MINT FARM
WATER TREATMENT PLANT

TREATMENT TECHNOLOGIES FOR WATER QUALITY IMPROVEMENT

CITY COUNCIL / BHWSD COMMISSIONER SPECIAL JOINT MEETING

NOVEMBER 3, 2016

Dissolved Oxygen Addition

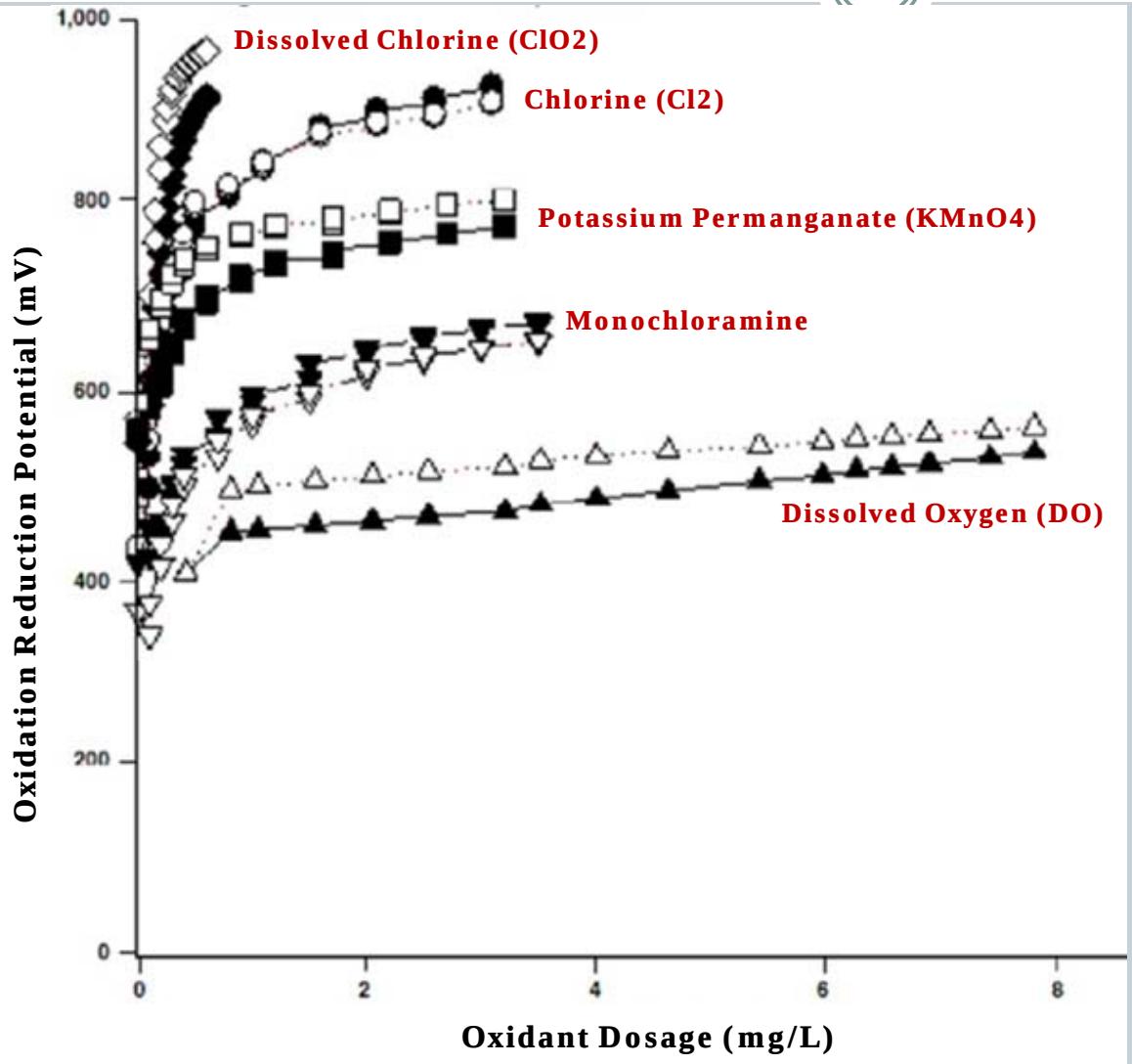
Benefits

- 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



