SLIDES: A Working Model for Oil and Gas Produced Water Treatment

Lee Schafer

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A Working Model for Oil and Gas Produced Water Treatment

Presented at the Opportunities and Obstacles to Improving the Environmental Footprint of Energy Extraction in the Uintah Basin Workshop, October 14th 2010, Utah State University, Vernal, Utah.

Lee Shafer, Integrity Production Services, Inc., Presenter for Anticline Disposal LLC
Anticline Disposal numbers

• Since 2006, treated and recycled more than 22 million barrels of water.
• Anticline’s pipeline delivery system has eliminated 186,500 truck haul trips.
• Can treat more than 60,000 barrels a day, 365 days a year.
• Discharge quality water is less than 100 mg/l TDS
• and exceeds drinking water standards for boron.

• Typical lab results, “non-detect”:
  ✓ VOCs
  ✓ Methanol
  ✓ Diesel and Gasoline range organics
  ✓ Sulfate
Anticline Disposal “Frac” Process

Produced Water

API Separator → Anaerobic Basin → Aeration Basin → Clarifier → Sand Filter

Frac Water to Pipeline Distribution

Process patented by Anticline Disposal
Anticline Disposal “Discharge” Process

Produced Water

API Separator → Anaerobic Basin → Aeration Basin → Clarifier → Sand Filter

Bioreactor → Membrane Bioreactor → Reverse Osmosis → Boron Ion Exchange

Additional Treatment and Disposal → Clean Water Discharged to Environment

Frac Water to Pipeline Distribution

Process patented by Anticline Disposal
Anticline Disposal “Discharge” Process

- Produced Water
- API Separator
- Anaerobic Basin
- Aeration Basin
- Clarifier
- Sand Filter
- Bioreactor
- Membrane Bioreactor
- Reverse Osmosis
- Boron Ion Exchange
- Electro-coagulation
- Reverse Osmosis
- Injection Well
- Clean Water Discharged to Environment
- Frac Water to Pipeline Distribution

Process patented by Anticline Disposal
## Anticline Disposal Feed Parameters vs. Discharge Limits and Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>WYPDES Discharge Limits</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed O&amp;G, mg/l</td>
<td>50 to 2,400</td>
<td>10</td>
<td>Non-Detect</td>
</tr>
<tr>
<td>TDS, mg/l</td>
<td>8,000 to 15,000</td>
<td>500</td>
<td>41</td>
</tr>
<tr>
<td>Chloride, mg/l</td>
<td>3,600 to 6,750</td>
<td>230</td>
<td>18</td>
</tr>
<tr>
<td>Sulfate, mg/l</td>
<td>10 to 100</td>
<td>3,000</td>
<td>Non-Detect</td>
</tr>
<tr>
<td>Conductivity, µS/cm</td>
<td>8,000 to 20,000</td>
<td>7,500</td>
<td>78</td>
</tr>
<tr>
<td>pH</td>
<td>6.5 to 8.5</td>
<td>6.5 to 9</td>
<td>7.34</td>
</tr>
</tbody>
</table>

### Whole Effluent Toxicity Testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Raw water</th>
<th>Salts added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceriodaphnia dubia, 80% survival, 48 hr</td>
<td>100% survival</td>
<td>100%</td>
</tr>
<tr>
<td>Pimephales promelas, 80% survival, 96 hr</td>
<td>98.3% survival</td>
<td>100%</td>
</tr>
</tbody>
</table>
# Feed Parameters vs. Anticline Disposal Internal Discharge Limits and Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Standards</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTEX, $\mu$g/l</td>
<td>28,000 to 80,000</td>
<td>Non-Detect</td>
<td>Non-Detect</td>
</tr>
<tr>
<td>Gasoline Range Organics, $\mu$g/l</td>
<td>88,000 to 420,000</td>
<td>Non-Detect</td>
<td>Non-Detect</td>
</tr>
<tr>
<td>Diesel Range Organics, mg/l</td>
<td>77 to 1100</td>
<td>Non-Detect</td>
<td>Non-Detect</td>
</tr>
<tr>
<td>Methanol, mg/l</td>
<td>40 to 1500</td>
<td>Non-Detect</td>
<td>Non-Detect</td>
</tr>
<tr>
<td>Boron, mg/l</td>
<td>15 to 30</td>
<td>0.75</td>
<td>Non-Detect</td>
</tr>
</tbody>
</table>
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