

MINT FARM WATER TREATMENT PLANT

TREATMENT TECHNOLOGIES FOR WATER QUALITY IMPROVEMENT

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CITY COUNCIL / BHWS D COMMISSIONER
SPECIAL JOINT MEETING
NOVEMBER 3, 2016

Dissolved Oxygen Addition

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Benefits

- Stabilize distribution system
- Inhibit hydrogen sulfide reversion
- Improve overall T&O profile
- Potentially reduce dependency on Cl₂ to maintain ORP
- Microbial growth on filter media may remove organic N

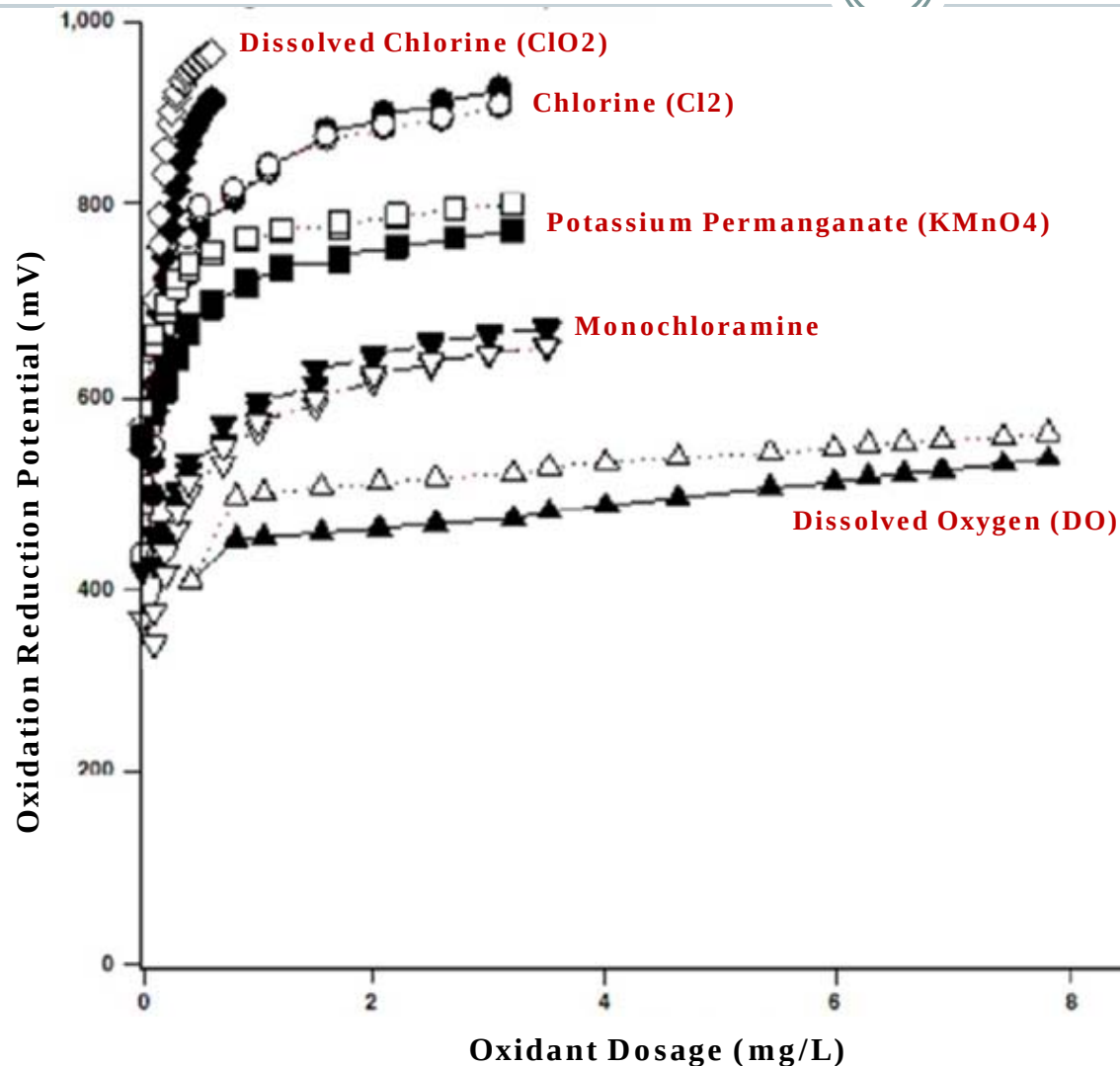
Drawbacks

- Potential over-aeration
- Incremental DO addition
- No guarantee of reduced Cl₂ dose



Dissolved Oxygen Addition

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- Most stable oxidant
