# Deionization Part II

## Keys to success in a service DI Environment

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RESINTECH® INC.

INNOVATIONS IN ION EXCHANGE

# Topics for Discussion

- Capacity Review from Part 1 (Mixed Bed)
- Resin Regeneration Efficiency
- Mixed Bed Regeneration
- Good Housekeeping
- Troubleshooting

# Types of Ion Exchange Resins

**Cation Resins**

Strong & Weak Acid

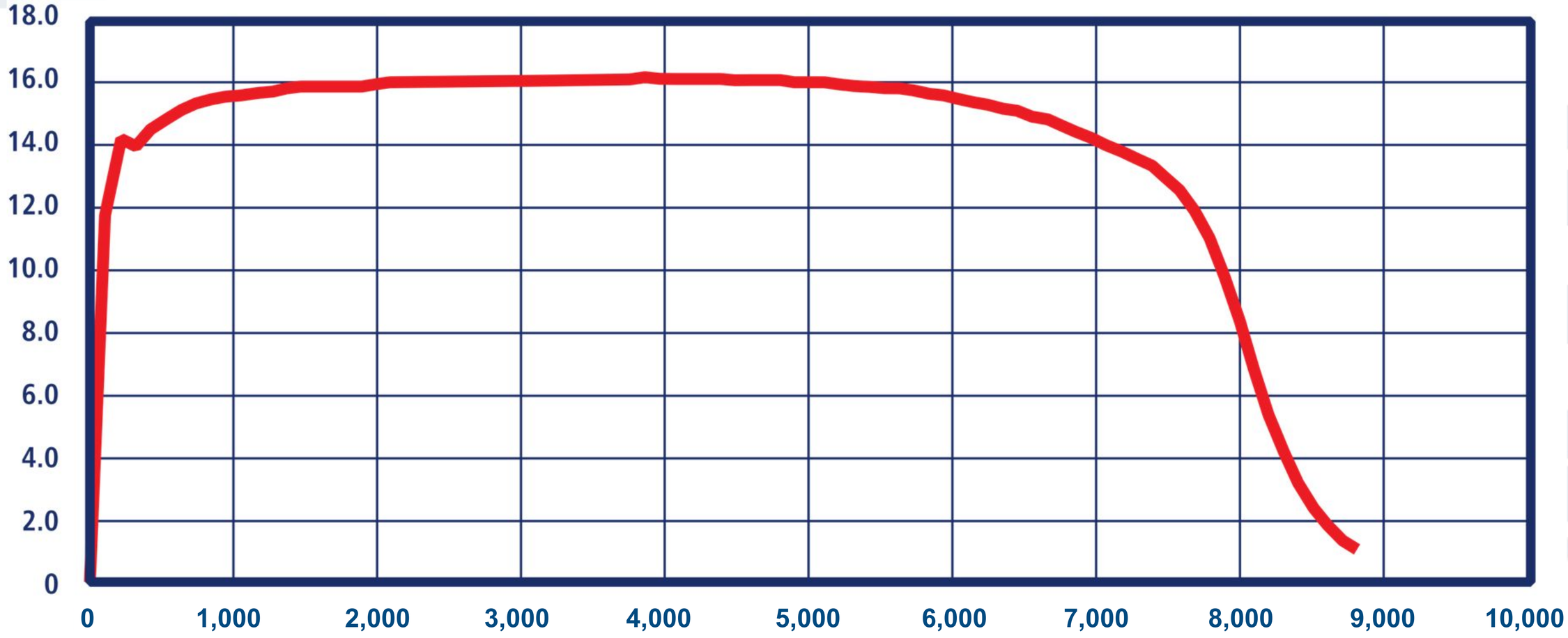
**Anion Resins**

Strong & Weak Base

**Mixed Bed Resins**

# Typical Mixed Bed Exhaustion

## Field Regenerated Resin *note y-axis Resistivity (MegOhm)



# Capacity Calculator (Example)

## Field Regenerated Mixed Beds

| | | | | | Exhaustion | | | |
|---|---|---|---|---|---|---|---|---|
| TDS as $CaCO_3$ | $CO_2$ ppm as $CO_2$ | $CO_2$ ppm as $CO_3$ | TEA ppm as $CO_3$ | TEA gr/gal as $CaCO_3$ | 17 meg end gal/ft3 @ 4,000 gr/$ft^3$ | 10 meg end gal/ft3 @ 5,000 gr/$ft^3$ | 1 meg end gal/ft3 @8,000 gr/$ft^3$ | 50K end gal/ft3 @10,000 gr/$ft^3$ |
| 1 | 2 | 2.28 | 3.28 | 0.19 | 20,853.66 | 26,067.07 | 41,707.32 | 52,134.15 |
| 1 | 5 | 5.7 | 6.7 | 0.39 | 10,208.96 | 12,761.19 | 20,417.91 | 25,522.39 |
| 1 | 20 | 22.8 | 23.8 | 1.39 | 2,873.95 | 3,592.44 | 5,747.90 | 7,184.87 |
| 200 | 5 | 5.7 | 205.7 | 12.03 | 332.52 | 415.65 | 665.05 | 831.31 |
| 200 | 20 | 22.8 | 222.8 | 13.03 | 307.00 | 383.75 | 614.00 | 767.50 |

# Capacity Comparison

## Rules of Thumb

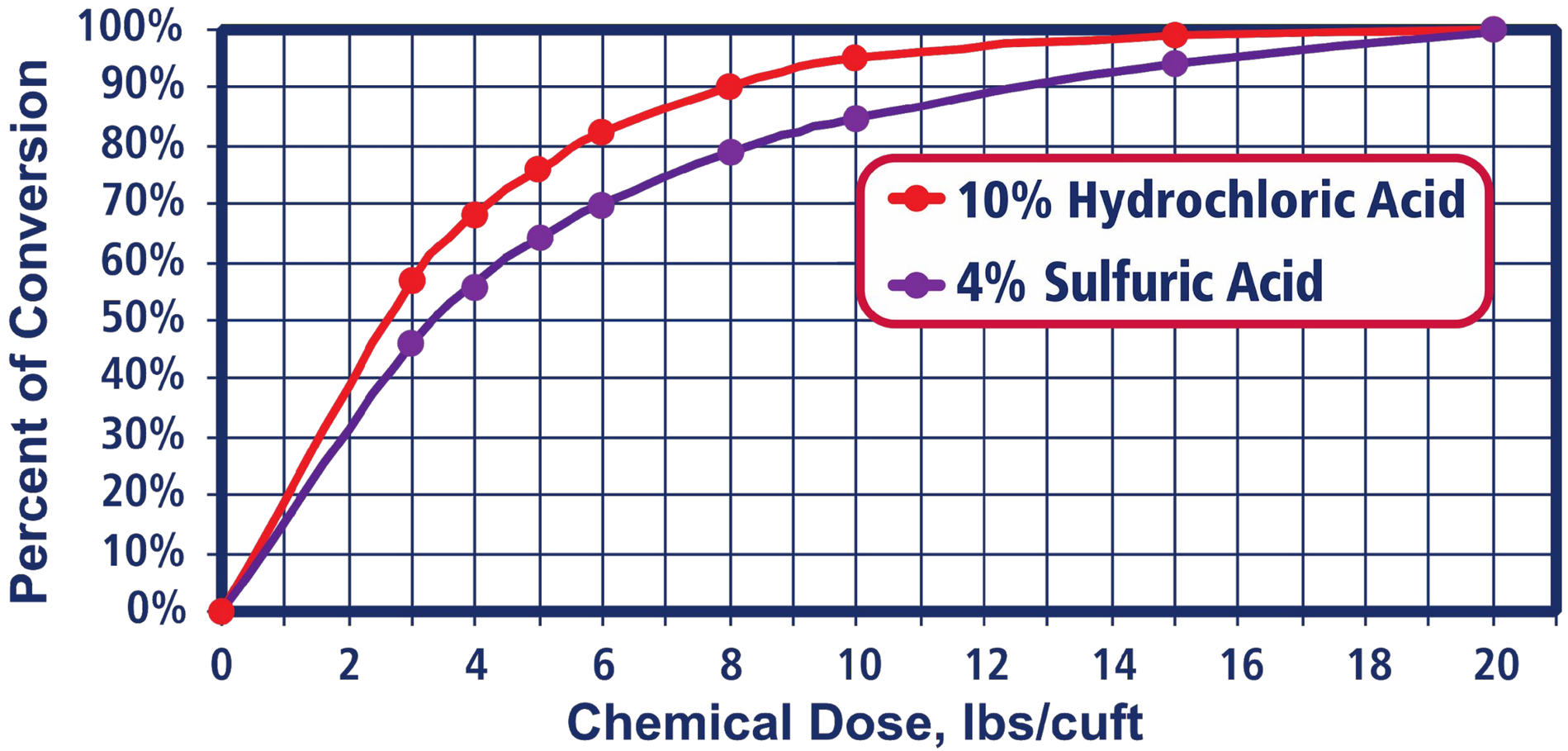
| Resin Type | Virgin (Grains / Cuft) | Regenerated (Grains / Cuft) |
|---|---|---|
| SAC (H+) | 38,000 | 30,000 |
| SBA (OH-) | 30,000 | 15,000 |
| Mixed Bed (H+/OH-) | 13,000 | 8,000 |

