Corrosion Control: Calcite or Limestone Contactors for Remineralization Downstream from Membrane Treatment

NC AWWA-WEA
November 2017
Introduction

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Tonka Water
Territory Manager, South Eastern United States
Established in 1956, Tonka Water has extensive experience in water treatment with just under 2500 installations.

Our water treatment expertise includes applications in surface water, groundwater, tertiary water filtration, environmental remediation, commercial and industrial projects.

We pride ourselves on delivering quality systems, with a solid base of technology and a strong commitment to meeting customer needs.
Tonka Water has just under 2500 individually designed water treatment systems for municipalities across North America.
WHAT IS A CALCITE CONTACTOR?
Calcite Contactors

Like Tums for your water system
Membrane Systems

- Nanofiltration and Reverse Osmosis (NF/RO) reduce total dissolved solids (TDS)
- But, also remove hardness and alkalinity - lowering pH
- Can result in corrosive water
  - Langelier Saturation Index (LSI)
  - Calcium Carbonate Precipitation Potential (CCPP)

Add hardness/alkalinity back in - remineralization
Remineralization Options

- **Chemical Feed**
  - Lower capital, but can be operationally expensive, potential for overfeeding

- **Lime**
  - Messy, less economical

- **Calcium Carbonate**
  - aka crushed limestone, or calcite
  - Self-limiting: pH adjustment only to equilibrium
  - Easy operation
  - Economical
    - 50% lime costs
    - 50% less CO$_2$ required than lime
Calcite (crushed limestone)

**Remineralization using calcite and CO₂**

\[ H₂O + CO₂ + CaCO₃ \rightarrow Ca^{+2} + 2HCO₃^- \]

**Remineralization using calcite and sulfuric acid**

\[ H₂SO₄ + CaCO₃ \rightarrow CaSO₄ + H₂O + CO₂ \]
\[ H₂O + CO₂ + CaCO₃ \rightarrow Ca^{+2} + 2HCO₃^- \]

**Summary:** \[ 2CaCO₃ + H₂SO₄ \rightarrow Ca^{+2} + 2HCO₃^- + CaSO₄ \]
Typical Contactor System

NF/RO Membrane

Permeate

CO₂ or Sulfuric acid

Calcite Contactor

Sodium Hydroxide

Concentrate

Bypass (Optional)
DESIGN CONSIDERATIONS
Design Conditions

- Upflow operation
- 3-6 gpm/ft$^2$ service loading rate
- 8-12 gpm/ft$^2$ backwash (or high rate flush)
  - Target: 35% expansion
- Freeboard: 50% bed expansion
- Bed depth: As needed, but depths vary from 24” to 60”
  - Rule of thumb: 10-30 min EBCT
Modeling

- Critical inputs
  - pH
  - CO$_2$
  - Alkalinity
  - Hardness
  - Temperature
  - Total dissolved solids (TDS)
  - Upflow velocity
  - Calcite particle size / characteristics
Bed Depth
Calcite Type and Size

Properties:
Size, Uniformity, Purity, Roundness, Specific Gravity/Density, NSF Certification
Vertical Pressure Vessels
Horizontal Pressure Vessels
Service Flow Pressure Drop

![Service Flow Pressure Drop Graph](from Clack Corporation datasheet)
INSTALLATION REVIEW
Mosquito First Nation, Canada
Start-up: October 2014

Design flow of 108 gpm
One (1) 5ft diameter x 7ft6in tall HDPE tank, 48” bed depth
Engineering: Associated Engineering

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<td>pH</td>
<td>6.2</td>
<td>8.25</td>
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<tr>
<td>Hardness (mg/l as CaCO3)</td>
<td>12.2</td>
<td>80</td>
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<tr>
<td>Alkalinity (mg/l as CaCO3)</td>
<td>16.2</td>
<td>89</td>
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Craven County, North Carolina
Start-up: September 2017

Design flow of 3.0 MGD
Two (2) 12ft diameter x 30ft long isolated cell horizontal vessels
Engineering: McKim & Creed
Craven County, North Carolina  
Start-up: September 2017

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<td><strong>Hardness (mg/l as CaCO3)</strong></td>
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<td><strong>Alkalinity (mg/l as CaCO3)</strong></td>
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<td>55-65</td>
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Craven County, North Carolina
Calcite Loading
New Providence, Bahamas
Start-up: November 2017

Design flow of 1.3 MGD
One (1)12ft diameter x 34ft long isolated cell horizontal vessel
Engineering: King Engineering
New Providence, Bahamas
Start-up: November 2017

Design flow of 1.3 MGD
One (1)12ft diameter x 34ft long isolated cell horizontal vessel
Engineering: King Engineering

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<td>Hardness (mg/l as CaCO3)</td>
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<td>Alkalinity (mg/l as CaCO3)</td>
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<td>TDS</td>
<td>225</td>
<td>&lt;500</td>
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Brunswick Regional, NC
Start-up: 2018

Design flow of 4.0 MGD
Two (2) 12ft diameter x 36ft long isolated cell horizontal vessel
Engineering: Wooten Co.
Brunswick Regional, NC
Calcite Loading

Design flow of 4.0 MGD
Two (2) 12ft diameter x 36ft long isolated cell horizontal vessel
Engineering: Wooten Co.
WHAT’S NEXT?
Simul-Wash™

- Simul-Wash™ is the only sustained backwash process using collapse pulsing technique
- Uses up to 50% less water
- Extended media life
- Versatile: applicable in vertical or horizontal tanks and retrofits
- Smaller backwash chamber reduces plant footprint
Contact Us

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