Concentrate Enhanced Recovery Reverse Osmosis: Part 2

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CONCENTRATE VOLUME REDUCTION IN EL PASO, TEXAS.
Introduction: CERRO System

In 2017, EPWater commissioned H2O-Terra the design and construction of 3 CERRO Desalination systems.

The design and initial construction phase were presented at the 2018 MSSC Annual Salinity Submit.

CERRO stands for Concentrate Enhanced Recovery Reverse Osmosis.

It is a “Batch” Desalination System.
History of CERRO

First Prototypes were tested at the Kay Bailey Hutchinson Desalination Plant in El Paso, Texas.

During this time, it was found that “Batch” Processes work better for Concentrate Desalination.

Induction Time of Mineral Formation.
Induction Time

Undersaturated solution

\[ \text{Ca}^{2+}, \text{SO}_4^{2-}, \text{Ca}^{2+}, \text{SO}_4^{2-}, \text{Ca}^{2+} \]

Supersaturated solution

\[ \text{SO}_4^{2-}, \text{Ca}^{2+}, \text{SO}_4^{2-}, \text{Ca}^{2+}, \text{SO}_4^{2-}, \text{Ca}^{2+} \]

Precipitation

\[ \text{SO}_4^{2-}, \text{Ca}^{2+}, \text{CaSO}_4^{2-}, \text{SO}_4^{2-}, \text{Ca}^{2+}, \text{CaSO}_4^{2-} \]

Conventional RO Treatment Time

CERRO Treatment Time

Induction time

CERRO flush
Single Pass CERRO System Schematic

Feed Water

- β = 1.2
- SWRO Membranes
- 40%

Batch Time: 26 minutes
Flush Time: 1-3 minutes

- β = 1.1
- SWRO Membranes
- 60%

- β = 1.05
- SWRO Membranes
- 75%

β = Concentration Polarization
### CERRO Batch Time and Operating Cost

<table>
<thead>
<tr>
<th>CERRO Batch Time (minutes)</th>
<th>Operating Cost (% Change)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 minutes</td>
<td>16.00%</td>
</tr>
<tr>
<td>5 minutes</td>
<td>9.00%</td>
</tr>
<tr>
<td>10 minutes</td>
<td>3.30%</td>
</tr>
<tr>
<td>15 minutes</td>
<td>0.00%</td>
</tr>
<tr>
<td>20 minutes</td>
<td>-1.35%</td>
</tr>
<tr>
<td>25 minutes</td>
<td>-2.50%</td>
</tr>
<tr>
<td>30 minutes</td>
<td>-3.00%</td>
</tr>
</tbody>
</table>

- **3 minutes**: 16.00%
- **5 minutes**: 9.00%
- **10 minutes**: 3.30%
- **15 minutes**: 0.00%
- **20 minutes**: -1.35%
- **25 minutes**: -2.50%
- **30 minutes**: -3.00%
Well Site 412
Reverse Osmosis System

Courtesy of El Paso Water (EPW 2015)
Well Site 412 @ El Paso, Texas

Courtesy of EPW (2015)
Confirmation Unit CERRO System – Well Site 412

Courtesy of EPW (2015)
In 2015, El Paso Water (EPW) decided to install a full scale CERRO system at one of its well sites.

Feed: 320 gpm, 3,000 mg/L

**Main RO**
- Concentrate: 80 gpm, 12,000 mg/L
- Salt: 11,000 lb/day
- 240 gpm Permeate

**CERRO**
- 60 gpm Permeate

**Sewer**
- Concentrate: 20 gpm, 48,000 mg/L
- Salt: 11,000 lb/day
- Recovery: 99%
Based on the results of the first CERRO prototype, El Paso Water requested H2O-TERRA to design 3 new CERRO systems on three of their well sites.

- 475,000 GPD of Drinking Water
- Concentrate volume reduction >70%
- Partially funded by US Bureau of Reclamations
CERRO Unit @ Well 414
New CERRO Systems (80 gpm)

Two new systems under construction (W-404 & W-414)
New CERRO System (140 gpm)

One new system under construction (W-408)
Texas Commission of Environmental Quality Permitting

TCEQ Requires new desalination units to be tested for 15 days before approving a drinking water distribution permit for the systems.

➢ Water samples must be collected and analyzed by a TCEQ Certified Laboratory.

➢ Unit Performance must be within 10% of the values predicted by Reverse Osmosis models.

➢ Final Water Quality must meet all primary drinking water standards.
CERRO Performance

CERRO BATCHES FOR EACH WELL SITE

Well 404
Well 414
Well 408
CERRO Final Blended Product

- **Well 404**
  - Flow: 81 gpm
  - TDS: 415 mg/L

- **Well 414**
  - Flow: 95 gpm
  - TDS: 420 mg/L

- **Well 408**
  - Flow: 145 gpm
  - TDS: 523 mg/L
CERRO Cost (USD per 1000 gallons)

<table>
<thead>
<tr>
<th>CERRO RECOVERY</th>
<th>WATER COST ($/1000 GALLONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40%</td>
<td>$3.37</td>
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<tr>
<td>50%</td>
<td>$2.69</td>
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<tr>
<td>60%</td>
<td>$2.27</td>
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<tr>
<td>70%</td>
<td>$2.02</td>
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<tr>
<td>80%</td>
<td>$1.90</td>
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<tr>
<td>90%</td>
<td>$2.06</td>
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Thanks for Your Time

“The most valuable of all talents is that of never using two words when one will do.”

- Thomas Jefferson