# Regeneration

- Capacity dependent upon efficiency of regeneration
  - Chemical dose and ions being removed from the resin
- The Law of Diminishing returns
    - 8-10 Lbs per Cuft of Acid (HCl) and Caustic (NaOH)
- Virgin resin capacity much higher than field regenerated resin

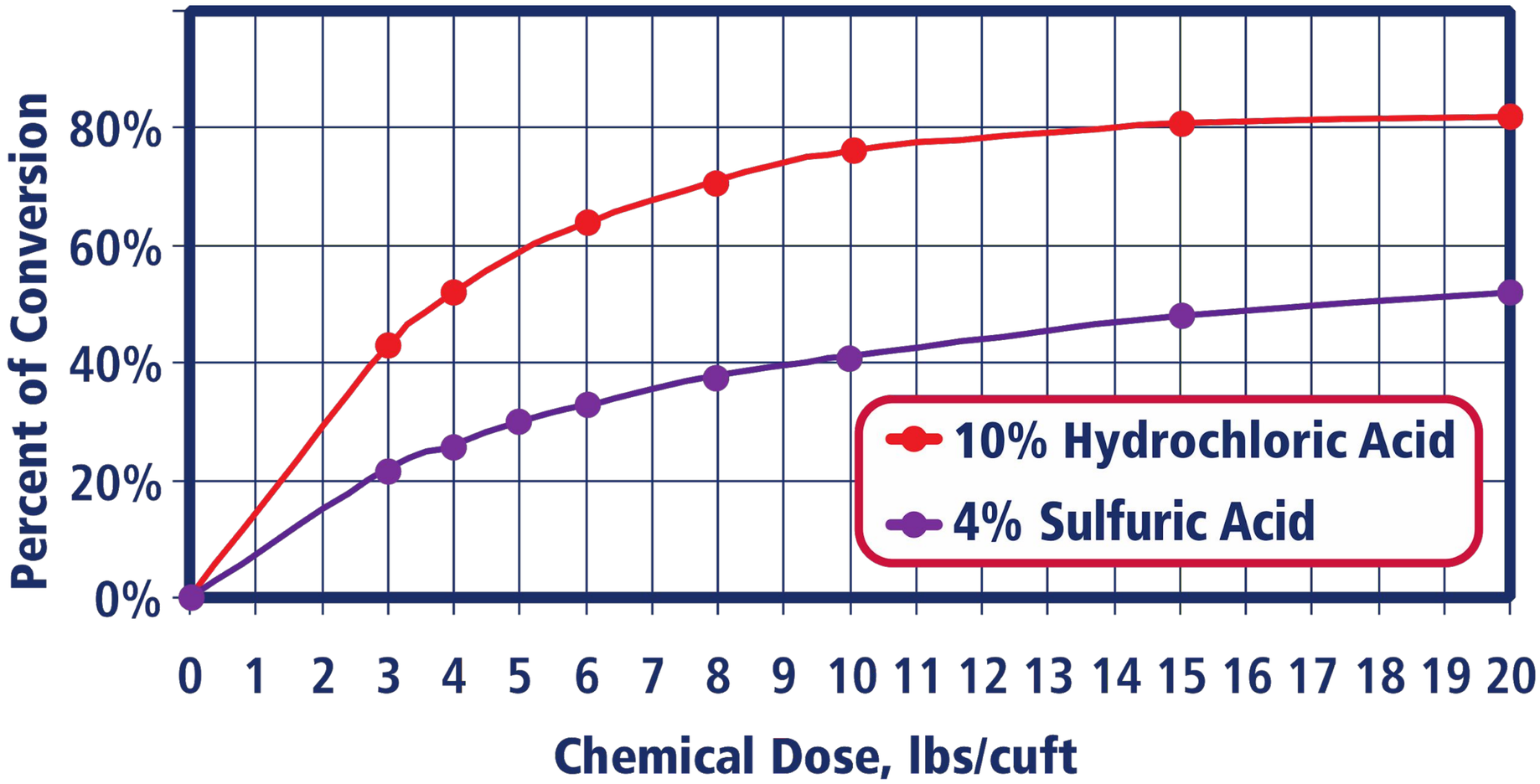
# Regeneration of CG8 (BL)

## from Sodium form to Hydrogen Form



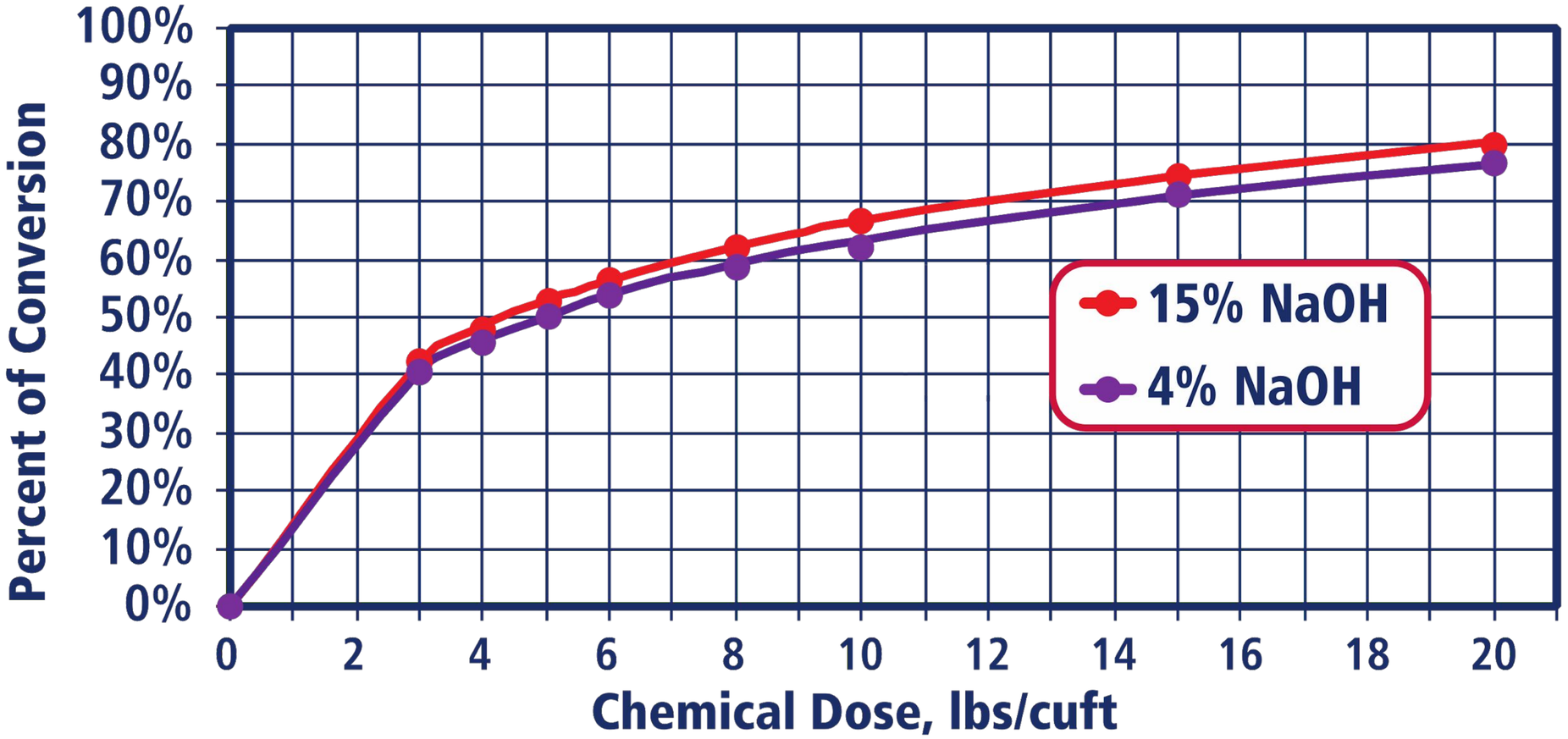
# Regeneration of CG8 (BL)