- Maintain ORP ~ 500 even at full loss of chlorine
- Does not generate DBP's
- No health based or aesthetic standard (MCL/SMCL)
- Can be adjusted to maximize distribution system benefit

Technologies for Dissolved Oxygen Addition

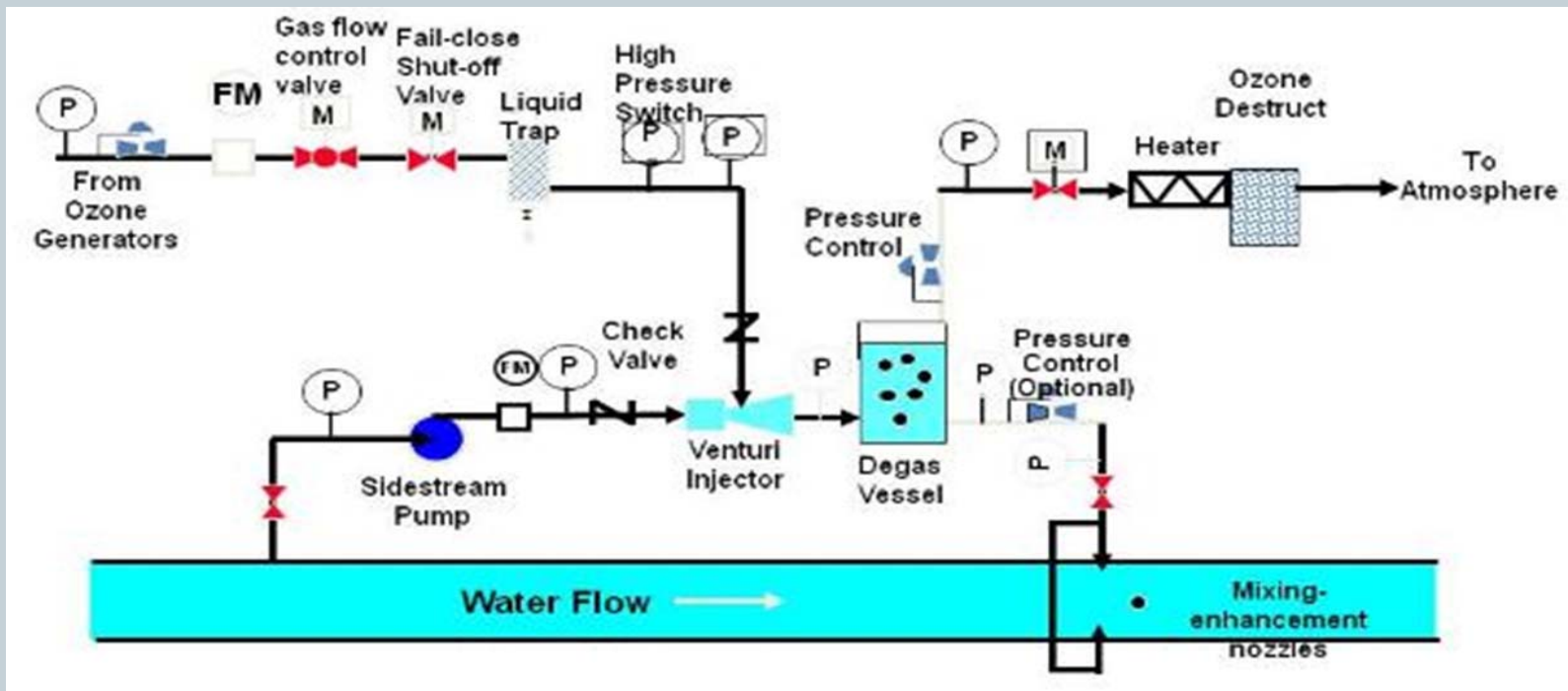
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Option	Liquid Oxygen	On-Site O ₂ Generation	Air Injection	Hydrogen Peroxide
Capital Cost	\$1.5 – 2.0M	\$2.0 – 2.5M	\$0.2 – \$0.5M	\$0.5-\$1.0M
Benefits	• Common • Equipment • Low O&M	• Common Equipment	• Common Equipment • Low Cost	• Additional Oxidation may benefit T&O issues
Drawbacks	• Vapor is flammable • Worker Safety • Public Concern	• Indoor Installation • Higher Operating Cost than LOX	• Nitrogen Addition (Air is 78% nitrogen)	• Highest Operating Cost

