- Equipment failure \rightarrow shut in and repair

Excessive Sand (robust systems; cleanout options)

• Systems failure \rightarrow patience, move to D

Excessive Water (ensure adequate onsite storage)

• Reservoir \rightarrow P drop; P cycling, move to D





Next Project Phase: Status



As of December, 2020



- STW confirmed site feasibility: Steering Committee approval to advance to next project phase obtained.
- PBU and DNR have reconfirmed interest in exploring a viable project structure under previous "standalone/3rd-party" framework and continue effort to gain alignment on project structure.
- **Context**: Oil price decline. Complications over PBU asset sale (finalized in June 2020). New PBU Operator in place. New proposed SOA tax initiative. COVID-related impacts.
- Issues: project design should minimize interference with PBU operations, PBU administrative burdens (during operations and acreage return to the unit), long-term liabilities, and unwanted precedents.
- Project schedule continues to visualize drilling/data acq. in CY2021, followed by testing operations, with project close-out by end of Q1 CY2023.



Ongoing Planning





- JOGMEC RFP designed to secure an experienced Operator capable of conducting the field program has been issued and closed
- Viable proposals received and now in consideration
- NETL will proceed to develop separate contract with separate scope and budget once JOGMEC negotiations are completed.
- Final resolution of leasing structure (agreement between PBU and Alaska DNR) TBD.
- Comprehensive Program Plan in Preparation
 - Purpose is to facilitate discussion with selected Operator
 - Statement of Data Requirements to achieve Science Objectives
 - Review of Operational Recommendations (based on lessons learned in prior tests within both the Japan and US programs).



THANK YOU

