Achieving Lower Operating Costs and Better Water Quality with More Advanced Ion Exchange System Designs

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Outline

• Make-up Demin Overview Map
• Various Ion Exchange System Designs
  – Co-Flow Regeneration
  – Reverse-Flow Regeneration
  – Packed Bed
  – Advanced Packed Bed
• Summary Table
  – Effluent quality: conductivity, silica
  – Efficiency: regeneration ratio, yield
Make-up Demin Overview

Pre-treatment
- Raw Water → Multi-Media Filter → Softener → Storage Tank → UF

Polishing
- UF → Storage Tank → EDI → Mixed Bed Polisher → Membrane Contactor / Degasifier → Membrane Contactor / Degasifier → UV → Storage Tank → Product Water

Roughing
Co-Flow Regeneration

Conductivity: 3-30 μS/cm
SiO₂: 30-200 μg/L
Regen. ratio: 180-400%
Yield: 90%
## Selectivity Coefficients

**Counter-Ion** | **Selectivity**  
--- | ---  
H\(^+\) | 1.00  
Na\(^+\) | 1.56  
Mg\(^{2+}\) | 2.59  
Ca\(^{2+}\) | 4.06  

*Selectivity (gel cation resin, 8% DVB cross-linking)*

**Diagram:**
- Exhausted resin
- Regenerated resin
- Regeneration

*Image of ion exchange columns showing the process of regeneration.*

*Image of ion exchange columns showing the layers of different ions.*
Reverse-Flow Regeneration
with compaction due to air or water blocking

Conductivity: 1-3 $\mu$S/cm
$\text{SiO}_2$: 20-40 $\mu$g/L
Regen. ratio: 130-180%
Yield: 90-95%
Packed Bed

Packed Bed Benefits:
- Very simple
- Very compact
- No inert (for upflow service)
- Low investment cost
- Low pressure drop
- Best water quality
- Backwashable (external tank for upflow service)

Conductivity: 0.1-1 µS/cm
SiO₂: 5-20 µg/L
Regen. ratio: 105-150%
Yield: 94-98%
Advanced Packed Bed

Conductivity: 0.1-1 µS/cm
SiO₂: 5-20 µg/L
Regen. ratio: 115-150%
Yield: 98%
## Summary – Effluent Quality & Efficiency

<table>
<thead>
<tr>
<th></th>
<th>Co-Flow Regeneration</th>
<th>Reverse-Flow Regeneration</th>
<th>Packed Bed (AMBERPACK™, UPCORE™)</th>
<th>Advanced Packed Bed (ADVANCED AMBERPACK™)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conductivity (µS/cm)</strong></td>
<td>3 - 30</td>
<td>1 - 3</td>
<td>0.1 - 1</td>
<td>0.1 - 1</td>
</tr>
<tr>
<td><strong>SiO₂ (ppb)</strong></td>
<td>30 - 200</td>
<td>20 - 40</td>
<td>5 - 20</td>
<td>5 - 20</td>
</tr>
<tr>
<td><strong>Regeneration ratio (%)</strong></td>
<td>180 - 400</td>
<td>130 - 180</td>
<td>105 - 150</td>
<td>105 - 150</td>
</tr>
<tr>
<td><strong>Yield (%)</strong></td>
<td>90</td>
<td>90 - 95</td>
<td>94 – 98</td>
<td>98</td>
</tr>
</tbody>
</table>