Air Injection System

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- Venturi System with small horsepower side-stream pump
- Flow Control Valve for 90%+ Gas Transfer Efficiency
- Instrumentation and control systems for SCADA integration
- Inject pre- or post- filter to maximum water quality benefit



Air Injection System

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Step	Time to Implement	Completion Date
Water Quality Testing	1-2 months	January-2017
Project Report	2 months	January-2017
DOH Approval	1 month	February-2017
Design	4 months	April-2017
Permitting	1 months	May-2017
Construction	4-5 months	October-2017
Start Up/Incremental Use	3-6 months	February-2018

Technologies for Silica Removal

					NOT RECOMMENDED	
Option	Reverse Osmosis	Lime Softening	Precip w/o Softening	Electro-coagulation	Ion Exchange	Activated Alumina
Feasibility	Effective	Effective	Effective	Effective	Effective	Effective
Capital Cost	\$20-\$30M	\$15-20M	\$10-15M	Unknown	\$15-20M	\$15-20M
Testing	Flat Plate Test	Jar Test	Jar Test	Jar and Pilot Testing	Pilot Test	Small Scale Column Test
Benefits	• Organic N • Softening • H₂S • Blending	• Organic N • Softening			Softening	
Drawbacks	• Low Recovery (increased waste)	• O&M • Sludge	• TDS • Sludge	• Sludge (less than others)	• Resin Fouling • Demin • T&O	• O&M