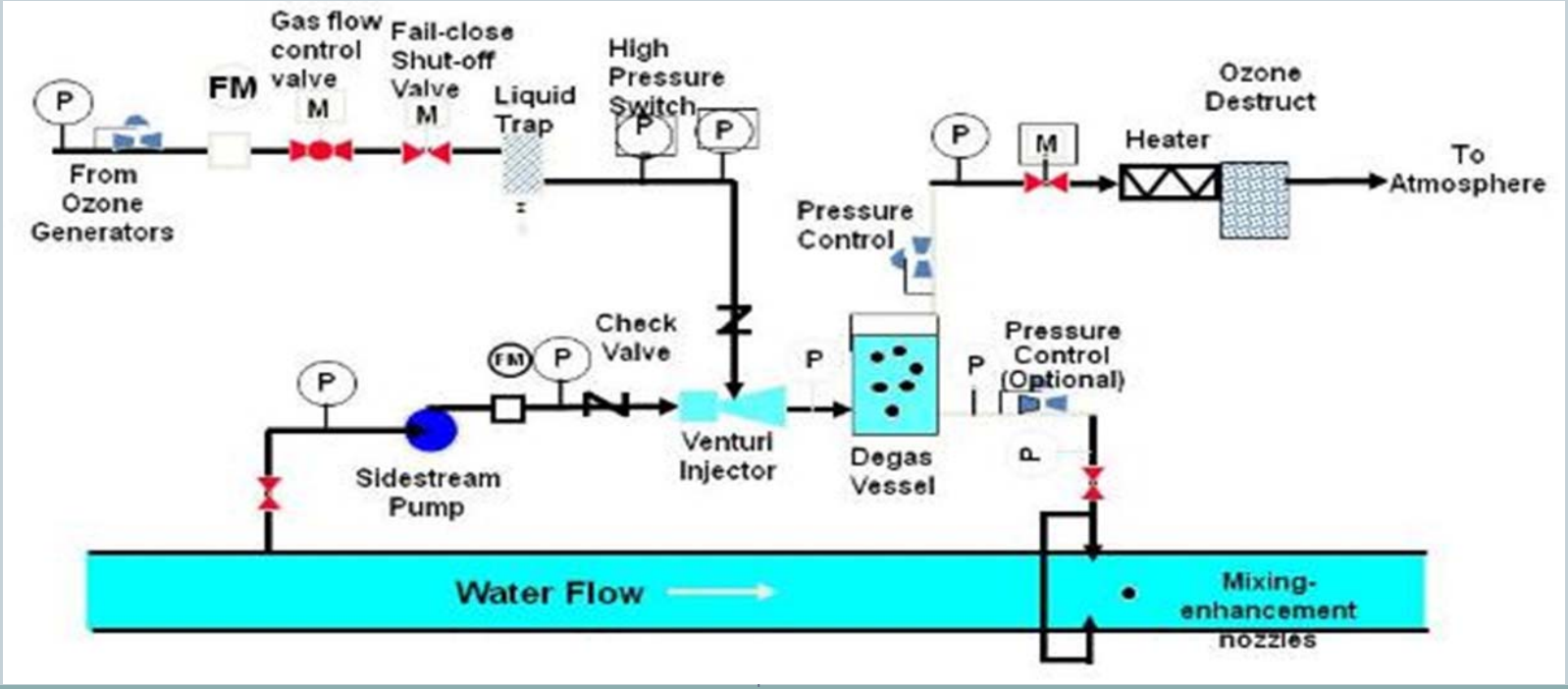
- Most stable oxidant
- Maintain ORP ~ 500 even at full loss of chlorine
- Does not generate DBP's
- No health based or aesthetic standard (MCL/SMCL)
- Can be adjusted to maximize distribution system benefit

