100% Frac Water Recycling - Strategy & Focus

April 13, 2011
Agenda

- Criteria for Frac Water Recycling
- On-Site Treatment vs. Off-Site Treatment
- Case Study #1 - On-Site Treatment
- Case Study #2 - Off-Site Treatment
- Ecosphere’s Ozonix Technology
- Implications for the Operator
Ecosphere Facts

- Ecosphere Has Over 15 Years of Water Treatment Experience
- Ecosphere Has Over 2 Years of Shale Gas Operating Experience
- Ecosphere Has Treated Over 15,000,000 bbl of Frac Fluid with Recycled Water
- Ecosphere Has Recycled Over 1,000,000 bbl of Produced Water
- Ecosphere’s ozonix Technology Has Been Proven By Third-Party Labs:
  - Results Gathered for Over 300 Wells
- Ecosphere Has Eliminated 450,000 + Gallons of Biocide from Frac Operations
Industry Concerns

- Water Resourcing and Permitting Issues
- Availability and Cost of Disposal
- Regulatory Changes
- Compatibility of Recycled Waters with Traditional Frac Systems
- Challenges of Recycling Water
- Political Pressure and Stakeholder Perception
- HSE Issues:
  - Hazardous Chemicals
  - Road Damage & Impact on Infrastructure
Why Should Operators Recycle Water?

- Less Fresh Water Consumption
- Reduces The Need For Disposal
- Reduces Regulatory Exposure
- Reduction of Liability Exposure
- Reduces Truck Traffic and Impact On Roads
- Extends the Economic Viability of the Play
- Improves Stakeholder Perception
- Reduces The Carbon Footprint
- Risk Mitigation
Where to Treat Water?
On-Site
Where to Treat Water?

Off-Site
Case Study #1
On-Site Treatment - Fayetteville Shale

How to Eliminate Chemicals at 120 bbl/min (5,000 gal/min) On-Site?
Case Study #1
On-Site Treatment - Fayetteville Shale

- Operations Began in Nov. 2009
- 100% of Frac Fluid Treated On-Site, “On The Fly”
- Eliminating Chemicals
- Destroying Bacteria
- Averaging 9 Wells Per Month
- Continuous Operations (24/7)
Case Study #1
On-Site Treatment - Fayetteville Shale

FACTS:

- 15,000,000 + bbl Processed
- 1,400 + Frac Stages
- 120 + Wells Completed
- 120 bbl/min Capabilities
Case Study #1
Typical Fayetteville Frac Blend

- 81% Fresh Water
- 19% Recycled Water
- 65% Flowback Water
- 35% Ground Water

High of 41% Recycled Water
Approximately 500 Wells / Year
Approximately 125,000 bbl / Well

11,875,000 bbl of Fresh Water Saved Per Year

CLEAN WATER FOR CLEAN ENERGY
Case Study #1
Microbial Control

On-Site Scenario:

- 3-Well Pad
- 120,000 bbl Frac’s
- 11 Stage Wells
- Treated at 100 + Bbl / Min
- Continuous Operations
Case Study # 2
Off-Site Treatment - Woodford Shale

Recycling Produced Water at a Centralized Facility
Case Study # 2
Off-Site Treatment - Woodford Shale

- Operations Began in Dec. 2008
- 100% Treated at a Central Location:
  - Recycled Produced Water
  - Flowback Water
- Ozonix Technology + Coagulation + TSS Separation (1-5 μm)
Case Study # 2
Off-Site Treatment - Woodford Shale

FACTS:

- 915,000 + bbl Processed
- 200 Wells Completed
- TDS Range:
  - 160,000 - 180,000 mg/l

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Case Study # 2
Scale Inhibition

Centralized Facility Scenario:

- Dynamic Tube Blocking Test:
  - Measures Scale Inhibition
  - Conducted by Third Party (Weatherford Labs)
- 170,000 mg/l TDS
- Treated at 200 bbl/Hour
- Fluid treated at 200 barrels per hour
What is the Ecosphere Technology?

Ozone ($O^3$) + Hydrodynamic Cavitation

Acoustic Cavitation + Electro-Chemical Precipitation

**USPTO Green Tech Fast Track Program**

The Ecosphere Evolution

Customer Driven Evolution

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<tr>
<th>EF-10 (EF-600)</th>
<th>EF-20 (EF-1200)</th>
<th>EF-60</th>
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<tbody>
<tr>
<td>Rated for 10 Barrels Per Minute</td>
<td>Rated for 20 Barrels Per Minute</td>
<td>Rated for 60 Barrels Per Minute</td>
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CLEAN WATER FOR CLEAN ENERGY
**Implications**

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<th><strong>ELIMINATE CHEMICALS</strong></th>
<th><strong>RECYCLE FLUID</strong></th>
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<tr>
<td><strong>BENEFITS</strong></td>
<td>Replace Biocides and Scale Inhibitors</td>
<td>Reuse Flowback Water and Produced Fluid</td>
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<td>Improve Friction Reducer Compatibility</td>
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<td><strong>HEALTH &amp; SAFETY</strong></td>
<td>Eliminate Dangerous Exposure to Chemicals</td>
<td>Reduce Truck Traffic</td>
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<td>Keep NORM in a Closed-Loop</td>
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<td><strong>ENVIRONMENT</strong></td>
<td>Eliminate Chemical Spills</td>
<td>Reduce CO2 Emissions</td>
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<td>Reduce Fresh Water Usage</td>
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<td><strong>POLITICAL RHETORIC</strong></td>
<td>&quot;Injecting Chemically-Laden Fluid....&quot;</td>
<td>&quot;Depleting Fresh Water Sources....&quot;</td>
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<td><strong>COST CONSIDERATIONS</strong></td>
<td>Biocide Cost</td>
<td>Freshwater Purchasing and Transfer</td>
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<td>Scale Inhibitor Cost</td>
<td>Trucking Hours</td>
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<td>Friction Reducer Cost</td>
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*CLEAN WATER FOR CLEAN ENERGY*
Eliminate Chemicals. Recycle Fluid

EcosFrac ®