Silica Removal by Reverse Osmosis

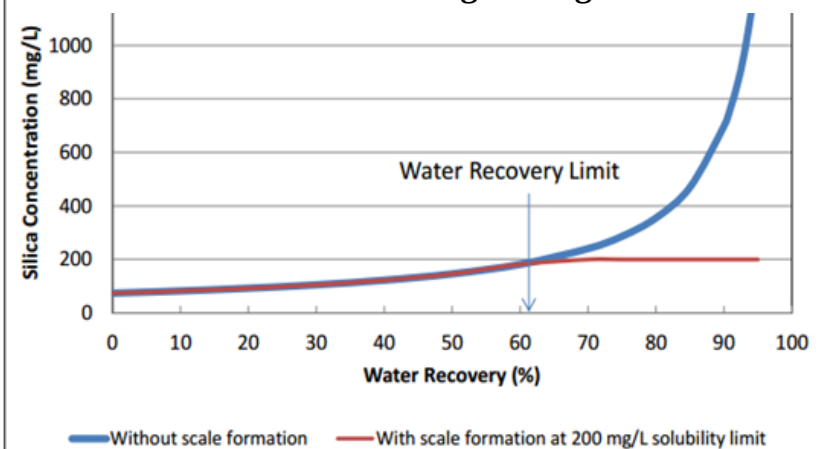


3 MGD Brackish Water: Hilton Head, SC
Installation Cost (2006): \$9 million

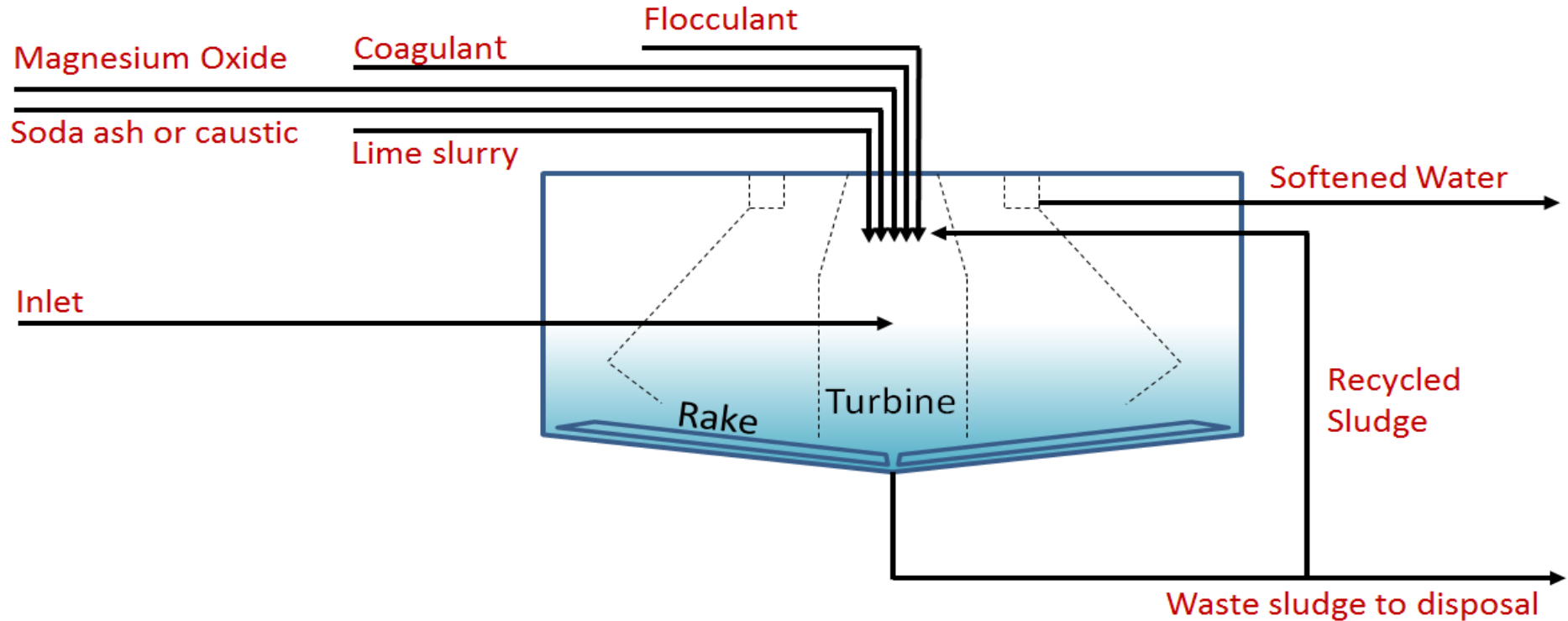
- 3 Flow Streams
 - Feed (unfinished water in)
 - Concentrate (recycle flow)
 - Permeate (finished water out)
- Feed = Concentrate + Permeate
- $\text{Recovery} = \frac{\text{Permeate}}{\text{Feed}} = \frac{\text{Product Out}}{\text{Water In}}$