## from Calcium form to Hydrogen Form



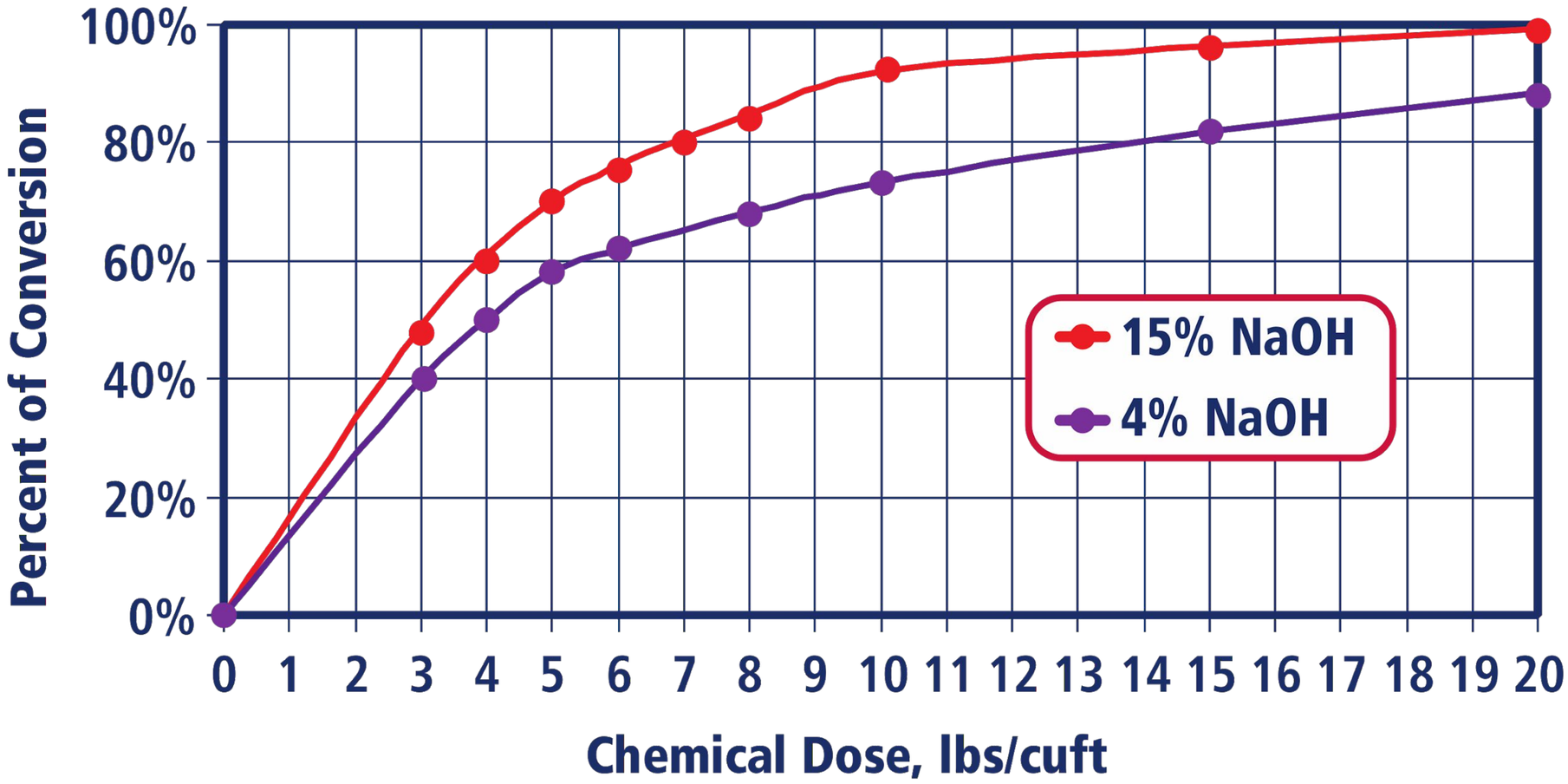
# Regeneration of SBG1P

## from Chloride form to Hydroxide Form



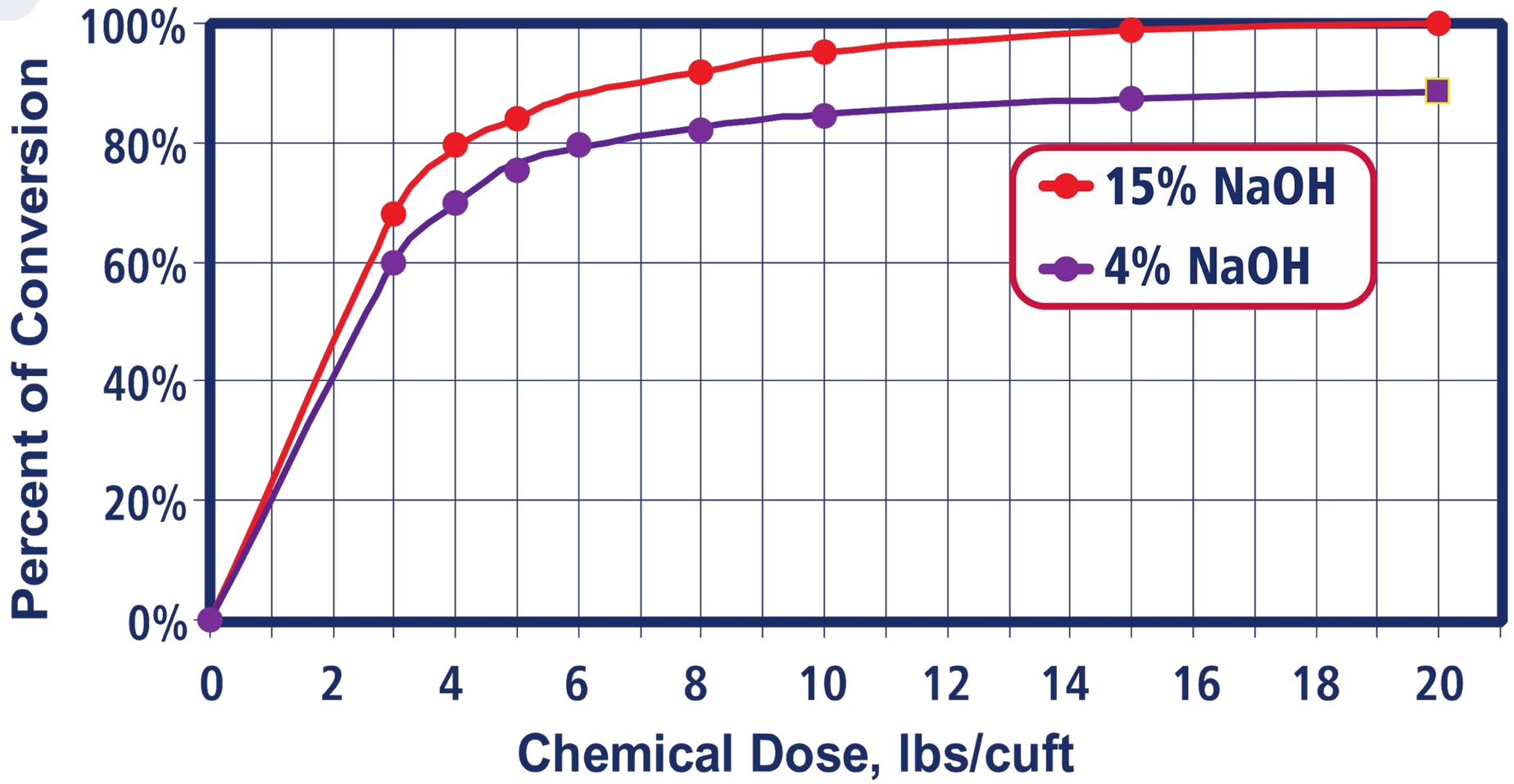
# Regeneration of SBG1P

## From Sulfate form to Hydroxide Form



# Regeneration of SBG1P

## From Bicarbonate form to Hydroxide Form

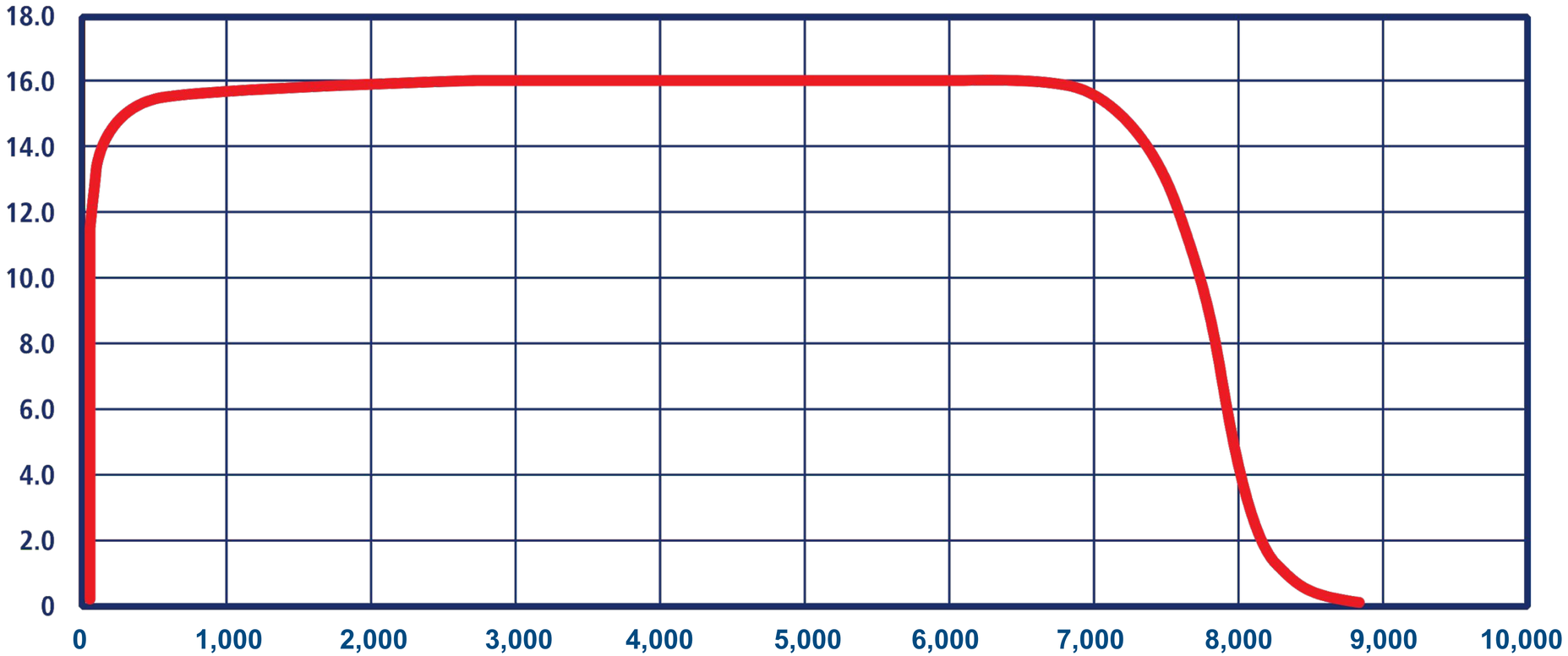


# Capacity & Effluent Water Quality

- Function of what was on the resin and regeneration dose
  - Least strongly held ion first to come off
  - $Na^+$ for SAC
  - $SiO_2$ for SBA
    - Heated NaOH Required to remove during regeneration (100-120º F)
- Regeneration Dose
  - Higher the dose, the lower the leakage

