Madison Metropolitan Sewerage District

SALT REDUCTION THROUGH EFFICIENT WATER SOFTENING

Training Workbook 2023

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INTRODUCTION

Chloride, a component of salt, has been increasing in local water bodies, which poses a threat to freshwater species. Most of the chloride that ends up in the sewer system is from water softeners, although road salt and other sources are also chloride contributors. Reducing the amount of salt used in water softeners is one of the most effective ways to reduce chloride entering our waters.

Use this workbook to follow along with the Saving Salt training. The appendices of this book also include reference material for work in the field with softeners using Madison Metropolitan Sewerage District's softener evaluation app.

LEARNING OBJECTIVES

By the end of this class, you will be able to:

- Describe chloride's role as a freshwater pollutant
- Identify different types of water softeners and their components
- Understand factors that influence softener efficiency
- Make recommendations to customers on increasing softener efficiency

WHY REDUCE SALT?

- Chloride, a component of salt, is a pollutant that threatens freshwater life.
- Wastewater treatment plants like Madison Metropolitan Sewerage District are not designed to remove chloride, so chloride that ends up in the sewer passes through the treatment plant into freshwater streams.
- Treating water to remove chloride is expensive and has negative environmental consequences. It's more effective and less expensive to reduce salt use at the source.
- Reducing salt use makes business sense: it cuts down on salt costs and saves the labor of having to refill brine tanks.

WATER HARDNESS

KEY POINTS

- The water source in the Madison area is mineral-rich groundwater. Magnesium and calcium in the water are referred to as water hardness.
- Water hardness is typically measured in grains of hardness per gallon of water. 1 grain of hardness = 17.2 milligrams per liter of calcium and magnesium.
- Water hardness varies between different wells. Water hardness in the Madison area ranges from 15 to 32 grains per gallon. Because of this variation, it's important that water softeners are set up to reflect the actual hardness of the source water.
- The same address can receive water from different wells with different hardnesses depending on the season and operation of the water utility.
- The best way to determine water hardness is to get the hardness level from the water utility serving that address. For addresses served by the Madison Water Utility, this information can be found at this link: www.cityofmadison.com/water/waterquality/mywells.cfm.

EXERCISE

Looking up water hardness for a given address

Use the hardness lookup link to find the wells serving the sewerage district and the hardness of the source water (1610 Moorland Road, Madison, WI 53713).

Well numbers: _____ _____

Percent of total service each well provides: _____ _____

Hardness (in grains per gallon): _____ _____

How else could source water hardness be determined?

SOFTENER COMPONENTS

KEY POINTS

- Softeners come in various configurations, but have the same basic components: a resin tank filled with resin beads that carry out ion exchange, a brine tank containing the salt that regenerates the resin, and a control head that regulates softener function.
- Resin tanks are typically sized according to water use, with larger tanks serving systems with higher water use. Tank size is measured in cubic feet of resin. The size of the resin tank affects the grain capacity of the softener, as more resin increases the grain capacity.
- Softeners can have a single resin tank or multiple resin tanks. The advantage of multiple-tank systems is that they can switch to another tank while one is regenerating, eliminating the need for reserve capacity.

EXERCISE

Identifying softener components and their function

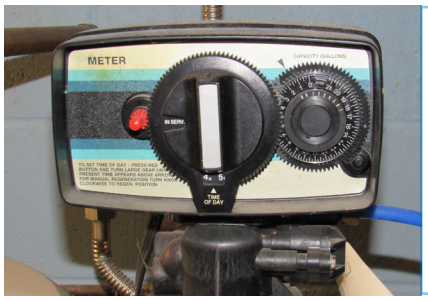
Label the components of the softener pictured below and describe their role.

SOFTENER CONTROL HEADS

KEY POINTS

- Control heads (control valves) include the settings that determine how the softener functions, including when it regenerates.
- You can determine whether a water softener is a time-clock or demand-initiated regeneration (DIR) from the control head. Time-clock units regenerate based on a programmed number of days, while DIR units regenerate based on amount of soft water used.
- Time-clock units are less efficient than DIR models and their new installation is not allowed. If you come across a time-clock unit, recommend replacement with new softener.

Type of control head:



Type of control head:

Type of control head:

SOFTENER SETTINGS

KEY POINTS

- Settings are not the same between different models of softeners. Some settings may be inaccessible in some models.
- Even a newer softener with a high potential efficiency can be set up to run inefficiently.
- Softener settings should reflect the actual conditions of the building (such as the actual source water hardness and water use).