Expected silica level in concentrate for feedwater containing 74 mg/L silica



Silica Removal by Lime Softening



- Warm or hot process often used in oil extraction to protect steam generators
- Solid magnesium oxide (MgO) is added to remove silica, forms $\text{Mg}(\text{OH})_2$
- Silica adsorbs onto $\text{Mg}(\text{OH})_2$; higher affinity for fresh (young) surfaces



Opportunity for higher removal efficiency using MgCl_2 instead of MgO



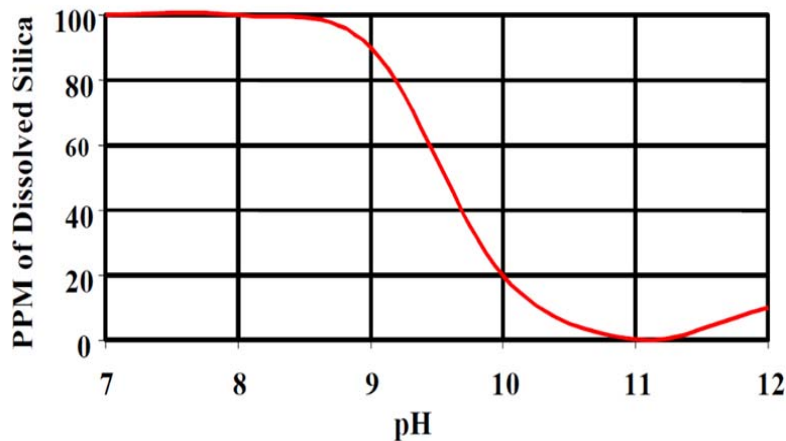
Opportunity to reduce operating costs using dissolved Mg with acid at $< \text{pH}$

Silica Removal by Precipitation

Magnesium based

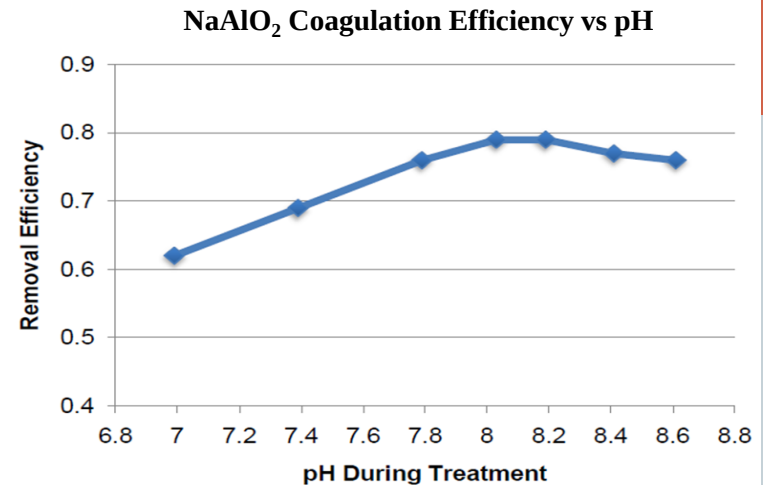
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Sodium Aluminate based



Considerations:

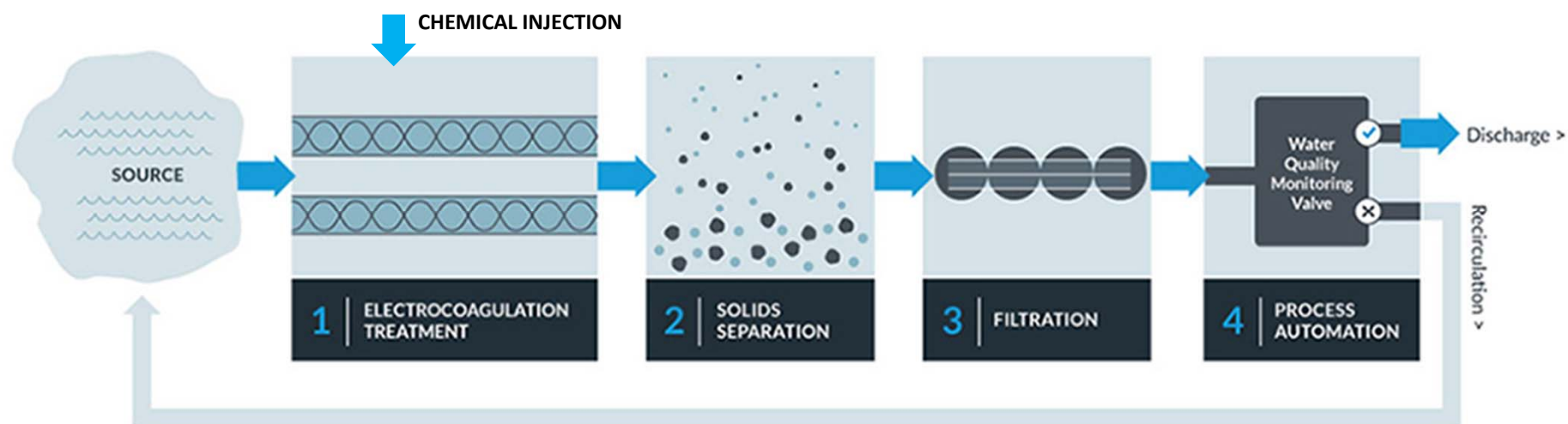
- Best SiO_2 removal: 22%
- Efficiency: $0.15 \text{ SiO}_2/\text{Mg}$
- Requires $\text{pH} > 10.5$
- Slow to precipitate and settle
- Sodium hydroxide demand



Considerations:

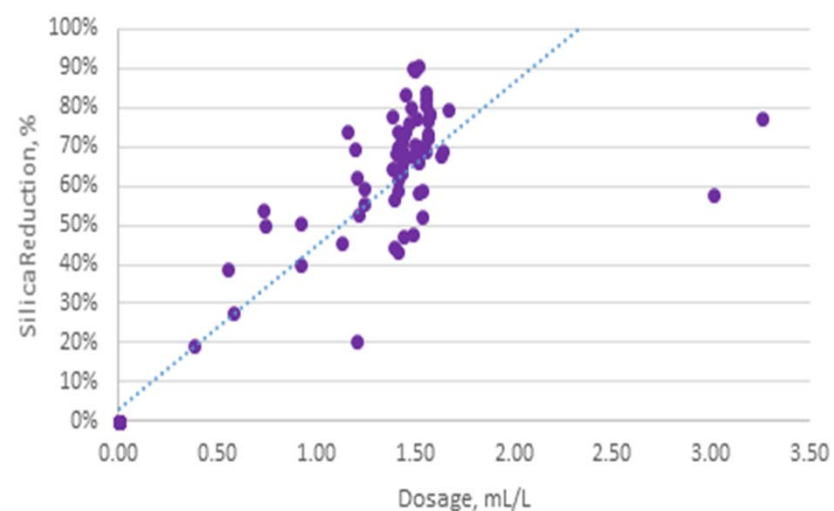
- Best SiO_2 removal: 79%
- Efficiency: $0.47 \text{ SiO}_2/\text{NaAlO}_2$
- Requires $8.0 < \text{pH} < 8.2$
- Slightly alkalizing
- Small sulfuric acid demand

Silica Removal by Electrocoagulation



- Emerging Technology, around since 1889 but typically < 1 MGD
- Drinking water, wastewater, stormwater and industrial uses
- Forms dissolution and hydrolysis of metals at the anode (Fe or Al)
- Forms hydroxyl ions and hydrogen gas at the cathode that may have benefits for oxidation and microbial disinfection

