Commercial Water Softening & Reverse Osmosis

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Presenters

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Agenda

- Defining the problem
  - Water quality in municipal water systems in North America
  - What is hardness? What is Total Dissolved Solids?
  - What issues are caused by Hardness and TDS?
- Commercial Water Softening
- Commercial Reverse Osmosis

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Water Quality Problems

Today's discussion will focus on two key problems prevalent in North American commercial water treatment applications:

- Water Hardness
- Total Dissolved Solids (TDS)

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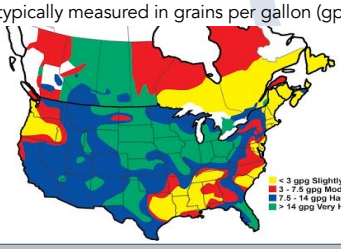
Water Hardness is North America

Water hardness is the amount of calcium and magnesium in water typically measured in grains per gallon (gpg) or parts per n



1 gpg = 17.1 ppm

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Why Use Water Softeners?

Water softeners use ion exchange to remove nuisance cation minerals (Ca, Mg) and other cations and replace them with sodium ions to soften the water.

These nuisance minerals can cause:

- Scaling in pipes, equipment & fixtures
- Shortened lifespan of equipment & higher maintenance costs
- Increased energy costs for heating water
- Increased soap usage for laundry and dish detergents*
- Spotting on dishes, glassware and automobiles
- Decreased life of linens and clothing

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Commercial Water Heaters

Electric Water Heaters
Every 5 gpg of Water Hardness creates 0.4 lbs of scale/year

GAS STORAGE TANK WATER HEATERS
With hard water = 24% loss of efficiency in water heaters

TANKLESS WATER HEATERS:
Tankless water heaters are especially susceptible to due to scale accumulation.

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Commercial Boilers

The most common cause of **overheating** and **failure** of boiler tubes is the formation of **hard scale (calcium and magnesium)** on the boiler tube surfaces.

A **1/16" thick layer** of hardness scale can reduce heat transfer by about **12 percent**, which is directly proportional to the increased fuel required to compensate for the loss.

The recommended hardness of boiler feedwater is **less than 1 gpg**.

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Water Quality Problems: Total Dissolved Solids (TDS)

- TDS represents the total concentration of dissolved substances in water and is typically measured in parts per million (ppm).

Water high in TDS (above 50 ppm) will leave white spots after the water has evaporated.

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Water Softening

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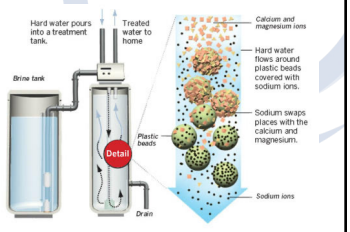
What is a water softener?

- Control Valve
- Resin
- Brine tank



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Commercial Water Softener Control Valves

Modern control valves feature:

- Flow monitoring with integral flow meters
- Multi-unit activation/deactivation
- Diagnostics
- Simple handling and installation

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Commercial Water Softener Tanks

	Steel	Fibreglass Reinforced Plastic
Material of construction	Steel	HDPE liner, fibreglass winding
Max operating pressure	100psi	150psi
Certifications	ASME	NSF for structural integrity
Cost	$$$	$
Weight (example 42")	1040lbs	340lbs

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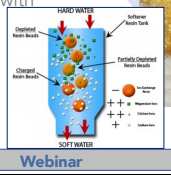
Water Softening Resin

- Made of polystyrene
- Referred to as cation resin in the sodium form
- Hardness ions exchange with sodium



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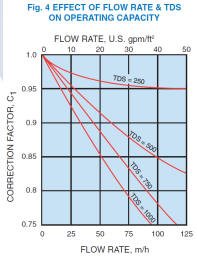
Resin mechanics

- Softening resin flow rate
  - **Maximum: 5gpm/ft³**
- Impact of exceeding those values?
  - Maximum flow rates
    - Reduced operating capacity
- Need to be considered in commercial applications?



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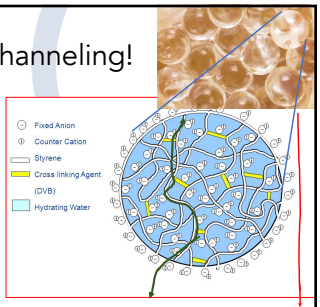
Resin Mechanics – Channeling!

- When minimum flow rates are not met
  - Preferential flow through a softener
- How does channeling impact performance?
  - Hardness leakage
  - Reduced and random operational capacities



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Softener Technology

The right softener for the right application

Twin Alternating

VS

Responsive Flow Softening

AKA: Progressive flow, demand recall

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Softener Technology

Twin Alternating	Responsive flow
• One tank online at a time	• One or all tanks online, flow rate dependent
• Regeneration initiated based on volume treated	• Regeneration initiated based on volume treated
• Single, larger common flow meter on a common outlet	• Each valve has their own, smaller flow meter

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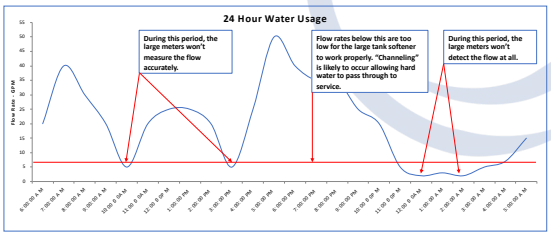
Does this matter in the real world?

