HYDROZONIX
Treatment for Blended Produced and Fresh/Brackish Water
Produced Water Cycle
Wellhead to Injection Well

Well Pad

Tank Battery

Gathering System

Salt Water Disposal

Oil/Water Separation

Chemical Treatment

Biocide
Typically placed prior to gun barrels to prevent bacteria and provide iron control.
Produced Water Cycle
Wellhead to Reuse

- Well Pad
- Tank Battery
- Gathering System
- Oil/Water Separation
- Produced Water Pit
Produced Water Options

Where are you getting your Produced Water

Produced Water from tank batteries can have higher oil, iron and solids. Must consider this if recycling from this point.

Produced Water from Gun Barrels is generally better quality. Low oil, low solids and if oxidation is being used for bacteria control, low iron.

Tank Battery

Gun Barrel OWS
Produced Water Options
Typical Reuse Model

Tank Battery
Gun Barrel OWS

HYDRO³CIDE
Produced Water Options

Typical Reuse Model w/Aeration

Tank Battery

Gun Barrel OWS

HYDROCIDÉ

Air hose

Outflow is upward

Inflow, 360 degrees
Aeration Background

- Air Driven
- Submersible or Floating
- Submersible better for oxidation and solids control
- Submersible include bubble tubing and diffuser type systems
- Floating only aerates the top few feet, leaving the remaining water to foul and bacteria to grow
- Systems must be sized based on water quality and oxygen demand
Aeration: Produced Water

Aeration Benefits

• Bacterial Control/Growth Inhibition
• Algae Control/Growth Inhibition
• Iron Control
• Sulfide Control
• Stratification Control
• Icing Inhibition
• Mixing / Homogenization
• Low Cost
Aeration: Produced Water
Produced Water Pit Mixing w/Aeration

Improved Water Quality – 24 hour

Pit Mixer Comparison

97.5% Reduction
99.7% Reduction
79% Reduction

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Active Pit with Mixing / Aeration</th>
<th>Reserve Pit without Mixing / Aeration</th>
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<tbody>
<tr>
<td>Pit Volume, bbl</td>
<td>100,000</td>
<td>15,000</td>
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<tr>
<td>ORP, mv</td>
<td>184</td>
<td>-336</td>
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<tr>
<td>Total Fe, mg/L</td>
<td>4.3</td>
<td>168.7</td>
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<tr>
<td>Fe²⁺, mg/L</td>
<td>0.3</td>
<td>103.0</td>
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<tr>
<td>Tannins, mg/L</td>
<td>15.5</td>
<td>73.0</td>
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</table>
Case Study: What Aeration Does

ATP over time

<table>
<thead>
<tr>
<th>Day</th>
<th>ATP, pg/ml</th>
<th>% Reduction</th>
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<tbody>
<tr>
<td>0</td>
<td>6906</td>
<td>0%</td>
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<tr>
<td>1</td>
<td>6148</td>
<td>0%</td>
</tr>
<tr>
<td>2</td>
<td>4018</td>
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</tr>
<tr>
<td>3</td>
<td>3483</td>
<td>40%</td>
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<tr>
<td>4</td>
<td>2373</td>
<td>60%</td>
</tr>
<tr>
<td>5</td>
<td>2046</td>
<td>80%</td>
</tr>
<tr>
<td>6</td>
<td>1294</td>
<td>100%</td>
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<tr>
<td>7</td>
<td>1379</td>
<td>100%</td>
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## Produced Water Reuse Requirements

### What Are Your Goals

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Slickwater</th>
<th>Guar (Linear)</th>
<th>Guar (XL)</th>
<th>Hybrids (XL)</th>
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<tbody>
<tr>
<td>Chlorides (ppm)</td>
<td>140K (anionic)</td>
<td>60K</td>
<td>60K</td>
<td>60K</td>
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<tr>
<td></td>
<td>No Limit (cationic)</td>
<td></td>
<td></td>
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<tr>
<td>Total Hardness (ppm)</td>
<td>50K</td>
<td>20K</td>
<td>20K</td>
<td>20K</td>
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<tr>
<td>Iron (ppm)</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Oil (ppm)</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>50</td>
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<tr>
<td>TSS (ppm)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Boron (ppm)</td>
<td>No Limit</td>
<td>10</td>
<td>10</td>
<td>No Limit</td>
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<tr>
<td>Bacteria (cfu/ml)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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</table>
Water Treatment Requirements
Slickwater Fracs