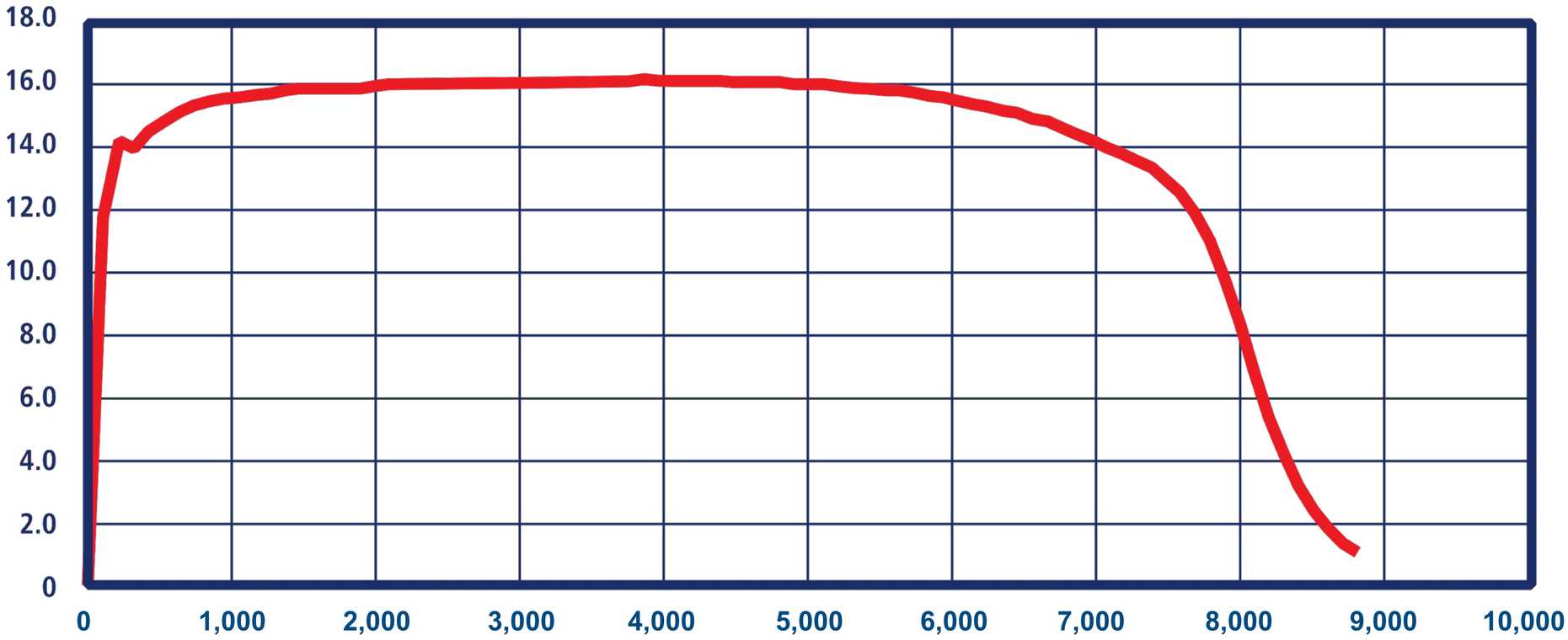
# Typical Mixed Bed Exhaustion

## (Virgin Resin)



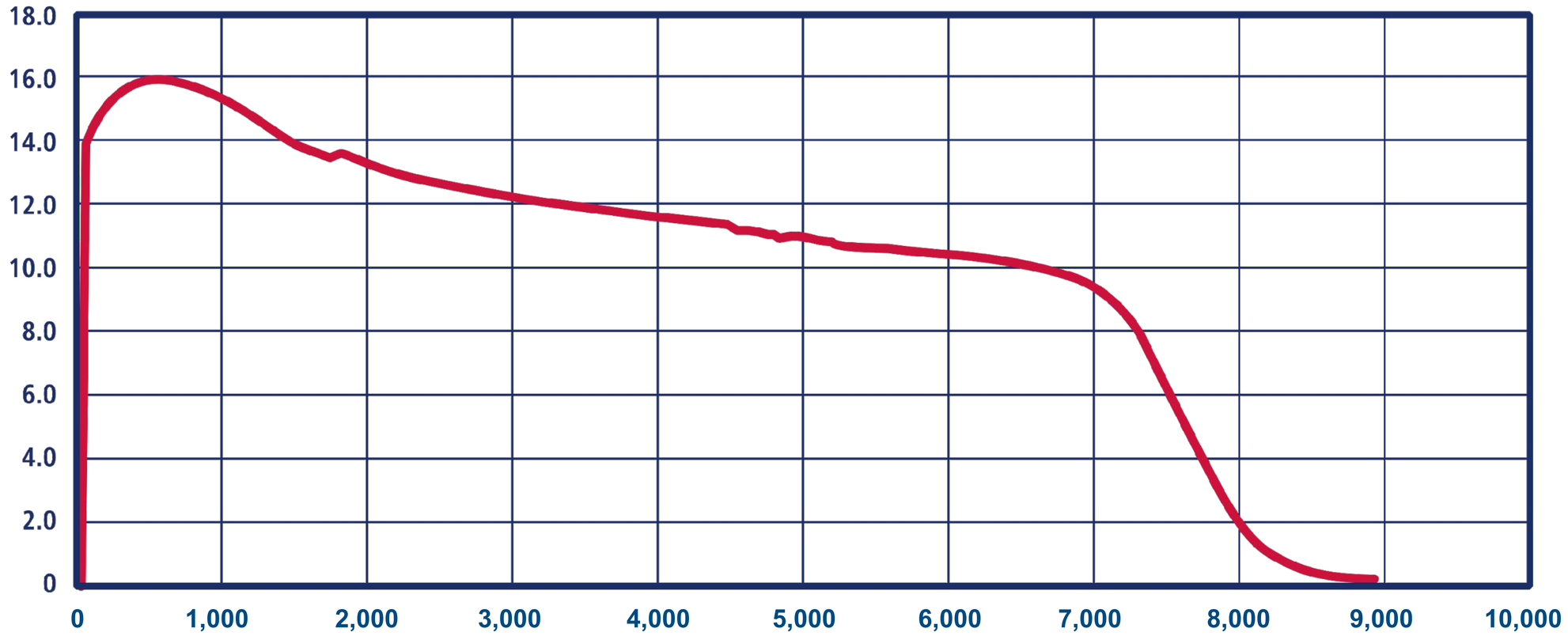
# Typical Mixed Bed Exhaustion

## (Regenerated Resin)



# Typical Mixed Bed Exhaustion

## (Regenerated Resin)

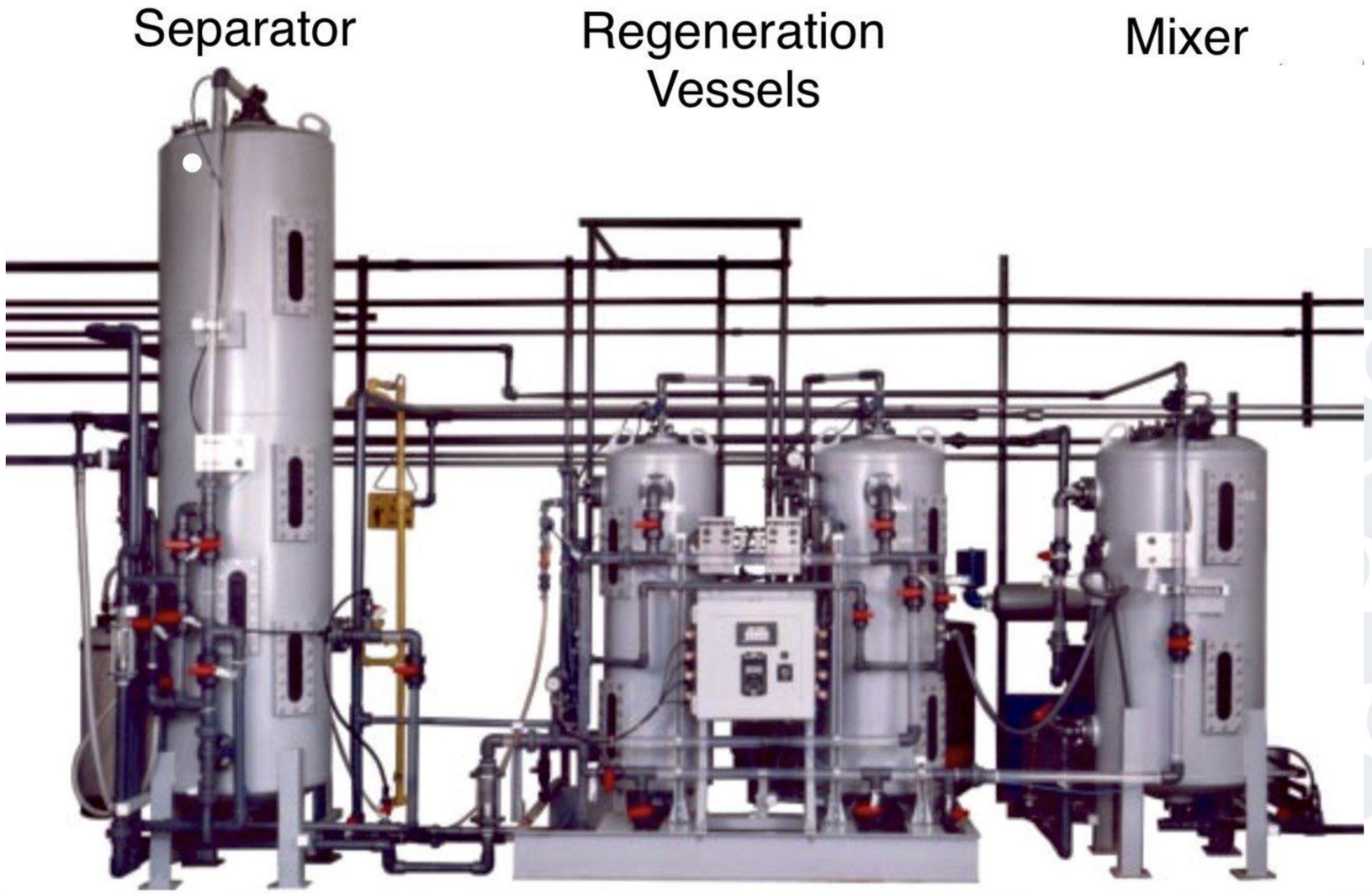


# Mixed Bed Regeneration

- Review in the context of Portable or Service Exchange Deionization
  - PEDI or SDI
- End goal to achieve consistent high effluent quality of water for as many gallons as possible
- Best way to achieve your goal is to pay attention to the details!

# Mixed Bed Regeneration

## Classic Ecodyne Style Regeneration Plant



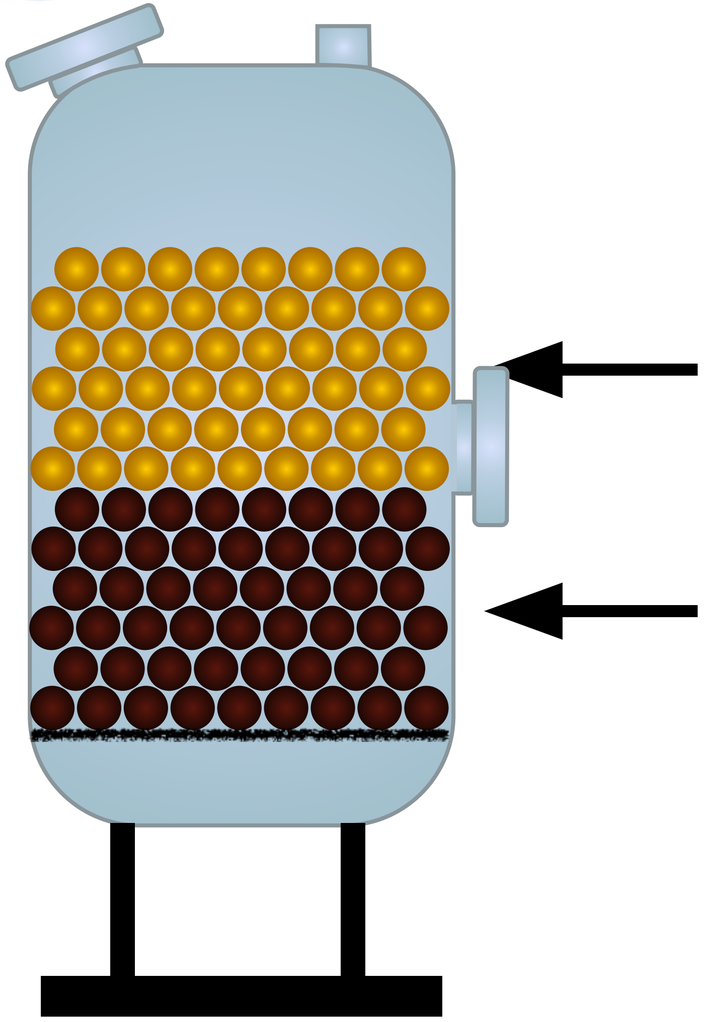
# Mixed Bed Regeneration

- Backwash & Separation
- Chemical Addition & Rinse
- Mixing
- Loading into Vessels
- Storage

