Notification of Intent to Develop Draft Efficiency and Performance Specifications for Cation Exchange Water Softeners

I. Introduction

Cation exchange water softeners are used to soften water by exchanging the calcium and magnesium ions contained in hard water with sodium (or potassium) ions. Once the resin bed containing the supply of sodium ions is fully exchanged with the calcium and magnesium ions, the water softener must regenerate. During the regeneration process, a brine solution of sodium chloride is passed through the resin bed and the calcium and magnesium ions are replaced once again with sodium ions. After regeneration the calcium and magnesium ions and excess sodium and chloride ions from the brine are discharged out of the system and the softener is again ready to soften incoming hard water. This regeneration process can be very water-intensive, with some residential water softeners consuming an average of 25 gallons of water or more per day during regeneration—or 150 to 200 gallons per week and 7,800 to 10,400 gallons per year.[1] Some older, less efficient models can consume even more, while newer technologies with flow sensors or conductivity probes can use less by regenerating only as needed, rather than on a prescribed schedule. To capitalize on this water savings opportunity, raise consumer awareness, and further improve the water efficiency of water softeners, the U.S. Environmental Protection Agency's (EPA's) WaterSense program is announcing its intent to develop a specification for water-efficient, high-performing cation exchange water softeners.

Current federal standards do not regulate water use or performance of water softeners. However, there is an industry standard for water softeners, *NSF/ANSI 44-2004 Residential Cation Exchange Water Softeners*, which many states have adopted as part of their plumbing codes.[2] Manufacturers seeking NSF/ANSI 44 certification can have their products further tested to voluntary salt- and water-efficiency requirements contained in the standard, in order to become "efficiency rated." The NSF/ANSI 44 voluntary water-efficiency requirement is the only known standard, voluntary or otherwise, employed in the United States that addresses water softener water use. Though this requirement is voluntary, market data indicate that many products have already been tested to and meet or exceed the specified water-efficiency criteria. As a result, WaterSense has determined that significant water savings can be achieved from improvements beyond the existing NSF/ANSI 44 voluntary water-efficiency requirement.

As with all of its specifications, WaterSense includes performance criteria to ensure that labeled products perform as well or better than standard models. With this notification of intent (NOI), WaterSense has preliminarily identified NSF/ANSI 44 as a basis for its water-efficiency and performance requirements, and has identified several supplemental performance factors to consider before developing a draft specification. As it moves forward with specification

[1] Bruursema, T. 2002. Water Matters. Water Softeners & Septic Tanks: A Compatible Combination? 44 (4).
[2] NSF International and American National Standard. 2004. *NSF/ANSI 44-2004 Residential Cation Exchange Water Softeners*.

development for this product category, WaterSense is also seeking to address concerns expressed by stakeholder groups regarding the impacts of water softener discharge. All interested parties are encouraged to submit written information and comments regarding any of the concepts or issues presented in this NOI to watersense-products@erg.com. Comments and information on the issues presented in this NOI are welcome and will be taken into consideration as WaterSense develops a draft specification for cation exchange water softeners.

II. Scope

The scope of NSF/ANSI 44 applies to manual, auto-initiated, and demand-initiated (DIR) regeneration residential cation exchange water softeners. These water softeners are designed to be used to remove hardness and reduce specific contaminant concentrations from drinking water supplies (public or private) considered to be microbiologically safe and of known quality. Because WaterSense is interested in using the NSF/ANSI 44 standard as the basis for its water-efficiency and performance requirements, it has determined that it is appropriate to limit the scope of this product category to the specific technology to which NSF/ANSI 44 applies. As such, WaterSense is considering developing a draft specification for cation exchange water softeners that are designed to remove hardness and reduce specific contaminants from drinking water supplies.