Technologies for Dissolved Oxygen Addition

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

- 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

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

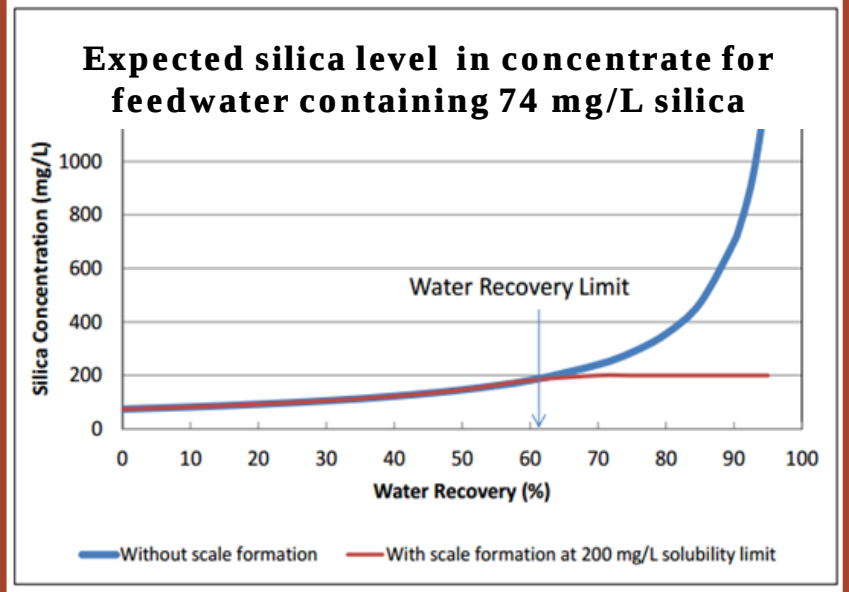
NOT RECOMMENDED

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

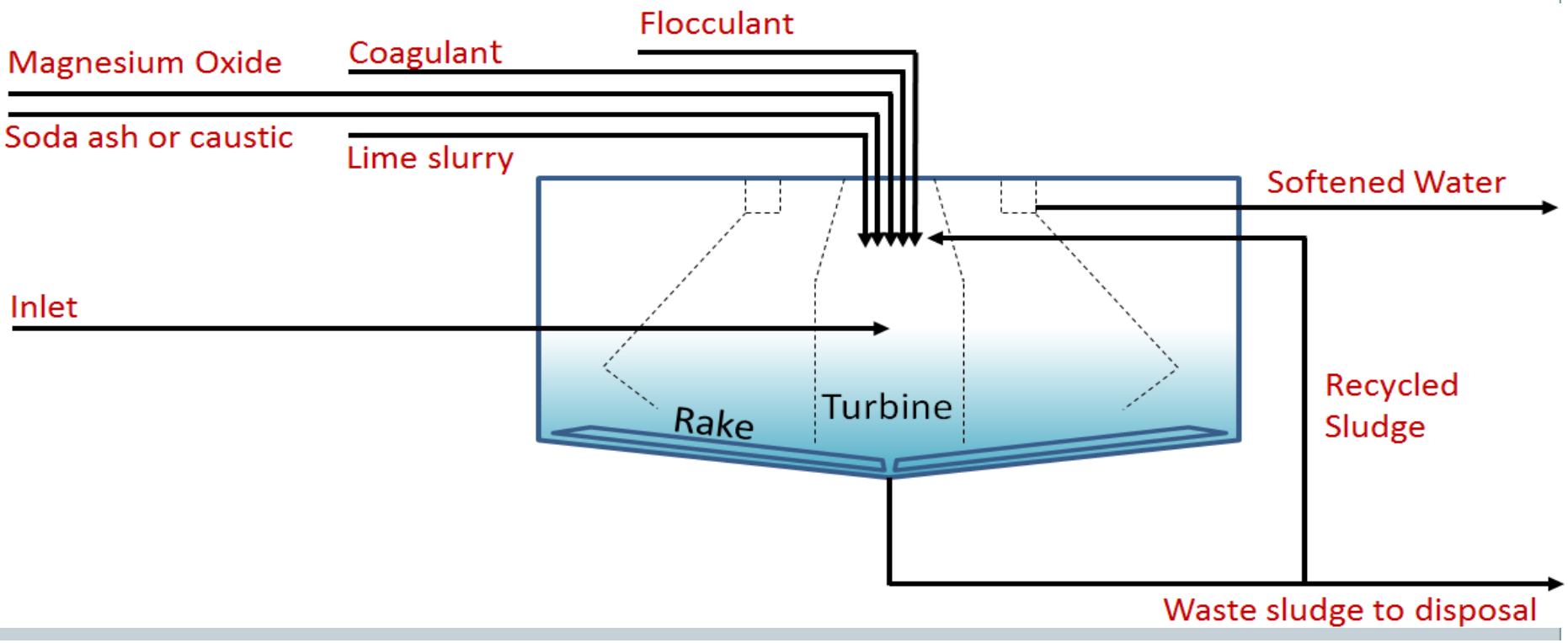
Silica Removal by Reverse Osmosis

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
- **Recovery** $= \frac{\textbf{Permeate}}{\textbf{Feed}} = \frac{\textbf{Product Out}}{\textbf{Water In}}$