# Backwash & Separation

- A flow of water is passed upward through the resin bed
- The resin bed expands and fluidizes
- Purpose
  - To remove suspended solids and resin fines
  - Cation and anion resin separation

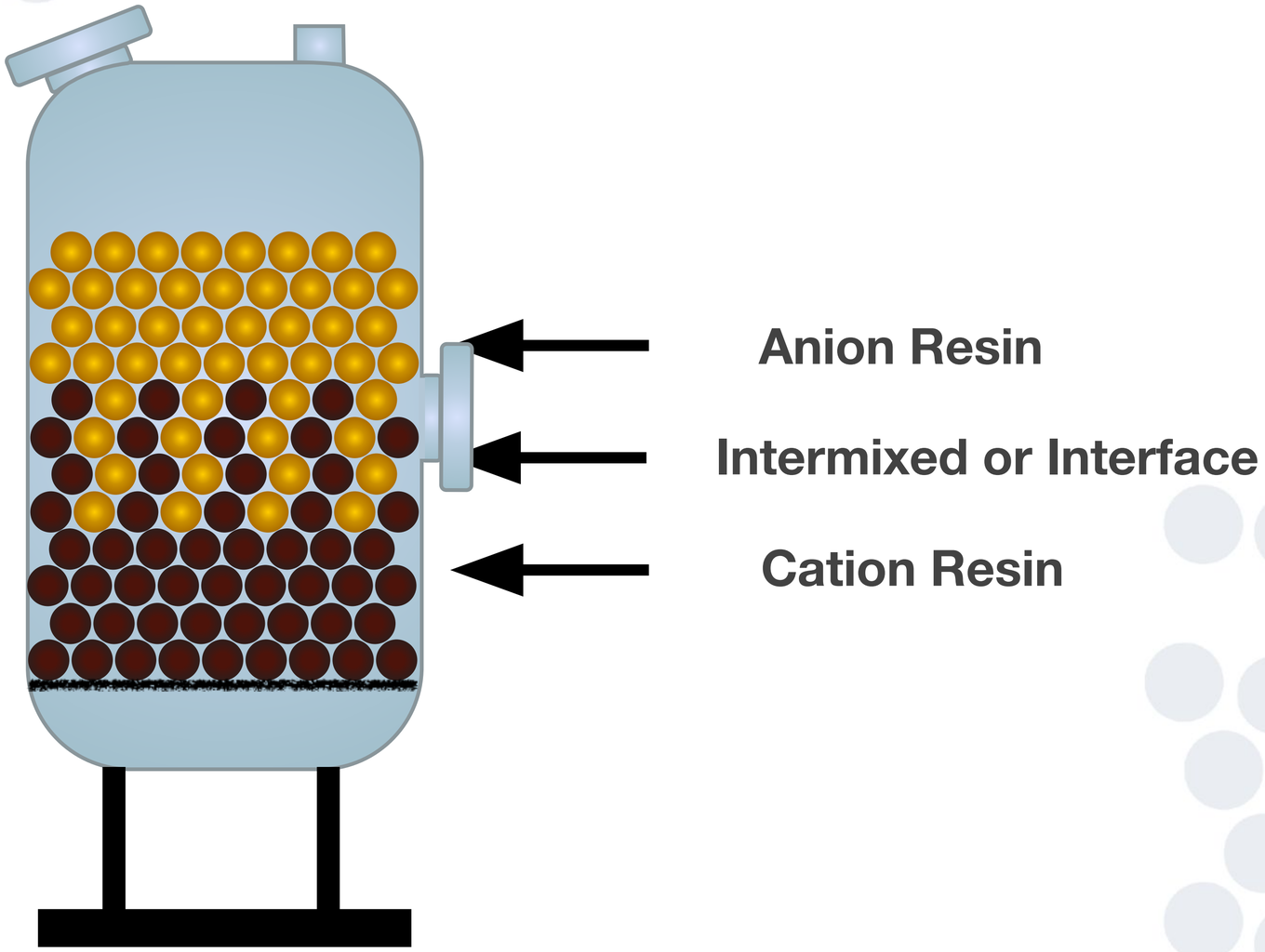
# Ideal Resin Separation



Anion Resin

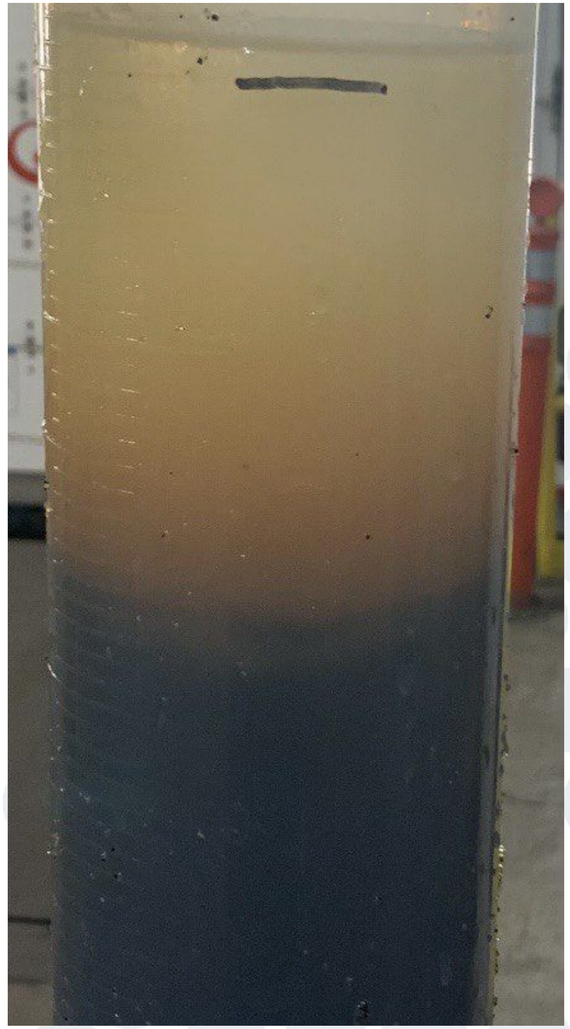
Cation Resin

# Realistic Resin Separation



# Factors Effecting Separation

- Limited expansion space
  - Don’t overload separation column
- Static attraction (stickiness) of resin
- Separation column internals
- Too high of backwash flow rate
- Ionic forms of resin
  - Exhausted resin separates easier (Brine Kill)



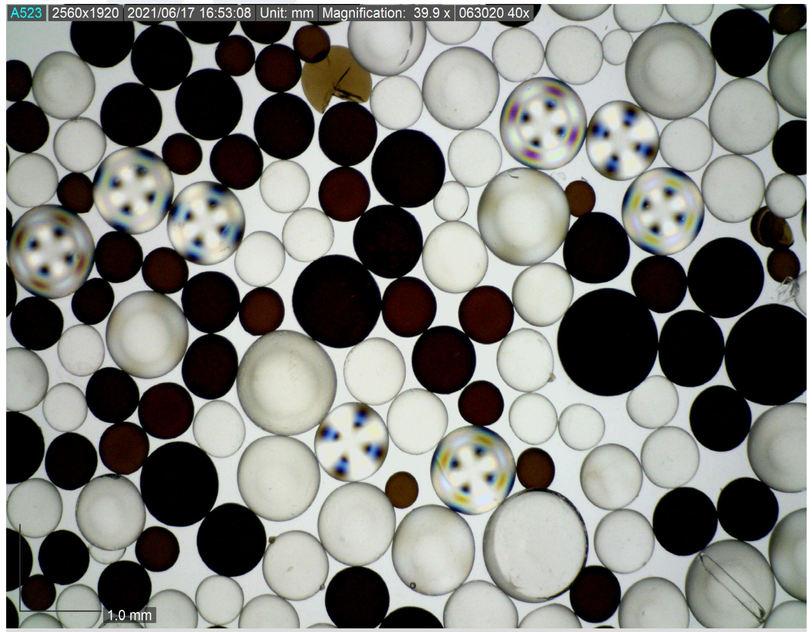
# Brine Separation

- Referred to as “Brine Kill”
- $Na^+$ and $Cl^-$ exchange for any remaining $H^+$ and $OH^-$ on resin
- Increases density differences between the resins
- Ease of separation

