AquaSel™ Brine Concentration Pilot Project Update

Jeff D. Wall P.E.
February 23, 2017
Eastern Municipal Water District (EMWD)
Overview of EMWD

- **MWD Member Agency**
- **Service Area** ≈ 542 square miles
- **Population** ≈ 768,000
  - 40 percent of ultimate build-out
- **Seven cities and the unincorporated areas western Riverside County**
  - Hemet
  - San Jacinto
  - Moreno Valley
  - Perris
  - Menifee
  - Murrieta
  - Temecula
- **Retail and wholesale customers**
  - Water
  - Wastewater
  - Recycled Water
EMWD Services

• **Water**
  – 145,000 accounts
  – 75,000 AF sold in 2016

• **Wastewater**
  – Approximately 237,000 accounts
  – Four Regional Water Reclamation Facilities treating 45 million gallons/day (MGD)

• **Recycled water**
  – 35,000 AF sold in 2016
  – Service to parks, municipal streetscapes, golf courses, industry, agriculture, and the San Jacinto Wildlife Area
EWMD’s Brackish Groundwater Desalination Program

- Brackish Groundwater Basins
  - Perris North
  - Perris South
  - Menifee
- TDS ≈ 1,200 – 2,500 mg/L
- Rising Groundwater
- Pump Brackish Groundwater from 11 Wells to EMWD’s Menifee and Perris I Desalters
  - Four Additional Wells On-line by 2020
EMWD’s Desalter Plants

**Menifee and Perris I Desalters**

- **Capacity:** 8.7 MGD
- **Production:** 8,600 AF/yr
- **75 percent recovery**
- **55 tons of salt removal per day**

**Proposed Perris II Desalter**

- **Capacity:** 3.5 MGD
- **Production:** 3,300 AF/yr
- **75 percent Recovery**
- **23 tons/day salt removal**
Brine Disposal Via Inland Empire Brine Line (IEBL)

- **Inland Empire Brine Line (IEBL)**
  - 70 mile long pipeline
  - Constructed by a five agency joint powers authority
  - Supports six desalters and industrial dischargers including EMWD’s Menifee and Perris I Desalters

- **Purchased Cost for Pipeline Capacity** = $3.75M/MG
  - (EMWD purchased 5.95 MGD)

- **Cost for Treatment and Disposal** = $8.7M/MG
  - (EMWD purchased 3.55 MGD)

- **EMWD’s O&M Costs** = $1.05M/year
Importance of Brine Concentration

• **Generated Brine Volume:**
  - Menifee Desalter: 0.9 MGD
  - Perris Desalter: 1.4 MGD
  **Total:** 2.3 MGD

• **Loss of Valuable Water Resources:**
  - Presently: 2,500 AF/year
  - Future: 4,000 AF/year

• **Brine Management Objectives:**
  - Maximize available water resources through improved recovery
  - Reduce disposal costs
EMWD’s AquaSel™ Brine Concentration Pilot Project

- December 2013 – EMWD Board Authorized AquaSel™ Pilot Project
- December 2014 – Commissioned the AquaSel™ Brine Concentration Pilot Unit by GE at EMWD’s Menifee Desalter
- Project Partners
  - Metropolitan Water District ($192,000 grant)
    - Foundational Action Funding Program research for new technologies to develop regional water resources
  - U.S. Bureau of Reclamation ($131,000 grant)
    - Desalination and Water Purification Research and Development Program
  - Carollo Engineers Retained for Technical Support ($92,815)
- July 2015 – Completed AquaSel™ Pilot Plant Testing

Total Pilot Project Cost = $512,500
AquaSel™ Pilot Project Objectives

• Demonstrate ability to reliably treat EMWD’s brine
• Recover additional water through brine concentration
• Verify and validate preliminary cost estimates
• Identify any operational and maintenance issues
• Develop appropriate treatment train design for a demonstration and full scale plant based on findings
# Desalter Concentrate Water Quality

## Product Targets

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS (mg/l)</td>
<td>&lt; 2,000 – 2,200</td>
</tr>
<tr>
<td>Conductivity (uS/cm)</td>
<td>3,300</td>
</tr>
</tbody>
</table>