Summary of Softener Settings

Setting	Definition	Notes
Hardness setting	Programmed amount of hardness in the source water to the softener, measured in grains	
Salt dosage (salt setting)	Amount of salt used to regenerate the softener (determines brine fill time)	
Reserve capacity	Volume of soft water held as a buffer to prevent soft water from running out before softener regenerates	
Gallon capacity	Number of gallons between regenerations	
Grain capacity	Number of grains of hardness removed between regenerations	

Relationships between settings

Grain capacity = (Gallon capacity) * (Hardness setting)

Gallon capacity = (Grain capacity) / (Hardness setting)

Number of regenerations = (Total soft water use) / (Gallon capacity)

Salt use = (Number of regenerations) * (Salt dosage)

Lower salt dosage--> lower grain capacity--> more regenerations

Higher salt dosage--> higher grain capacity --> fewer regenerations

SOFTENER SETTINGS EXERCISES

EXERCISE

Calculating softener settings and salt use

1. A softener has a grain capacity of 32,000 grains and a hardness setting of 25 grains per gallon. How many gallons will be softened between regenerations?

    a. 1000
    b. 1280
    c. 2060
    d. No way to tell

2. You look up the hardness for the source water for the same softener and find that the hardness is 20 gpg, so you adjust the softener's hardness setting to 20 gpg. How many gallons will be softened between regenerations at this new hardness setting?

    a. 1280
    b. 950
    c. 1600
    d. No way to tell

3. This softener treats 9600 gallons of water per month. How many times will the softener regenerate per month at the 20 gpg hardness setting?

    a. 2
    b. 4
    c. 6
    d. 8

4. The softener has a salt dosage of 8 lbs. How much salt will this softener use per month at the 20 gpg hardness setting?

    a. 16 lbs.
    b. 32 lbs.
    c. 48 lbs.
    d. 64 lbs.

5. Bonus: how much salt will this softener use per month at the 25 gpg hardness setting?

SOFTENER EFFICIENCY

$$\text{Softener efficiency} = \frac{\text{Grain capacity (grains)}}{\text{Salt dosage (pounds)}}$$

KEY POINTS

- Softener efficiency affects how much salt a softener uses and how often it regenerates. It refers to how much hardness is removed per pound of salt.
- Higher salt efficiencies are achieved at lower salt dosages.
- MMSD recommends a softener efficiency of at least **4000 grains per pound**. All new softener installations should meet or exceed this target.

Factors that affect softening efficiency

Factor	Effects on efficiency	Notes
Age	Softeners lose efficiency over time as resin and parts break down. The lifespan of a softener is about 15-20 years.	
Type of regeneration (time-clock or demand-initiated)	Time-clock softeners may regenerate before they need to, decreasing efficiency. Demand-initiated softeners are more efficient.	
Salt dosage	Lower salt dosages result in lower grain capacities, but higher salt efficiencies.	
Reserve capacity	A higher reserve capacity decreases the efficiency of the softener since it takes up more of the grain capacity. Twin-tank units do not require reserve capacity and so can achieve their full grain capacity. Variable reserve is more efficient than fixed reserve because it sets the reserve based on the actual water use of the building.	

ADJUSTING SOFTENER SETTINGS

KEY POINTS

- Many existing softeners are programmed at higher settings than necessary compared to the actual conditions of the facility, causing the softeners to use more salt than necessary.
- Adjusting softeners to operate at their optimal settings can help raise softener efficiency and reduce overall salt contributions to the sewer.
- Some settings and control heads are simpler to adjust than others. For example, some controls may have a labeled screen or dial for setting water hardness. Others may display only the gallon capacity, having calculated the necessary gallon capacity based on water hardess and softener grain capacity.
- Some softeners determine reserve based on a number of people in the building and an estimated water use per person. Using the actual water use to set the gallon capacity is more accurate than using the number of people setting.
- Even without adjusting settings, there are still best practices you can take on every service call to assess a softener's efficiency and opportunities for salt reduction, listed below.

Softener evaluation best practices

- Evaluate the unit's age, type of regeneration, and model. If the softener is inefficient or obsolete, recommend replacement with a new model with an efficiency of at least 4000 grains per pound.
- Check the building for leaks or inefficient fixtures that waste soft water. Recommend repair of leaks and new fixtures to reduce soft water use.
- Make sure that outdoor water is not softened, and disconnect outdoor water pipes from the softener if found.
- Refer customer to a softener service provider familiar with that customer's softener brand if you're not sure how to optimize that type of softener.

EXAMPLE SOFTENER SETTINGS

EXERCISE

Determining softener salt dosage, capacity and efficiency

A softener with 0.75 cu. ft. of resin comes with a user manual that includes the following chart. What is the salt dosage for this softener to use the least amount of salt?

a. 11.3 lbs.
b. 7.5 lbs.
c. 10.0 lbs.
d. 4.5 lbs.

