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Produced Water Management Options – One Size Does Not Fit All

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Outline of Presentation

- What is produced water?
- Characteristics and statistics
- Options for managing produced water
  - Water minimization
  - Water recycle or reuse
  - Treatment and disposal
    - Removal of salt and inorganics
    - Removal of oil and organics
What Is Produced Water?

- Water that comes to the surface with oil and gas
- Contains many chemical constituents
  - Salt content (salinity, total dissolved solids [TDS], electrical conductivity)
  - Oil and grease
    - Composite of many hydrocarbons and other organic materials
  - Toxicity from various natural inorganic and organic compounds or chemical additives
  - NORM
  - Some oxygen demanding materials
Produced Water Characteristics

- Usually is salty
  - Chlorides vary from <1 to >200,000 mg/l

Source: S. DeAlbuquerque, ConocoPhillips
Produced Water Volume

• Largest volume waste stream from oil and gas production
  – U.S. offshore – >1 billion bbl/year
  – U.S. onshore (more than 850,000 wells)
    • 18 billion bbl/year (1995 API study)
    • 15-20 billion bbl/year

• Ratio of water-to-oil
  – World-wide estimate – 2:1 to 3:1
  – U.S. estimate – 7:1
  – Many older U.S. wells have ratios > 50:1
Produced Water Volume Changes Over Time in a Well and a Field

Conventional oil and gas well

Coal bed methane well
Why Worry About Produced Water?

• The cost of managing large volumes of produced water is a significant factor in the profitability of wells. The total life-cycle cost includes:
  – The cost of constructing treatment and disposal facilities, including equipment acquisitions
  – The cost of operating those facilities, including chemical additives and utilities
  – The cost of managing any residuals or byproducts resulting from the treatment of produced water
  – Permitting, monitoring, and reporting costs
  – Transportation costs

• Improper management can harm the environment
  – Expensive clean up
  – Bad publicity for company
**Basic Separation of Oil, Gas, and Water**

- Free-water knockout tank separates three fluid phases plus solids
- Emulsions
  - Heater-treater
  - Demulsifying chemicals
- Most common practice
  - Onshore – pass through tank battery, then inject
  - Offshore – discharge
Produced Water Management Options

- Follow 3-tier water management/pollution prevention hierarchy
  - Water minimization
  - Recycle/reuse
  - Treatment and disposal
- Use most environmentally friendly option where possible

**Tier 1 - Options for Minimizing Produced Water**

- **Keep produced water from the entering the well**
  - Mechanical blocking devices
  - Water shut off chemicals
- **Keep produced water from reaching the surface**
  - Downhole separation
  - Sea floor separation
Waste Minimization – Keep Produced Water Out of the Well

- Mechanical blocking devices
  - Packers
  - Plugs
  - Cement

- Water shut-off chemicals
  - Polymer gels

Source: Baker Hughes
Waste Minimization – Manage Water without Bringing It to the Surface

- Separate downhole
  - Downhole oil/water separation
  - Downhole gas/water separation
  - Downhole water sink

Source: Baker Hughes

Source: A. Wojtanowicz, Louisiana State University
Waste Minimization – Manage Water without Bringing It to the Surface

- Separate at the sea floor

Source: ABB
Tier 2 - Options for Recycle and Reuse of Produced Water

- Injection for recovering more oil
- Injection for future use
- Injection for hydrological purposes
- Agricultural use
- Industrial use
- Drinking water and other domestic uses
Injection for Recovering More Oil

- **California**
  - Nearly 25,000 produced water injection wells
  - 1.8 billion bbl/year total injection
    - 900 million bbl/year water flood
    - 560 million bbl/year steam flood
    - 360 million bbl/year injection for disposal

- **New Mexico**
  - 5,036 wells permitted for enhanced recovery
    - 350 million bbl/year
  - 903 wells permitted for disposal
    - 190 million bbl/year