Flow rate data from a 40 room hotel



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Specification Considerations for Commercial Applications

- Space considerations for the equipment
  - How will the operator fill the brine tank with salt?
- When sizing for peak flow, think about how it impacts the minimum flow rate
  - Are there ways around it?
- Detail performance expectations (ie. Flow rate, pressure drop, etc.) to receive more competitive and better sized systems

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Reverse Osmosis (RO)

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Overview

- What is RO?
- Common terminology
- Types of membranes
- Industry standard of membranes
- How to size RO's
- Pre-treatment & post-treatment

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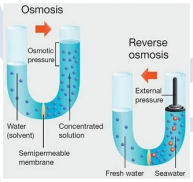
What is Reverse Osmosis?

- OSMOSIS - naturally occurring process where a liquid (water) flows through a semipermeable membrane towards the more concentrate side of the membrane.
- REVERSE OSMOSIS - occurs when we apply pressure to the more concentrated side of the membrane and push it through to the less concentrated side.



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Common Terminology

- Feed Water
- Concentrate / Waste
- Recycle
- Permeate / Product
- TDS
- Rejection
- Recovery

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Types of Membranes

- Reverse Osmosis (RO) – **98% TDS rejection**
- Nano Filtration (NF)
- Ultra Filtration (UF)
- Desalinization

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Industry Standards

Membrane Performance Ratings Based On:

- 500-2000 ppm NaCl
- 77°F (25°C)
- pH 7.5
- 100-200 psi operating pressure
  - **Typically, RO booster pressure is around 180 psi**

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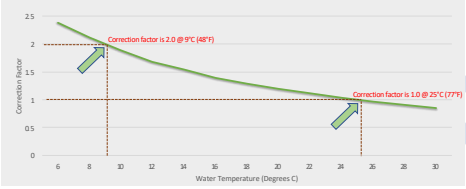
Temperature Correction



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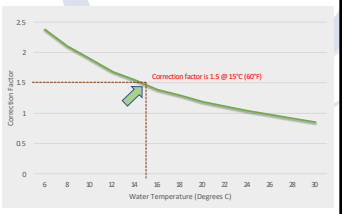
Temperature Correction Sizing RO systems:

EX: A car wash requires 2000 USGPD of RO water for their spot free rinse cycle:

- Water supply: City of Phoenix municipal water
- Water temp: 15°C (60°F)

At 15°C, temperature correction factor is approx. 1.5:
2000 USGPD x 1.5 = 3000 USGPD

Therefore, RO should be rated for at least 3000 USGPD



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RO Pre-Treatment

- Filtration
  - Sediment & Turbidity
  - Iron & Manganese
  - Chlorine & Organics
- Softening
- Antiscalant

Feed Water Guidelines	
Feed Water Pressure	30 - 65 psi
Temperature	33 F - 100 F
pH	3.0 - 11.0
Maximum TDS	2,500 mg/l
Turbidity	< 1.0 NTU
Maximum SDI	< 5.0
Hardness	<1 grains per gallon
Iron	< 0.1
Manganese	< 0.05
Hydrogen Sulfide	zero
Organics	zero
Chlorine	zero
Oil (Hydrocarbons)	zero

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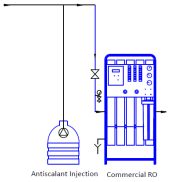
Pre-Treatment: Antiscalant vs. Softener ?



Antiscalant Advantages:

- Smaller footprint
- Lower capital/operational costs
- No salt required

Disadvantages:

- No immediate feedback if it's working
- Requires specialized chemicals, training & monitoring
- Sequestration doesn't last forever

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RO Post-Treatment

- Storage (pressurized, atmospheric)
- Disinfection
- pH adjustment
- Blending / TDS adjustment

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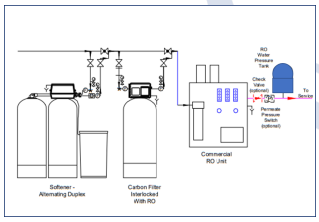
Typical Flow Diagram: Pressurized Storage



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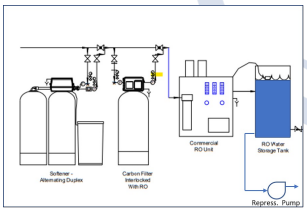
Typical Flow Diagram: Atmospheric Storage



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In Conclusion…

Reverse Osmosis
- Water purification
- Reduction of TDS or problematic minerals/salts

Membranes
- Reverse Osmosis (RO)
- Nano Filtration (NF)
- Ultra Filtration (UF)
- Desalinization

Temperature Correction
- Will directly impact production rates of RO
- Lowest water temp should be considered when sizing

Pre- & Post-Treatment
- Critical for performance of RO & lifespan of membranes
- Will vary depending on water source & needs of application

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In Conclusion continued…

- Softening removes scale forming minerals
- Not operating in the resin design flow rates limits the softener effectiveness

- Responsive flow softeners have a wider working range
- Are (typically) easier to install on site due to smaller tank sizes making them easier to handle

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THANK YOU!

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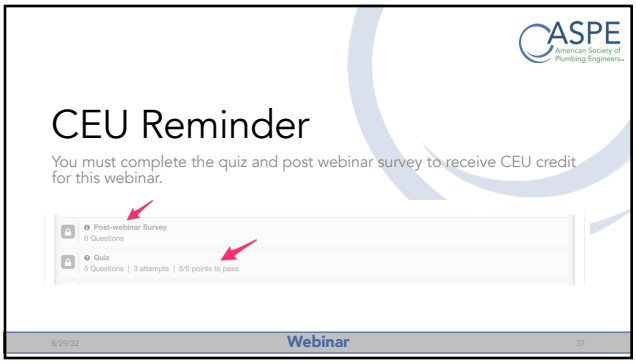
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