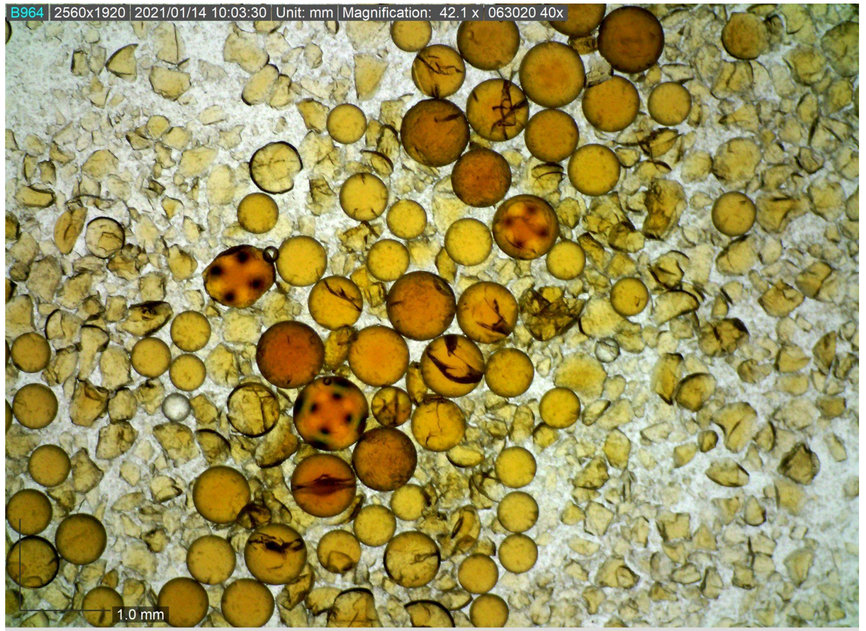
# Drawbacks of Brine Kill

- Having $Na^{+}$ and $Cl^{-}$ on resin require higher chemical doses to remove from the resin.
- Resin beads can fracture due to osmotic shock. Cracked beads lead to broken beads which leads to resin loss and quality issues.
- Anion more fragile than cation. Will lose volume faster.

