EOR Produced Water Recycling

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Solar Saltworks
Project Overview

- Reliable desalination of oil and gas produced water for reuse.
- Desalination saves chemical costs (Polymer), which pays for water treatment and yields 20% Return on Investment, improving EOR economics
- More water reuse
- Exceeded all metrics for capacity, economics, reliability and timeline
- Delivered 8 months ahead of schedule, treated more than 2 x the water planned

*Flex EDR pilot plant at Enerplus site in Medicine Hat, Alberta*
Polymer Flood Enhance Oil Recovery (EOR)
Polymer increases solution viscosity, extracting more oil
Heavy oil (Alberta) requires higher viscosity = 2-3x more polymer than other regions
Polymer costs can be very high ($2-10M/year for 1,000-4,000 m³/day site)
Polymer Flood Enhance Oil Recovery (EOR)
With Desalination

Desalination offers:
• Reduced polymer consumption by ~50%, saving on chemical cost ($1M-$5M/y)
• Higher injectivity and reduced well scaling
• Reduced waste water volume
Electrodialysis Reversal (EDR)
Electrodialysis Reversal (EDR)

- Low pressure membrane system
- Low Cost ($2-6/m³)
- Self Cleaning
- Target salt concentration can be tuned to desired concentration

Animation: https://www.saltworkstech.com/technology/flex-edr-advanced-electrodialysis-reversal-system/
Ion Flux: Ion Exchange Membranes

- Novel, highly cross-linked polymer composition improves resistance to oils, solvents and acids/bases.
- High selectivity to multivalent ions
Flex EDR Field Pilot
Medicine Hat, Alberta
## Flex EDR Field Pilot
### Medicine Hat, Alberta

<table>
<thead>
<tr>
<th></th>
<th>Flex EDR Fit</th>
<th>Pilot Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inlet TDS</strong></td>
<td>5,000-25,000 mg/L</td>
<td>7000-8000 mg/L</td>
</tr>
<tr>
<td><strong>Treatment Target TDS</strong></td>
<td>500-3000 mg/L</td>
<td>1500-2000 mg/L</td>
</tr>
<tr>
<td><strong>Recovery</strong></td>
<td>Chemistry dependent, typical 85-95%</td>
<td>90%</td>
</tr>
<tr>
<td><strong>Oil in water concentration</strong></td>
<td>Tested up to 1000 ppm Not limited yet Ideally Remove &gt;C10</td>
<td>50-1000 ppm</td>
</tr>
</tbody>
</table>

*Produced and Treated Water*
Pilot Operating Conditions

• 2-5 m³/day (prefiltration capacity)

• 24/7 automated operation with self cleaning cycles

• Operated for 42 days, treating 150 m³

• >90% uptime

• System held under anaerobic conditions (Nitrogen blanket)
Desalinated produced water used less polymer to reach target viscosity

- The data suggests **50% polymer savings.**
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- Cost of desalination is less than the polymer savings
Challenges

Filtration
• Field pilot produced water had very high oil-in-water
• More research required into reliable, reusable filtration.

Extreme weather
• Blizzards and windstorms interrupted pilot operation
Keys to Success

- Alberta Innovates management of schedule and objectives drove project to completion
- Working with a “right-size” corporate partner to implement efficiently and drive innovation
- Off-site testing for better field pilot expectations and design
- Field pilot testing to experience real conditions
Thank you