## Pilot Feed (Desalter Brine)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO Recovery</td>
<td></td>
<td>75%</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/l</td>
<td>1,079</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/l</td>
<td>260.6</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg/l</td>
<td>774</td>
</tr>
<tr>
<td>Potassium</td>
<td>mg/l</td>
<td>25.7</td>
</tr>
<tr>
<td>Strontium</td>
<td>mg/l</td>
<td>6.1</td>
</tr>
<tr>
<td>Barium</td>
<td>mg/l</td>
<td>0.75</td>
</tr>
<tr>
<td>Ammonia</td>
<td>mg/l</td>
<td>&lt; 0.5</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>mg/l</td>
<td>809</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/l</td>
<td>489</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/l</td>
<td>2,953</td>
</tr>
<tr>
<td>Fluoride</td>
<td>mg/l</td>
<td>0.61</td>
</tr>
<tr>
<td>Nitrate</td>
<td>mg/l</td>
<td>97</td>
</tr>
<tr>
<td>Total PO₄</td>
<td>mg/l</td>
<td>4.1</td>
</tr>
<tr>
<td>Silica (total)</td>
<td>mg/l</td>
<td>154</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>CaCO₃</td>
<td>3,772</td>
</tr>
<tr>
<td>TDS</td>
<td>mg/l</td>
<td>~6,500 – 7,500</td>
</tr>
<tr>
<td>Conductivity</td>
<td>uS/cm</td>
<td>10,500</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>7.4</td>
</tr>
</tbody>
</table>
AquaSel™ Brine Concentration Technology

- AquaSel™ is a proprietary process by GE which uses electrodialysis reversal (EDR) and a precipitator.
- Has been successfully applied in the beverage industry.
- EDR process addresses the high silica concentration.
- Precipitator allows for precipitation of calcium sulfate (gypsum).
- Conducted pilot testing at 10 GPM over a nine-month period.
  - 1,890 hours of run time.
Pilot Plant Process Schematic
Site Photos

EDR Pilot Container

EDR Stack

Cartridge Filters

Precipitator
Precipitator

- Designed for controlled gypsum precipitation
- Continuous mixing zone maintains solids in solution versus settling in the bottom of the precipitator
- Operates at reduced pH
  - $\text{H}_2\text{SO}_4$ added
- Precipitate as much calcium sulfate (gypsum) as possible
- Monitored daily for solids loading
- Purged on a periodic basis to maintain chemistry
  - Blow down excess solids for disposal
Challenges

• Experienced several operations and water quality related issues
  – Silica fouling
  – Calcium carbonate fouling (scaling)

• Occasional interruptions in the operation due to scale formation on the membranes

• Occasional interruptions in the operation due to:
  – Hydraulic imbalance during solids blow-down cycles
  – Hydraulic imbalance in when returning off-spec EDR product water
Final Phase Performance Overview

EDR Conductivities

- **Startup / Troubleshooting**
  - After recovery change to 80%, start concentrate make-up

- **Final Testing Phase**
  - Start of final test period
  - Precipitator upset causes loss of solids and concentrate

- Conductivity, µS/cm

- Feed Conductivity
- Product Conductivity
- Concentrate Conductivity
Results

• Achieved significant operation time
  – 1,890 hours of operation
  – 320 hours of continuous run time

• Achieved 95 percent overall recovery of brackish groundwater through improved brine concentration
  – 75 percent recovery through RO plant
  – An additional 80 percent recovery of RO brine waste stream through AquaSel™
Summary of Findings

- Experienced substantial silica fouling of EDR membranes at the outset
  - Membrane filtration was not suitable for filtering of effluent from precipitator

- Discovered ferric chloride and sulfuric acid ($\text{H}_2\text{SO}_4$) dosing prior to EDR stack were deactivating the antiscalant
  - Mitigated by replacing multi-media filtration with cartridge filters and ceased dosing sulfuric acid
  - Discovered the pilot operated better without pre-treatment
Summary of Findings

• Observed operational upsets caused by changes in flow during precipitator solids blow-down cycle and during periods when returning off-spec EDR product water
  – Mitigated with the addition of a buffer tank on the cartridge filter backwash return to the precipitator

• Continuous control of the feed water (e.g. RO desalter brine concentrate) pH at 7.0 was crucial to prevent deactivation of the antiscalant used in the RO plant
  – Antiscalant used in RO de-salter for control of silica is deactivated at low pH
  – Necessary to prevent silica and CaCO3 from coming out of solution and plugging filters and pipes

• Electrodialysis reversal (EDR) with solids precipitator (e.g. AquaSel™) was ultimately successful in EMWD’s high silica brine concentration application
Acknowledgments

• **Metropolitan Water District of Southern California**
  – Stacy Takeguchi and Don Bentley

• **U.S. Bureau of Reclamation**
  – Bill Steele, Yuliana Porras-Mendoza, Saied Delagah, and Katie Guerra

• **GE Water and Process Technologies**
  – Matt Reeve, Carl Hopkins, Ken Irwin, Bryan de Souza

• **Carollo Engineers**
  – Graham Juby and Andrew Weisner

• **Eastern Municipal Water District**
  – Phil Lancaster, John Dotinga, Tim Parker, Jim Ulrich, and Andrew Rozenstraten
Contact Information

Jeff D. Wall, P.E.
Assistant General Manager of Operations and Maintenance
Phone Number (951) 928-3777 Ext. 6255

Email: wallj@emwd.org