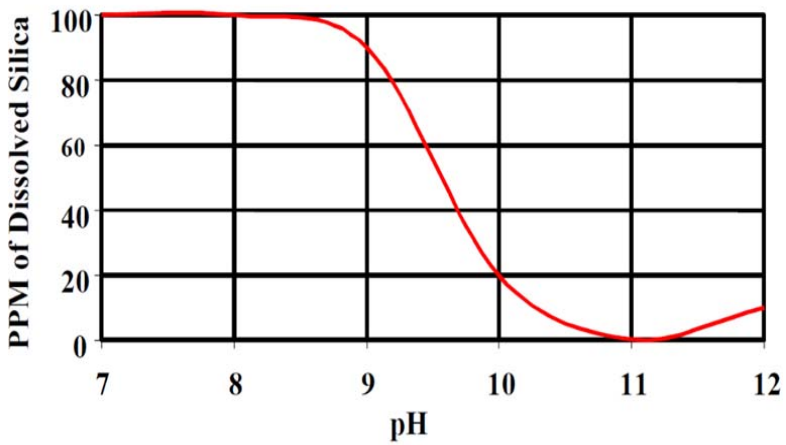
Silica Removal by Lime Softening



- Warm or hot process often used in oil extraction to protect steam generators
- Solid magnesium oxide (MgO) is added to remove silica, forms Mg(OH)2
- Silica adsorbs onto Mg(OH)2; higher affinity for fresh (young) surfaces
- Opportunity for higher removal efficiency using MgCl2 instead of MgO
- Opportunity to reduce operating costs using dissolved Mg with acid at < pH

Silica Removal by Precipitation

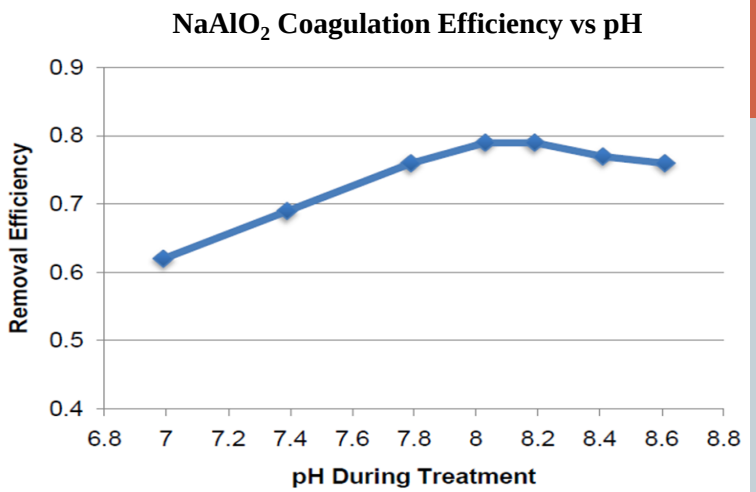
Magnesium based



Considerations:

- Best SiO_2 removal: 22%
- Efficiency: 0.15 SiO_2/Mg
- Requires pH > 10.5
- Slow to precipitate and settle
- Sodium hydroxide demand

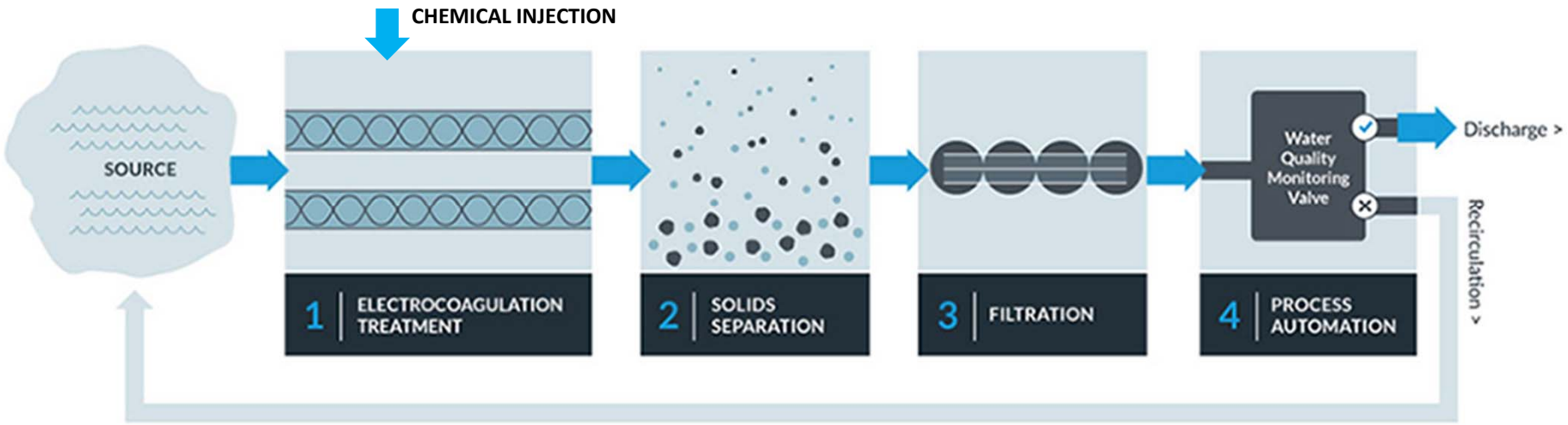
Sodium Aluminate based



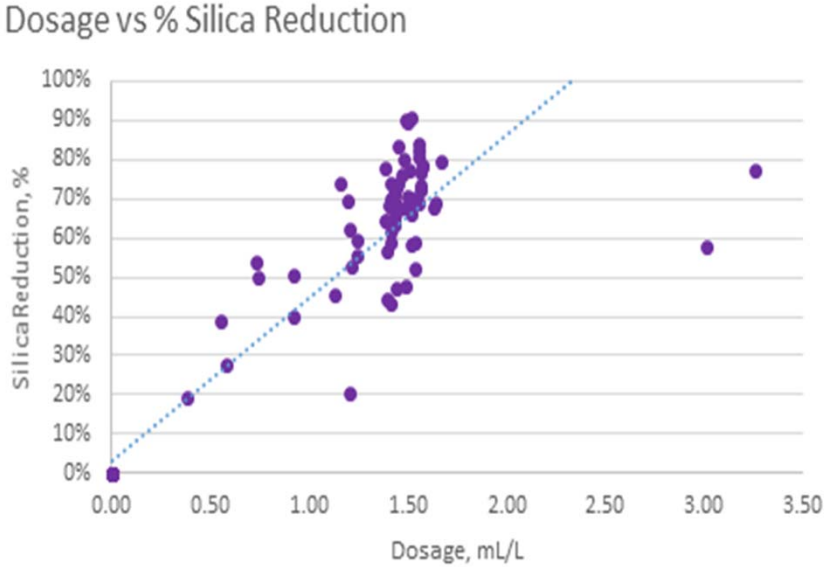
Considerations:

- Best SiO_2 removal: 79%
- Efficiency: 0.47 SiO_2/$NaAlO_2$
- Requires 8.0 < 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

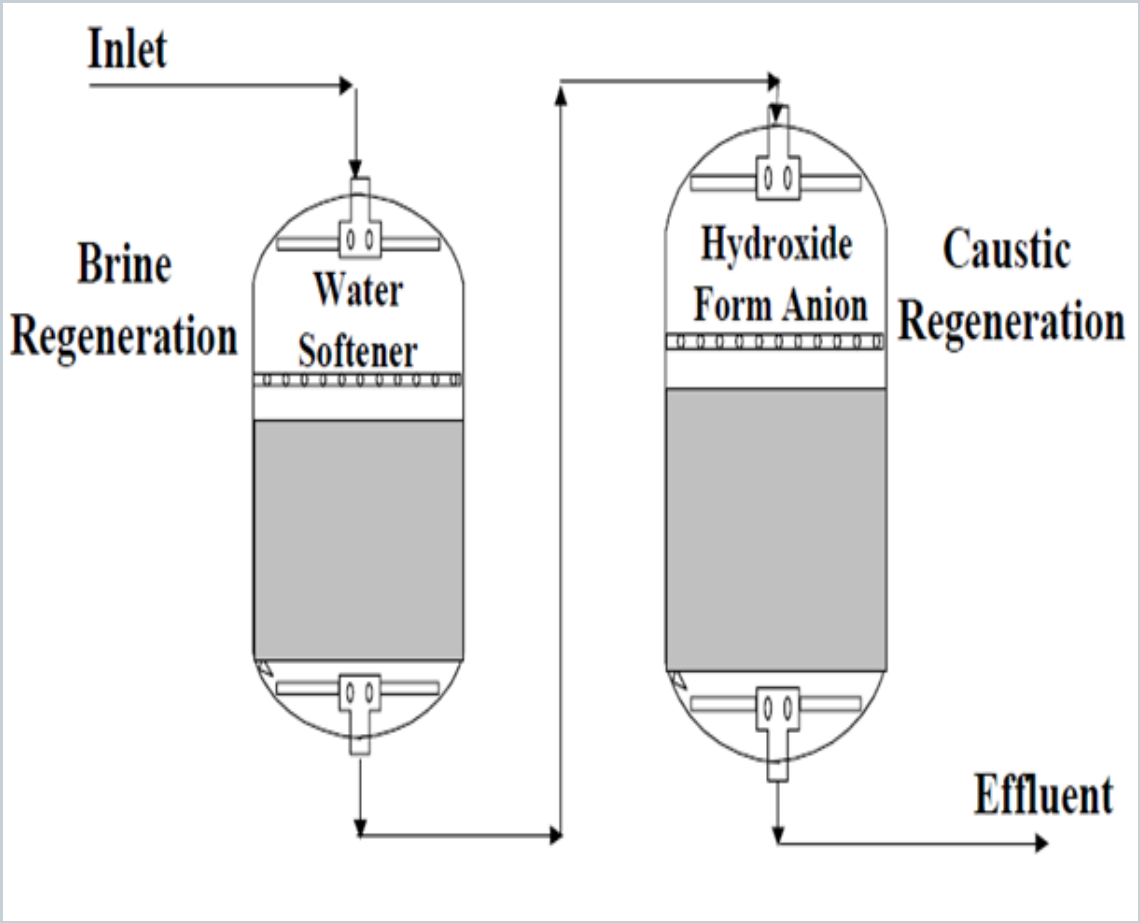


Data showing silica reduction process using EC with chemicals to treat RO concentrate at 100 mg/L of silica.