Dosage vs % Silica Reduction



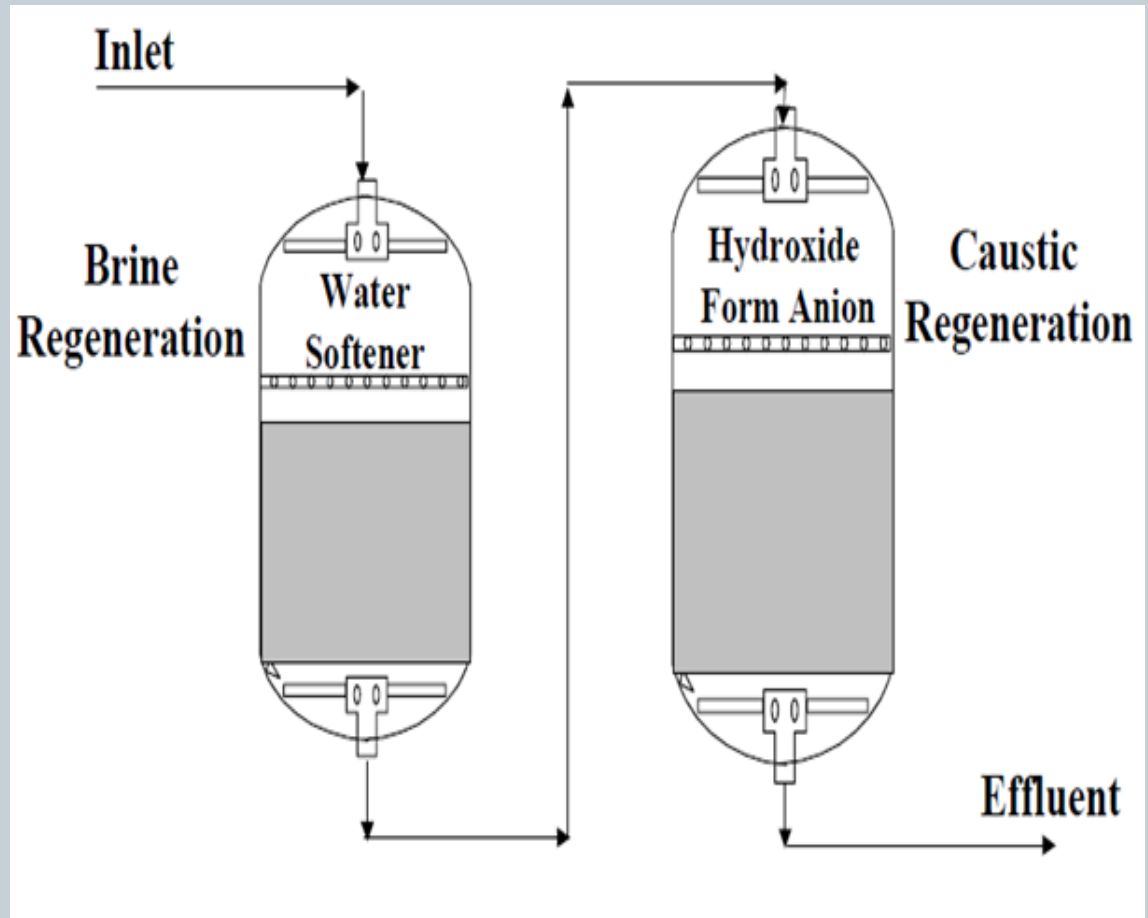
Data showing silica reduction process using EC with chemicals to treat RO concentrate at 100 mg/L of silica.

