Wastewater Salinity Reduction Webinar

Applications Using Alternate Flow Sheets

December 3, 2019

How to Participate Today

• Audio Modes
  • Listen using Mic & Speakers
  • Or, select “Use Telephone” and dial the conference (please remember long distance phone charges apply).

Submit your questions using the Questions pane.

• A recording will be available for replay shortly after this webcast.
Today’s Presenters

Jamie Vinsant
Product Manager for Electrodialysis Products, SUEZ Water Technologies & Solutions

Jason Haase
Global Business Intelligence Manager, SUEZ Water Technologies & Solutions

Patrick Girvin
Global Sales Leader for Reverse Osmosis & Electrodialysis Products & Systems, SUEZ Water Technologies & Solutions

Agenda

• Review technology options for wastewater salinity reduction
• Discuss irrigation water application
• Overview of Bashneft-Ufa oil processing complex case study
• Q & A
Technology Options

Jamie Vinsant
Product Manager
Electrodialysis Products

Salinity Reduction

Goals:
- Target product TDS or target specific ion concentration
- Brine with low volume and high TDS

There are generally two technologies involved in wastewater salinity reduction:
- Reverse Osmosis / Nanofiltration
- EDR (Electrodialysis Reversal)
Reverse Osmosis/Nanofiltration (RO/NF)

Commonly used and understood
Broad spectrum removal
- Salts (and general total dissolved solids - TDS)
- Metals
- Organic pollutants
- Pathogens, viruses, bacteria

WW treatment typically requires pretreatment such as MF or UF
Chemical dosing also common

Electrodialysis Reversal (EDR)

Less commonly discussed
Target to TDS value or for removal of specific ionized species
Chloride, sodium, nitrate, etc.

Typically requires only MMF pretreatment for WW applications
Typically operates at higher recovery and reduced chemical dosing
Electrodialysis Reversal: the less commonly discussed

Key Factors for Selection of EDR

<table>
<thead>
<tr>
<th>Customer Need</th>
<th>Key Factor</th>
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<tbody>
<tr>
<td><strong>Reuse for irrigation</strong></td>
<td><strong>EDR</strong></td>
</tr>
<tr>
<td>landscape and agriculture</td>
<td>Often 40-60% less wastewater generated with the same feed flow rate (higher recovery)</td>
</tr>
<tr>
<td><strong>Discharge limitation</strong></td>
<td>Higher tolerance to suspended solids, enabling the alternate flow sheet to MF/UF-RO</td>
</tr>
<tr>
<td>sodium, chloride</td>
<td>Variability of feedwater</td>
</tr>
<tr>
<td><strong>Wastewater</strong></td>
<td><strong>RO/NF</strong></td>
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<tr>
<td>industrial use</td>
<td>When pathogens/viruses/bacteria need to be removed by RO</td>
</tr>
<tr>
<td><strong>Indirect/Direct potable reuse</strong></td>
<td>When silica and non-charged species need to be removed</td>
</tr>
<tr>
<td><strong>Industrial reuse</strong></td>
<td></td>
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<tr>
<td>boiler feed water</td>
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Farmers have widely voiced concern over long term effects of salinity

Irrigable Land: Worldwide

- Salinity damaged soil increased almost 40% since the early 1990s to 153 million acres (approximate size of France)

Example Geographical Data

Irrigable Land: USA (Dating Back to 1958)

- Soil Salinity Issues 25%
- No Soil Salinity Issues 75%
- Soil Salinity Issues 20%

- No Soil Salinity Issues 80%

Community resilience will require partnership between agriculture and water districts

- Irrigation Water Salinity
- Weather Patterns
- Soil Conditions
- Farming Practices
Water TDS should be < 1,000 ppm to enable wide ranging crop choices

Worldwide trend toward increasing salinity in drinking water (saltwater intrusion, deeper and declining quality of brackish wells, home softener use)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Threshold Soil Salinity (ppm TDS, value where yield loss begins)</th>
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<tbody>
<tr>
<td>Corn</td>
<td>≈ 1,100</td>
</tr>
<tr>
<td>Green Beans, Carrots, Strawberries</td>
<td>≈ 640</td>
</tr>
<tr>
<td>Tomatoes (Several Species)</td>
<td>≈ 1,050-1,600</td>
</tr>
<tr>
<td>Citrus (Lemon, Grapefruit, Orange)</td>
<td>≈ 800-960</td>
</tr>
<tr>
<td>Almond/Blackberry/Grapes</td>
<td>≈ 960</td>
</tr>
</tbody>
</table>

Note irrigation water must be diluted (i.e. rain) to exceed these values.

Multiple variables impact and create wide ranging individual agricultural needs. Choice of plant, soil, local weather, sodium and chloride content of water, and irrigation practices are all relevant factors, as are many more.

Webinar - Wastewater Salinity Reduction - Applications Using Alternate Flow Sheets

Reuse for irrigation in the USA is prevalent and has potential

*Source: The Water Research Foundation, Agricultural Use of Recycled Water, 2019

It’s practiced:
41 states
791 wastewater plants
821 MGD

It’s part of future plans:
922 plants project reuse for irrigation totaling 1,864 MGD of peak flow

Agriculture near wastewater facilities
80% of irrigated cropland within 10 miles
44% of irrigated cropland within 5 miles
How is reuse for irrigation different than potable reuse?