Bacteria causes corrosion, plugging/fouling and generation of hydrogen sulfide

Iron & Sulfide Control
Iron can cause formation damage and Sulfides form dangerous gases

Solids Control
Solids can cause formation damage and contribute to plugging/fouling

Scale Inhibition
Scale can cause plugging/fouling, and contribute to underlayment corrosion
Water Treatment Requirements

Conventional Treatment Program

Blend

Disinfection

Fresh/Brackish Water

Produced Water

Pre-treatment

TDS Removal (Softening)
- Floc and drop
- EC
Water Treatment Requirements

Conventional Treatment Program

Blend for Scale Inhibition/Add Scale Inhibitor

Disinfection

Fresh/Brackish Water

Produced Water
Water Treatment Requirements
Slickwater Fracs

Bacteria causes corrosion, plugging/fouling and generation of hydrogen sulfide

Iron & Sulfide Control
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Solids Control
Solids can cause formation damage and contribute to plugging/fouling

Secondary
The Hydrozonix Difference

- Identify right micron size to satisfy your goal
- Field evaluations and size distribution are performed to identify micron size performance
- Nominal vs. Absolute

Particle Size Distribution for Produced Water Samples
Producued Water Reuse Cycle
Slickwater Fracs

- Wellhead
- Gathering System
- Oil/Water Separation
- Produced Water Pit
- On the Fly Disinfection
- Frac Reuse
Producued Water Reuse Cycle
Slickwater Fracs

Wellhead

Oil/Water Separation

Produced Water Pit

On the Fly Disinfection

Gathering System

AERATION

Frac Reuse
Produced Water Management for Reuse

HYDRO$_3$CIDE
Bacteria, Iron & Sulfide Control

Aerating Mixer
Bacteria, Iron, Sulfide & Solids Control

On-the-Fly
Bacteria, Iron & Sulfide Control

- **Bacteria:** 90%
- **Iron:** 90%
- **Sulfides:** 90%

- **Bacteria:** 70%
- **Iron:** 90%
- **Sulfides:** 80%

- **Bacteria:** 90%
- **Iron:** 90%
- **Sulfides:** 90%
Water Treatment Requirements

Conventional Treatment Program

Blend for Scale Inhibition/Add Scale Inhibitor

Disinfection

Fresh/Brackish Water

Produced Water
Volume of Fresh Water and Produced Fluid Treated at Different Stages
Blend Control

TDS & Blend Ratio

TDS in the Treated Water, mg/L

Stage #

% of Produced Fluid

Water Volume, BBL

Stage #
Produced Water Stratification

Pit Stratification

- A static, unmixed pit will stratify
- Chlorides will increase with depth
- Temperature will decrease with depth
- Zones are created at different depths with changing water quality
Produced Water Pit Mixing
Continuous TDS Monitoring: Baseline shows stratification
Produced Water Pit Mixing w/Aeration
Continuous Temperature Measurement: 3 zones monitored
Blend Control
Keep Blend Ratio Consistent with TDS/Chloride Real Time Monitoring

Monitor Chlorides and TDS
- To Monitor Blend
- For KCl equivalency
Solution
Keep Blend Ratio Consistent

- Calibrate Pumps
- Monitor TDS Real Time
- Adjust Blend Ratio
- Prevent Friction Reducer Compatibility Issues
Filtration
Solids Control
No what micron size you need.

HYDRO3CIDE
Pretreatment
Bacteria, Iron & Sulfide Control

Aeration
Pit Treatment
Bacteria, Iron & Sulfide Control

Bacteria Control
On-the-Fly
Bacteria, Iron & Sulfide Control w/ Ozone

Water Quality Assurance
Real Time
Critical to a successful program & Blend Control

HYDRO3CIDE
Aerating Mixers
EF80 – Ozone based treatment

Summary
Optimize your chemical program in your gathering system. Use aeration to preserve your water quality. Simplify your On-the-Fly disinfection program. Monitor compatibility and disinfection real time.
Questions ?

www.hydrozonix.com