CAPACITY CHART

Resin Cu. Ft.	Rated Capacity Low Salt Grains @ Lbs.	Rated Capacity Medium Salt Grains @ Lbs.	Rated Capacity High Salt Grains @ Lbs.	Flow Rate Cont.
.50	9,800 @ 3.0	14,100 @ 5.0	16,600 @ 7.5	6.1
.75	14,700 @ 4.5	21,200 @ 7.5	24,900 @ 11.3	8.0
1.00	19,600 @ 6.0	28,200 @ 10.0	33,200 @ 15.0	10.0
1.50	29,400 @ 9.0	42,300 @ 15.0	49,800 @ 22.5	10.0
2.00	39,200 @ 12.0	56,400 @ 20.0	66,400 @ 30.0	10.7
3.00	58,800 @ 18.0	84,600 @ 30.0	99,600 @ 45.0	11.5

For the same softener, what should the grain capacity be set to?

a. 21,200 grains
b. 14,700 grains
c. 24,900 grains
d. 28,200 grains

For the same softener, what is its softening efficiency at its most efficient salt setting?

a. 3267 grains per pound
b. 2203 grains per pound
c. 2820 grains per pound
d. 4000 grains per pound

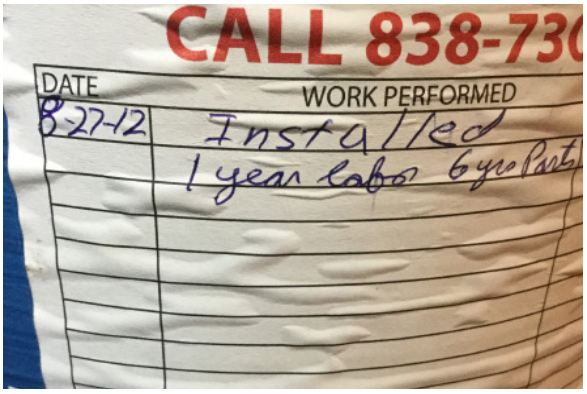
SOFTENER EVALUATION PRACTICE

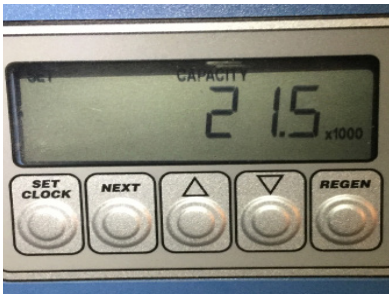
EXERCISE

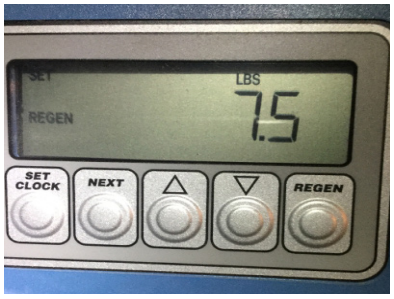
Example water softener evaluation

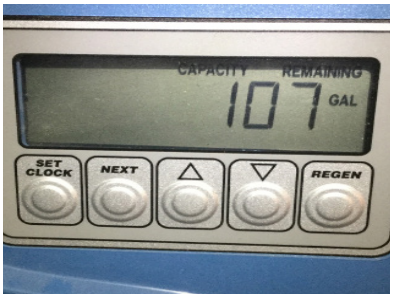
On a service call, you encounter the softener pictured below. The source water has an average hardness of 18 grains per gallon. Review the pictures below and determine:

a. The type of regeneration of this softener
b. The efficiency of the softener
c. The recommendations you would make to this customer to reduce their salt use, if any









GENERAL SOFTENER EVALUATION PROCESS

Evaluation step	Hints	Recommendation
1. Determine type of regeneration.	Look at control head for indicators of what triggers regeneration (volume vs. time).	• If time-clock, recommend replacement.
2. Determine age of softener.	• Look for a sticker or service sheet that may indicate the date of installation. The year of manufacture may also be reflected in the unit's serial number. • If not available on the unit, ask the building owner about the softener's history. Has it been replaced in the time that they have occupied the building?	• If 6-15 years old, check parts (piston, seals, spacers, injector assembly) for signs of wear and replace if needed. • If over 15 years old, the softener is at or near the end of its life span. Recommend replacement. • Resin deterioration makes grain capacity diminish over time, losing about 1.5% of grain capacity each year.
3. Determine brand and model of softener.	This information may be indicated on a sticker or labels on the unit. • Model names sometime refer to the size or capacity of the unit. For example, you might see "24" or "32", referring to the approximate grain capacities of 24,000 or 32,000. • If not identified from the unit itself, ask the building owner if the brand and model of softener are known.	If the softener is identified as an inefficient model (identified on the Inefficient Softeners list), recommend replacement.
4. Examine softener settings.	• Different control heads will have different settings available. In an evaluation, look for the following settings: » Hardness setting » Reserve capacity (sometimes determined by number of people) » Salt dosage	• The softener should have: » A hardness setting equal to the actual hardness of the source water » A reserve capacity equal to the actual daily soft water use of the home, and » The lowest possible salt dosage. • If able to adjust settings to these values, do so. If not, recommend further optimization.

More information:
www.madsewer.org/SaltSavers