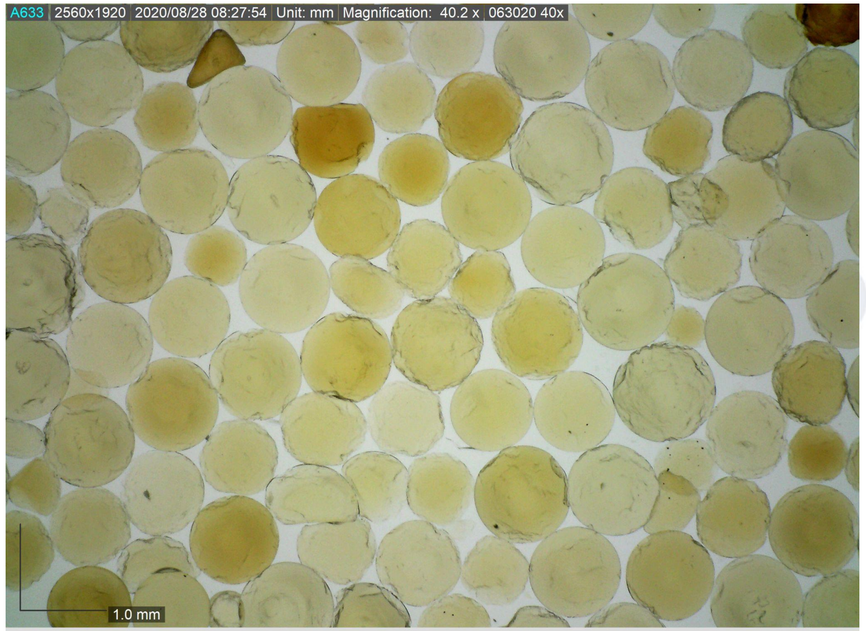
# Resin Under the Microscope




Virgin Mixed Bed




Physically Broken

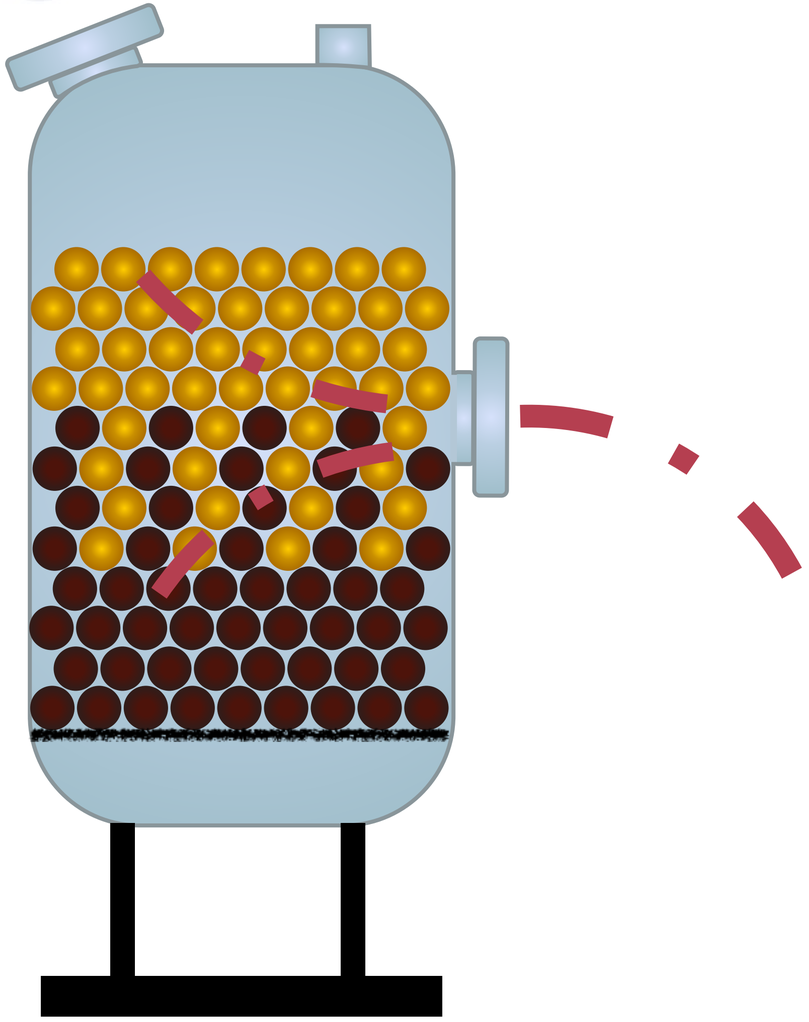



Oxidized

# Importance of Separation

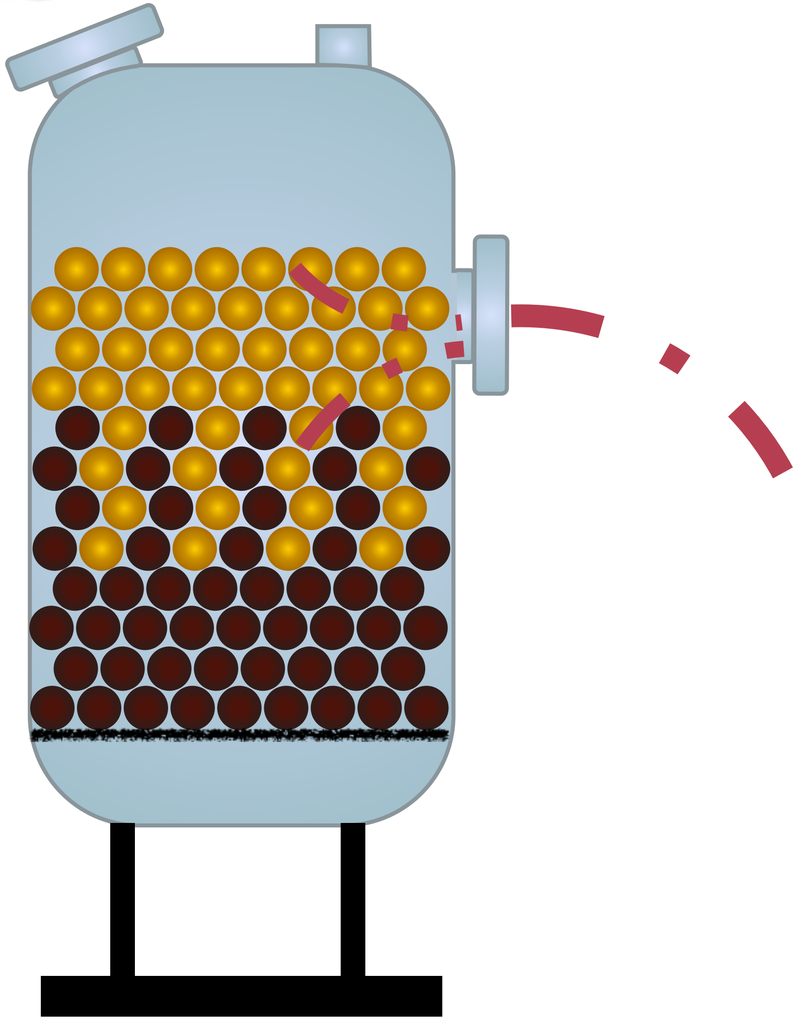
- Minimize cross-contamination
  - Anion in Cation - OK- minimize
  - Cation in Anion - Very Bad!!
- Keep interface as small as possible
- Draw anion off top very slowly and meticulously

# Anion Resin Transfer Side Take off



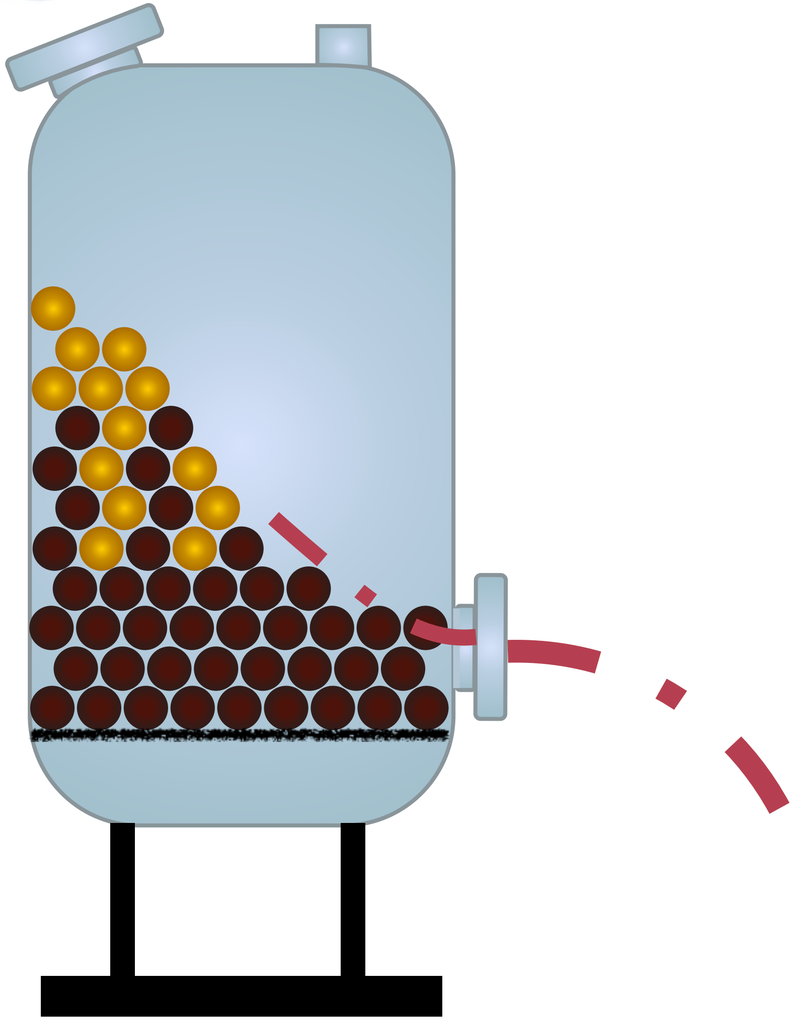
If anion draw off point is too low, some intermixed resin will transfer

# Anion Resin Transfer Side Take off



Moving the anion draw off point up prevents intermixing but leaves some anion resin behind.

# Cation Resin Transfer Side Take off



During transfer, some mixed resin is pulled down into the draw off collector along with cation resin.

# Minimizing contamination during transfer

- Slow backwash during transfer
  - Maintaining a slow backwash during transfer helps prevent funneling by keeping the bed surface relatively flat
- Stop Transfer/ Level Bed/Resume Transfer
  - This technique is more effective than backwashing alone.

# Chemical Addition

- Acid solution through cation bed- HCl
- Caustic solution through anion bed- NaOH
- The relatively high concentration of hydrogen or hydroxide ions causes the reverse exchange
- The resin is restored to the hydrogen or hydroxide form

# Chemical Addition

- Concentration + Flow Rate + Time = Dose
- Dose controls the capacity and ion leakage of both ion exchange resins
- Very important to insure all parameters are met
- Improve anion regeneration by utilizing warm NaOH (100-120º F)

# Displacement or Slow Rinse

- Increases contact time between regenerant and the bottom of the bed
- Helps push remaining regenerant through the bed without significant mixing
- Begins the rinse process

# Fast Rinse

- Removes the last traces of regenerant chemical from the resin
- Warm water (100-120º F) will decrease amount of time needed to rinse anion resin
- Any HCl/NaOH left on the resin will decrease capacity and increase ion leakage  of resulting mixed bed