Treatment objectives are different:
• Pathogen removal vs. EPA drinking water standards
• TDS is not a public health concern, but is for irrigation
• Sodium and chloride are primary ions needing removed for plant health
• Many divalent ions, minerals, and nutrients can be left behind and are beneficial for a circular economy

Perception and science:
• Contaminants of emerging concern have been reported to have reduced uptake by plants resulting in reduced human exposure to recalcitrant compounds versus IPR/DPR

It’s a case where the concept of not overtreating to potable standards makes sense if it can be practically implemented

Parallel Case Studies: California, USA

<table>
<thead>
<tr>
<th>City of San Diego, California, USA</th>
<th>Carmel Area Wastewater District &amp; Pebble Beach Community Services District</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flow Sheet</strong></td>
<td><strong>City of San Diego, California, USA</strong></td>
</tr>
<tr>
<td>Tertiary Treated WW + Cartridge Filters + EDR → Direct agricultural use</td>
<td>MF + RO → Direct agricultural use or groundwater recharge</td>
</tr>
<tr>
<td><strong>Treatment Objective</strong></td>
<td><strong>Carmel Area Wastewater District &amp; Pebble Beach Community Services District</strong></td>
</tr>
<tr>
<td>Adjustable TDS removal from influent peak 1,300 ppm to 300-1,000 ppm.</td>
<td>Reduce sodium from 150 ppm to 55 ppm</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td><strong>Carmel Area Wastewater District &amp; Pebble Beach Community Services District</strong></td>
</tr>
<tr>
<td>6.6 MGD (EDR effluent)</td>
<td>1.5 MGD (RO effluent)</td>
</tr>
<tr>
<td><strong>Key Notes</strong></td>
<td><strong>Carmel Area Wastewater District &amp; Pebble Beach Community Services District</strong></td>
</tr>
<tr>
<td>85% recovery</td>
<td>80% recovery</td>
</tr>
<tr>
<td>Filter + EDR was 25% lower CapEx than MF/RO at install (1998)</td>
<td>Reuse for irrigation began in 1994, MF+RO added in 2009</td>
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Case Study:
Bashneft-Ufaneftekhim oil processing complex

Patrick Girvin
Global Products Sales Leader
Reverse Osmosis, Electrodialysis, Electrodeionization

Challenge

End-User: Bashneft, an oil company in Russia
Location: Ufa, Republic of Bashkortostan

Technical details:
84,000 m³/day (22.2 MGD) wastewater influent
Combined waste flows from oil refinery and other industry in region

Two drivers for new treatment facility:
New discharge regulations and fees
Drive to reuse to minimize river discharge and raw water usage

Project challenges:
Difficult feed water, River disposal requires ppb levels of contaminants
Extensive piloting required to optimize process and maximize recovery
Feed Water Challenges

<table>
<thead>
<tr>
<th>Parameter in mg/L unless noted</th>
<th>Raw Feed-water Quality</th>
<th>Guaranteed River Discharge Quality</th>
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</thead>
<tbody>
<tr>
<td>Ammonium, NH₃</td>
<td>40</td>
<td>0.5</td>
</tr>
<tr>
<td>Iron</td>
<td>0.4</td>
<td>0.099 (as Fe)</td>
</tr>
<tr>
<td>Manganese/Mn⁺</td>
<td>0.2</td>
<td>0.01 (as Mn⁺)</td>
</tr>
<tr>
<td>Sulfates</td>
<td>250</td>
<td>100 (as SO₄)</td>
</tr>
<tr>
<td>Chloride</td>
<td>300</td>
<td>273.9 (as Cl)</td>
</tr>
<tr>
<td>Nitrate, as NO₃</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>Phosphate, PO₄</td>
<td>0.2</td>
<td>0.13</td>
</tr>
<tr>
<td>Dry residue TDS</td>
<td>1,250</td>
<td>1,000</td>
</tr>
<tr>
<td>pH [pH Units]</td>
<td>6.5 – 9.5</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>COD</td>
<td>450</td>
<td>30</td>
</tr>
<tr>
<td>BOD</td>
<td>135</td>
<td>3</td>
</tr>
<tr>
<td>Non-ionic or non-anionic surfactants</td>
<td>2.0</td>
<td>0.35</td>
</tr>
<tr>
<td>Phenols</td>
<td>7.0</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Solution

MBR: COD/BOD and metals removal (ZeeWeed 500D in 12 trains)

MACarrier: improves removal of recalcitrant COD and stabilizes biological process

- Reuse flow: 45,800 m³/day (12.1 MGD)
- Well Disposal: 2,200 m³/day (0.6 MGD)
- River Disposal: 36,000 m³/day (9.5 MGD)

EDR: salinity reduction (8+1 redundancy)

RO: further brine concentration (2+2 redundancy)

IX: removes heavy metals from EDR dilute stream
Results

Benefits of Bashneft process train:

• Meets surface water discharge regulations - avoid discharge penalties
• High recovery process - minimize payments for well discharge (less than 3%)
• High quality product - up to 55% of the wastewater can be reused
• Maximizes reuse - reduce costs incurred for raw water

Thank you for your time.

Are there are any questions?

For more information visit www.suezwatertecchnologies.com