SALT REDUCTION THROUGH EFFICIENT WATER SOFTENING

Training Workbook
2020
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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.
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 12 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.

Looking up water hardness for a given address

Use the hardness lookup link to find the wells serving this building 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.

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

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

Relationships between settings

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

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

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

Higher salt dosage --> higher grain capacity --> fewer regenerations
Calculating softener settings

a. A softener has a grain capacity of 32,000 grains and a gallon capacity of 1280 gallons. What is the hardness setting of this softener?

b. A softener has a gallon capacity of 1500 gallons and a hardness setting of 20. How many grains of hardness will be removed by the softener between regenerations?

c. A softener has a grain capacity of 24,000 grains, a hardness setting of 18, and a fixed gallon setting of 1000 gallons per regeneration. What is the fixed reserve capacity?

d. What should the gallon capacity be (minus reserve capacity) for a softener in the following conditions:
   • 24,000 grain capacity
   • Single-tank
   • Source water hardness: 18 grains
   • Average daily soft water use of 200 gallons
Locating settings on different control heads

Locate the settings on the example control heads and write down notes about how to access settings and other information about these types of controls.

Particularly, make sure how you could find or determine the settings below, which affect the efficiency of the softener. Not all these settings will be accessible on every control head.

• Salt dosage
• Grain capacity (or gallon capacity)
• Reserve capacity
• Hardness setting

Type of control:

Notes on accessing settings:
SOFTENER EVALUATION

EXERCISES

Type of control:

Notes on accessing settings:

Type of control:

Notes on accessing settings:

Type of control:

Notes on accessing settings:
SOFTENER EFFICIENCY

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

<table>
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<th>Factor</th>
<th>Effects on efficiency</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>Softeners lose efficiency over time as resin and parts break down. The lifespan of a softener is about 15-20 years.</td>
<td></td>
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<tr>
<td>Type of regeneration (time-clock or demand-initiated)</td>
<td>Time-clock softeners may regenerate before they need to, decreasing efficiency. Demand-initiated softeners are more efficient.</td>
<td></td>
</tr>
<tr>
<td>Salt dosage</td>
<td>Lower salt dosages result in lower grain capacities, but higher salt efficiencies.</td>
<td></td>
</tr>
<tr>
<td>Reserve capacity</td>
<td>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.</td>
<td></td>
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</table>
Determining softener efficiency at different settings

a. A softener has a grain capacity of 32,000 grains and is set to a medium salt dosage of 10 pounds. What is its softening efficiency?

b. You adjust the salt dosage to the softener’s lowest setting, 4 pounds, and change the grain capacity to 18,000. What is the new efficiency?

c. A softener has a rated grain capacity of 24,000 grains at a medium salt dosage of 8 pounds. The hardness setting is 20 grains per gallon and the fixed reserve capacity is 300 gallons.
   - What is the efficiency of this softener without reserve capacity?
   - How much grain capacity is represented by the reserve capacity?
   - What is the actual grain capacity of this softener, adjusted for reserve capacity?
   - What is the actual efficiency of this softener, adjusted for reserve capacity?

d. A softener has a hardness setting of 25 grains per gallon, a grain capacity of 27,000 (after adjusting for reserve capacity), and a salt dosage of 8 pounds per cubic foot.
   - How many gallons are softened between regenerations?
   - The home served by this softener uses 250 gallons of soft water per day. How many days pass between regenerations?
   - What is the new gallon capacity if the hardness setting is adjusted to 20 grains per gallon?
   - How many days pass between regenerations at this new gallon capacity?
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 hardness 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.
Adjusting hardness setting

A softener with a dial-operated control valve serving 1 John Nolen Drive has a gallon capacity of 1280 gallons between regenerations. The dial indicates a hardness setting of 25 grains per gallon and a grain capacity of 32k grains. (In this example, assume reserve capacity is 0.)

a. Determine the actual source water hardness for this address.

b. You change the hardness setting to match the source water hardness. Calculate the new gallon capacity based on the new hardness setting.

Adjusting reserve capacity

A single-tank softener with a dial-operated control valve has a hardness setting of 15, a “number of people” setting of 2, and a grain capacity of 24k. These settings line up with a gallon capacity of 1400 gallons. The home uses 100 gallons of soft water per day.

a. Determine maximum gallon capacity based on grain capacity and hardness setting.

b. Determine necessary reserve capacity based on daily water use.

c. Adjust gallon capacity to reflect actual necessary reserve.
Scenario 1

While on a service call for a new toilet installation at a single-family home in McFarland (5923 Exchange St.), you offer to evaluate the water softener. The homeowner agrees and shows you this softener:

Use the Salt Savers reporting app to document your evaluation of this softener.

Notes:
- You did not find any leaks.
- You did not test for iron.
- You did test the hardness at the toilet and hose bibb using hardness strips (see picture above.)
- Based on your recommendations, the homeowner wants to schedule an appointment with you in a few weeks to install a new, high-efficiency softener.
Scenario 2

The Town of Dunn is sponsoring a softener improvement event for the neighborhood near the intersection of Keenan Road and Mahoney Road. You complete the following inspection and optimization at a house on Waubesa Hill Road with a well that has a hardness of 20 grains per gallon and an iron concentration less than 0.3 mg/L. No leaks were evident in the home. Both the hose bibb and toilet receive soft water.

You find the softener below with the settings shown in the pictures below. Document your evaluation and optimization using the app.
Scenario 3

You get called for a softener inspection and optimization at a single-family home on Zor Court, Town of Dunn (Stoughton mailing address), where the private well tests negative for iron and has a hardness of 14 grains per gallon. The outside hose bibb tests for hard water and you did not find any leaks around the house.

The softener has the control head at right and does not have any other labeling. The homeowner tells you it is about 10 years old.

Scenario 4

You go on a job to install a 9" Culligan High Efficiency Aqua-Sensor water softener in a new home at 5213 Perfect Drive, Madison, WI. Because this is a new home, there was no softener present before.

Use the product spec sheet from the user manual, right, to set up the softener so it has an efficiency of at least 4000 grains per pound.
### General Softener Evaluation Process

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<th>Hints</th>
<th>Recommendation</th>
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<tr>
<td>1. Determine type of regeneration.</td>
<td>Look at control head for indicators of what triggers regeneration (volume vs. time).</td>
<td>• If time-clock, recommend replacement.</td>
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</table>
| 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