- WaterTectonics, 8/16/2016

Silica Removal by Ion Exchange

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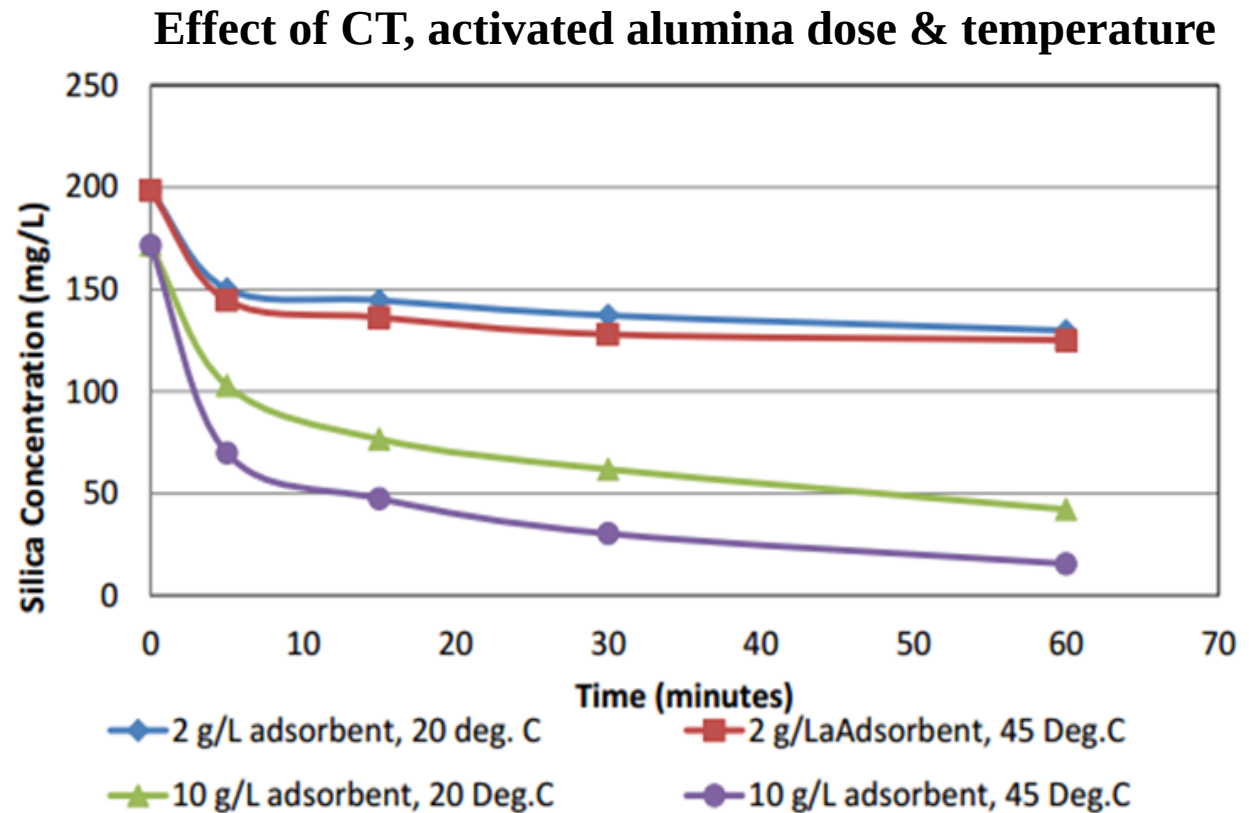
- Desilizer (poor man's demineralizer)
- Fouling is common
- Regeneration requires excess caustic and may require heat
- Inefficient Process
- Some systems waste 30%



Silica Removal by Activated Alumina

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- Regenerate using caustic followed by acid
- Media fouling by silica
- Long contact times (CT)
- Strips naturally occurring fluoride



Silica removal by adsorption, Minara RO Brine

Financial Summary

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	Budget Amount	Added /Spent	Funds Available	Additional Funds Required	Total Contract
Original Contract	\$217,256	-	\$217,256	-	\$217,256
Amendment 1	\$327,550	\$327,550	\$544,806	-	\$544,806
Total Contract	\$544,806	(\$390,102)	\$154,704	-	\$544,806
DO Design (only)	\$166,564	-		\$11,860	\$556,666
Si Concepts (only)	\$67,296	-		\$0	\$544,806
DO & Si Concepts	\$233,860	-		\$79,156	\$623,962

Discussion

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- Provide direction to staff regarding options:
 - Proceed with design and construction of Dissolved Oxygen
 - Proceed with evaluation of Silica Removal Technologies
 - Other