Improving Water Efficiency Through Membrane Capacitive Deionization

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Cooling Towers

Commonly used in district/central plants.

Energy efficient means to provide cooling, BUT must use a substantial amount of water.
Importance of Understanding Makeup Water Quality

- Optimal Cycles of Concentration (COC)
- Pretreatment
- Materials of Construction
- Water Treatment Program
Impact of Cycles on Water Usage

• Operating cycles dictates the volume of blowdown from an evaporative unit

\[ \text{Blowdown} = \frac{\text{Evaporation}}{\text{COC} - 1} \]

• Less blowdown means less makeup water needed

\[ \text{Makeup} = \text{Blowdown} + \text{Evaporation} + \text{Drift} \]
CALCULATING CYCLES: CENTER GROVE H.S.

1. Test makeup water sample – Greenwood, IN

   Makeup Conductivity = 694 umho/cm

2. Run water modelling software
   (materials of construction, scaling indices, corrosion rates)

   Conductivity Set Point = 1735 umho/cm

   Cycles of Concentration = \( \frac{1735}{694} = 2.5 \)
1000 Tons

![Graph showing Gallons of Water / Day vs. Cycles of Concentration with Blowdown and Evaporation categories.]

- **Blowdown** and **Evaporation**
- Cycles of Concentration: 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9
- Gallons of Water / Day ranges from 0 to 120,000
- 40% for Blowdown at 1.5 cycles
- 20% for Evaporation at 2 cycles

Legend:
- **Green** for Blowdown
- **Red** for Evaporation
<table>
<thead>
<tr>
<th>Attribute</th>
<th>MU</th>
<th>Units</th>
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<tbody>
<tr>
<td>Conductivity</td>
<td>694</td>
<td>umho/cm</td>
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<tr>
<td>pH</td>
<td>8.0</td>
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<tr>
<td>Total Hardness</td>
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<td>ppm as CaCO₃</td>
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<tr>
<td>Ca Hardness</td>
<td>45.1</td>
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<tr>
<td>Mg Hardness</td>
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<tr>
<td>Alkalinity</td>
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<td>ppm as CaCO₃</td>
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<table>
<thead>
<tr>
<th>Attribute</th>
<th>MU</th>
<th>Units</th>
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<tbody>
<tr>
<td>Silica</td>
<td>16</td>
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<tr>
<td>Chloride</td>
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<td>Sulfate</td>
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<tr>
<td>Phosphate</td>
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<tr>
<td>Sodium</td>
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<td>ppm</td>
</tr>
<tr>
<td>Iron</td>
<td>&lt;0.1</td>
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THE PROBLEM: CENTER GROVE H.S.
MEMBRANE CAPACITIVE DEIONIZATION (MCDI)

- Pretreatment system that lowers the conductivity of the makeup water
  - Increases COC
  - Decreases Blowdown

\[
\text{Blowdown} = \frac{\text{Evaporation}}{\text{COC} - 1}
\]

\[
\text{COC} = \frac{1735}{694} = 2.5
\]

\[
\text{COC} = \frac{1735}{347} = 5.0
\]
WATER MASS BALANCE
Center Grove Water Savings

Evaporative Cooling Unit

MCDI Skid

Evaporation

MAKE-UP WATER

LOWER CONDUCTIVITY MAKE-UP

CAPTURED IONS TO DRAIN

@ 2.5°C

~1.5MM SAVED

~4.8MM gpy

Evaporative Cooling Unit

LESS BLOWDOWN TO DRAIN

= ~4.8MM gpy
MCDI BENEFITS: CENTER GROVE H.S.

✓ ~1.5MM gpy saved
✓ Adjustable Ion Reduction: 35 – 50%
✓ 50% reduction allows cycles to be doubled
✓ Removes all dissolved ions except Silica
✓ High recovery rate: 75 – 85%
✓ Reduces amount of water treatment chemicals needed
✓ Can be run by typical city water feed pressure
✓ Pretreatment system capable of safely increasing cycles without corresponding risk
WHO IS THIS TECHNOLOGY FOR?

Customers interested in:
1. Saving Water
2. Meeting Local Regulations
3. Reducing Scaling Potential
4. Reducing Chemical Usage
Questions

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