- WaterTectonics, 8/16/2016

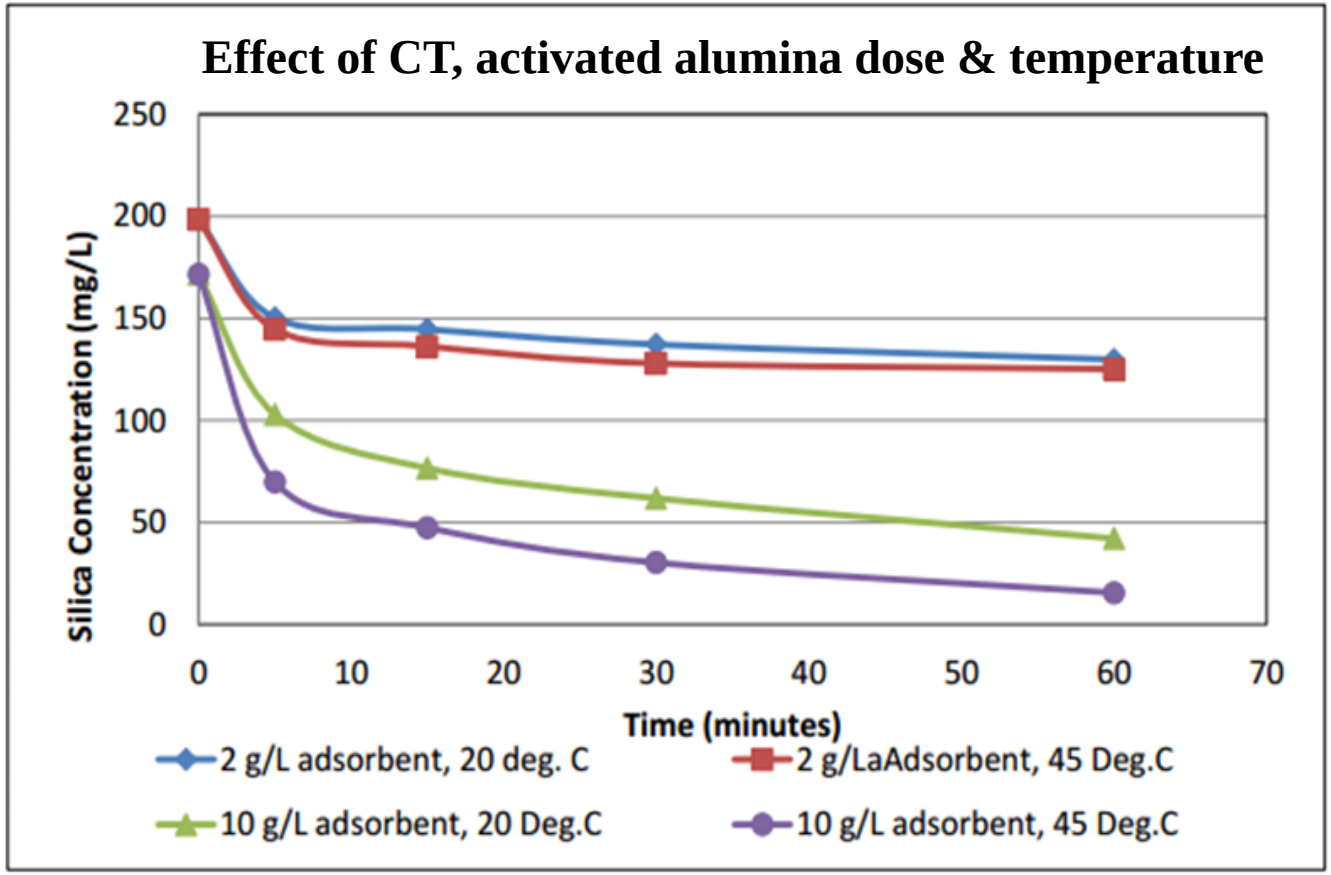
Silica Removal by Ion Exchange

- 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

- 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

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

Financial Summary

	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

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