# RO vs. City Water Floats

- RO water float will require higher doses of chemicals due to amount of Na+ and Cl- on resin.
- Poor regenerations are easier to notice
- Inversely, City water float will regenerate a little easier
- Organics can foul anion resin and may require cleaning
- Indication of organics is long rinses
- Warm brine/caustic treatment is best

# Mixing of Components

- Dry mixing is theoretically the best
  - Most intimate
  - Labor intensive
- Wet mixing is more than fine
  - Key is minimizing risks of resin separating
  - Very quick process

# Loading of Vessels

- Dry loading is best
  - Labor intensive
  - Prevents separation
- Wet loading is more than adequate
  - Minimize risks of resin separating
  - Very quick process
- No Freeboard in tanks!

# Storing Regenerated Resin

- Regenerated Cation and Anion resin
- Store freshly regenerated components wet, sealed in drums
  - Minimizes odor from anion resin
  - Prevents $CO_2$ intrusion (1% in 24 hours)
- Ideally, mix immediately to minimize amine odor from anion (fishy)

# Storing Regenerated Resin

- Regenerated Mixed Bed Resin
- Store resin dry, sealed in tank or drums
  - Wet storage with free board, can cause separation
  - Remove water from tanks, air is best
  - Prevent $CO_2$ intrusion (top 1”can be lost to conversion in 24 hours)

# Troubleshooting

## A process of elimination

### Equipment

- Distribution problems
- Control malfunctions
- Leaking valves
- Operator error

### Water

- Change in influent chemistry

### Media

- Loss of resin in vessels
- Poor Regenerations
- Oxidation of Resin
- Fouling
- Resin Age
  - SAC (10 yrs)
  - SBA (4 yrs)

# Housekeeping

- Store regenerated resins properly
- Mix components immediately
- Clean up all resin spills, safety!
- Keep floats separate- City vs. RO
- Take your time and pay attention to details

# Questions?

Did you like this webinar?

Scan and follow the link to provide feedback

# Upcoming Webinars

## This Summer!

**Deionization Part 3:**
Focusing on High Purity Applications

**Per- and Polyfluoroalkyl Substances (PFAS)**
Identification & Remediation

# THANK YOU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