An Integrated Framework for Treatment and Management of CBM Produced Water

Jörg E. Drewes, Tzahi Cath, Pei Xu, Nathan Hancock, Katharine Dahm, Katie Guerra, Xanthe Mayer, Andrew Wait, and Dean Heil
Colorado School of Mines
Jim Graydon, Jean Debroux, Dawn Taffler
Kennedy/Jenks Consultants
John Veit, Seth Snyder, Bob Sullivan, YuPo Lin
Argonne National Laboratory
Bob Raucher and Jim Henderson, Stratus Consulting
Wayne Buschmann, Eltron Research

17th International Petroleum and Biofuels Environmental Conference (IPEC)
San Antonio, TX, September 1st, 2010

Outline
► Current practices and challenges associated with management and beneficial use of produced water
► Opportunities and technical challenges
► Guidance needed for beneficial use
► An integrated framework approach to facilitate beneficial use
► Concluding remarks
Coal Bed Methane (CBM) Produced Water: The Options…

- Reinjection Well
- Natural Gas Pipeline
- Surface Discharge
- Treatment for Beneficial Reuse

CBM Proved Reserves (BCF) By Basin

Source: DOE/NETL (M. Chan, July 2002)

Source: EIA 2006
Produced Water Quality: Salt Composition

Benko and Drewes (2008), Env. Eng. Science 25, 2, 239

Produced Water Quality

- Salt tolerant crops
- Drinking water
- Salt sensitive crops
- Livestock

Benko and Drewes (2008), Env. Eng. Science 25, 2, 239
Produced Water Quantity by Basin

Potential Statewide Water Production from CBM Basins
- 0 - 5,000
- 5,000 - 10,000
- 10,000 - 20,000
- 20,000 - 50,000 (figures in billion gallons)

Produced Water: Potential Utilization

Natural Gas

Augmentation Water = Water Rights

Livestock & Crop Irrigation

Potable Water Treatment Plant

Domestic Home Use

Produced Water Treatment Plant

CBM
Produced Water as a Water Supply

Reliable Resource

- Drought-proof
- Presently unused
- Non-tributary water not subject to water right limitations

Long Term Supply

- Oil and gas development 30-70 more years
- Water resource could continue to be mined

Challenges for Widespread Beneficial Use

Geographic Challenges

- Long distances between produced water sources and end users
- High cost of water conveyance infrastructure

Gas Market Challenges

- Fluctuating gas prices might deter investments in treatment technology

Regulatory Challenges

- Complex water rights
- Interstate variations in environmental regulations and permits
- Difficult to assess the quantity and scope of mitigation and compensation owed to 3rd parties
- Liability and uncertainties associated with conveyance and end use
- Institutional boundaries between private management of oil and gas resources and public management of water resources
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Project Goal

► Develop an integrated guidance framework that links the composition of produced water to beneficial use applications and identify the most cost-efficient, environmentally sound, and most beneficial strategies for management and treatment of produced water from CBM operations

Project Schedule:
September 2008 - March 2011
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► Industry Advisory Council (IAC):
  • 10 medium- and large-size gas producers
  • Major CBM players in the Rocky Mountain region

► Technical Experts/Advisors:
  • Jeff Cline, Cline Energy Consultants
  • Dave Stewart, Stewart Environmental Consultants

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► Stakeholder Advisory Committee (SAC):
The Integrated Framework

http://aqwathec.mines.edu/produced_water/tools

Water Quality and Quantity

Treatment Selection

Beneficial Use Options

Beneficial Use Economics

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Project Overview

- Task 1 - Classification of Produced Water Qualities and Management Strategies
  - Characterize and classify produced water qualities across different basins/formations: Water Quality Module (WQM)
  - Determine produced water quantities (by basin and resource; gas/water ratios; current disposal/use strategies; etc.)
  - Develop a beneficial use matrix considering natural and engineered conveyance systems, water qualities of beneficial non-potable and potable uses, and quantity and quality of residuals generated
  - Address regulatory requirements among different locations
Produced Water Quality: Powder River

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► Task 2 - Selection and Testing of Treatment Technologies for Produced Water
  • Identification and evaluation of robust, low-maintenance, modular pre-treatment and desalination technologies as well as brine management and disposal strategies (considering both well-established conventional as well as emerging desalination technologies):
    Treatment Technology Assessment Report
  • Explore most appropriate and cost-efficient technologies for treatment of produced water considering water quality of produced water and targeted beneficial use: Treatment Selection Module (TSM)
  • Pilot-scale treatment trains are currently being designed, assembled and tested at laboratory setting and representative production sites for field-scale validation
  • Develop cost modules for management options
Technology Assessment Report

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Task 3 - Assessment of Management Options

- Explore through cost/benefit analyses the multiple conditions that have to be fulfilled in order to establish beneficial use from a technical, regulatory, political, environmental, economic, and legal standpoint:
  - Beneficial Use Screening Module (BSM)

- Develop a structured decision process that identifies, evaluates, and, where possible, quantifies benefits, risks, and costs of each management option:
  - Beneficial Use Economic Module (BEM)
Treatment Selection Module

- WQM Output → TSM Input → User Input → Outputs to User Only
- Costs/Energy → Output to User and BSM → BSM Input
- Draw from Internal Database based on User Input → Find Treatment Trains → Treatment Train Selection Loop

Beneficial Use Screening Module

- WQM Output → TSM Output → BSM Input
- Calculates:
  - BU rankings
  - BU ranges
  - TBL values
- Output to User (BSM Dashboard) → BEM Input
- User Input

BSM Flowchart

BSM Construction Consultants
Engineers + Scientists
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► Task 4 - Field Validation of Viable Treatment Processes for Produced Water
  • Bench/pilot-scale treatment trains were designed, constructed and being tested at representative production site for field-scale validation
  • Data is being analyzed to determine the effectiveness, robustness, and ease of operation of treatment strategies
  • Testing results will provide validation of the integrated decision making framework

Concluding Remarks

► Unconventional natural gas production will increase
► CBM produced water represents significant unconventional freshwater resource for the next 20-70 years
► Treatment, conveyance, and storage are needed
► Water rights and liability are biggest issues
► Third parties might function as water purveyors
► Integrated Framework Tools can assist in facilitating beneficial use
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Acknowledgment

► RPSEA Stakeholder Advisory Committee (SAC) and the Industry Advisory Council (IAC)
► Industry Sponsors
► U.S. Bureau of Reclamation
► RPSEA