- **Texas**
  - 38,540 wells permitted for enhanced recovery
    - 5.3 billion bbl/year
  - 11,988 wells permitted for disposal
    - 1.2 billion bbl/year
Injection for Future Use

- Aquifer storage and recovery

Source: USGS
Injection for Hydrological Purposes

- Subsidence control
- Salt water intrusion
- Flow augmentation
**Agricultural Use**

- Irrigation
- Livestock and wildlife watering
- Managed wetlands
- Microalgae growth as feedstock for biodiesel

Source: USDA

Source: USFWS
Industrial Use

- Use in drilling fluids or hydraulic fracturing fluids
- Cooling water makeup
- Dust control
- Other
Drinking Water and Other Domestic Uses
Tier 3 - Options for Treatment and Disposal of Produced Water

- Practices to dispose of produced water
  - Discharge
  - Injection
  - Evaporation
  - Offsite commercial disposal

- Treatment to remove salt and other inorganics from produced water
- Treatment to remove oil and grease and other organics from produced water
Evaporation

- Evaporation ponds
- Mechanical evaporation
- Freeze-thaw evaporation

Source: BC Technologies Ltd.

Source: U.S. Fish and Wildlife Service

Source: BC Technologies Ltd.
Offsite Commercial Disposal

Offsite Commercial Disposal of Oil and Gas Exploration and Production Waste: Availability, Options, and Costs

Environmental Science Division

http://www.ead.anl.gov/project/dsp_topicdetail.cfm?topicid=18
Tier 3 - Options for Treatment and Disposal of Produced Water

• Practices to dispose of produced water

• Practices to remove salt and other inorganics from produced water
  – Membrane processes
  – Ion exchange
  – Capacitive deionization
  – Thermal distillation

• Practices to remove oil and grease and other organics from produced water
Membrane Processes

- Filtration
- Reverse osmosis
- Electrodialysis

Source: DOE/NETL
Ion Exchange

Source: Argonne

Source: Severn Trent Services
Capacitive Deionization

Source: ENPAR Technologies
Thermal Distillation

Source: Altela Inc.
Tier 3 - Options for Treatment and Disposal of Produced Water

- Practices to dispose of produced water
- Practices to remove salt and other inorganics from produced water

- Practices to remove oil and grease and other organics from produced water
  - Physical separation
  - Flotation
  - Coalescence
  - Combined physical and extraction
  - Solvent extraction
  - Adsorption
Physical Separation

- Separation
- Hydrocyclone
- Filtration
- Centrifuge

Source: Natco

Source: USEPA
Flotation

Source: Natco
Coalescence

Source: Opus
Combined Physical and Extraction Processes

Source: Pro-Sep

Source: M-I Epcon AS

Source: M-I Epcon AS
Extraction

Source: VWS MPP Systems
Adsorption

- Organoclay

Source: CETCO Oilfield Service Company
Produced Water Management Information System

The Produced Water Management Information System is an online resource for technical and regulatory information for managing produced water, including current practices, state and federal regulations, and guidelines for optimal management practices.

Visitors can use these resources to:

- learn about industry standard practices;
- determine which regulatory requirements must be met;
- select optimal management strategies for their location and circumstances.

:: Introduction to Produced Water ::

:: Technology Descriptions ::
Basic information about practices that are currently employed to manage drilling wastes.

:: Federal and State Regulations ::
Existing state and federal regulations that form the regulatory context for drilling waste management practices.

:: Technology Identification ::
An interactive tool to determine optimal management practices for a given geographical or environmental setting.

The Produced Water Management Information System was developed by Argonne National Laboratory. Funding for the project was provided through DOE’s National Energy Technology Laboratory.

Contact Us :: Privacy/Security

http://www.netl.doe.gov/technologies/PWMIS/
Final Remarks

- Management of produced water poses a significant cost and challenge
- There are many options available for managing produced water
- In a water-short world, produced water can become a resource

• QUESTIONS?