WaterSense is, however, interested in limiting the scope of its draft specification to DIR water softeners, and will likely exclude manual or auto-initiated water softeners. DIR water softeners are considered the most water-efficient models, because they regenerate based on system demand. Furthermore, NSF/ANSI 44 specifies that only products that use DIR are eligible to become "efficiency rated," meaning they are able to meet the water and salt-efficiency requirements. A DIR water softener is defined by the standard as "a water softener equipped with a flow meter or sensing control system that automatically initiates the regeneration process after determining the depletion, or impending depletion, of softening capacity."

NSF/ANSI 44 is limited to residential water softeners, which are conventional plumbing fittings not exceeding 1.25 inch nominal pipe size. WaterSense is considering specifying a size limit to define the scope of its draft specification that would allow for the inclusion of commercial units as well, to further increase water savings. At this time, WaterSense is seeking to better understand the design of commercial water softeners compared to residential units. Specifically, WaterSense would like to determine if water softeners used in light commercial applications are able to meet the requirements of NSF/ANSI 44 (including the voluntary efficiency requirements) or potentially even more stringent requirements, as indicated in the water efficiency and performance sections of this NOI. WaterSense would also like to determine if a nominal pipe size limit would be the appropriate metric for differentiating between residential/light commercial and heavy commercial or industrial applications, and whether the current specified nominal pipe size limit of 1.25 is sufficient for distinguishing these applications. WaterSense is requesting information as to how light commercial water softeners are packaged, marketed, and sold to better understand the impacts of the WaterSense label in the marketplace.

WaterSense is not considering portable exchange tank systems for inclusion in a draft specification at this time. These are systems where the tank is removed and replaced by a

service professional for regeneration off-site. WaterSense acknowledges that these products are a viable alternative to traditional cation exchange water softeners, but because the regeneration process occurs off-site, the water use of an exchange tank system is not a function of the water softener unit itself. As a result, WaterSense has no means by which to promote or improve upon the water efficiency of these products.

Similarly, WaterSense is not considering anti-scaling devices for inclusion in a draft specification. These products do not use or control the use of water and WaterSense has no means by which to promote or improve upon their water-efficiency.

III. Water Efficiency

The goal of the WaterSense program is to label products that are at least 20 percent more efficient and perform as well as or better than standard models. To achieve the water-efficiency component of this goal, WaterSense is seeking to establish new water-efficiency criteria for water softeners to potentially earn the WaterSense label. The water efficiency of water softeners is defined by NSF/ANSI 44 as the amount of water used during the regeneration process per 1,000 grains of hardness removed during the exchange cycle. The NSF/ANSI 44 voluntary water-efficiency requirement establishes a water-efficiency level of 5.0 gallons of water used per 1,000 grains of hardness removed for residential DIR water softeners.

Available market data indicates that more than 60 percent of residential DIR units meet or exceed the NSF/ANSI 44. Furthermore, at least half of the residential DIR units on the market use 4.0 gallons of water or less, which corresponds to a water savings of at least 20 percent over the voluntary standard. Some products consume as few as 1.5 gallons of water during regeneration per 1,000 grains of hardness removed. For these reasons, WaterSense anticipates establishing a maximum water use requirement within the range of 1.5 gallons to 4.0 gallons per 1,000 grains of hardness removed. To help inform this requirement, WaterSense is seeking a robust set of water use data for a wide variety of products on the market, including both residential and commercial water softeners.

IV. Performance

All WaterSense specifications establish performance criteria to ensure that user satisfaction is not sacrificed in order to achieve water savings. Products certified to NSF/ANSI 44 must meet a number of performance requirements such as softening performance and structural integrity. WaterSense intends to require products to comply with the general requirements of NSF/ANSI 44, though it has identified several other performance factors that it is considering before releasing a draft specification.

Softening Performance

The NSF/ANSI 44 standard requires water softeners to deliver water that contains less than 1 grain of hardness per gallon of water. WaterSense is interested in determining how this specific hardness level relates to consumer expectations for softened water and if a less stringent softening performance requirement may improve the water and salt efficiency of water softeners.

Salt Efficiency

Salt efficiency is defined by NSF/ANSI 44 as "the hardness removal capacity of a water softener divided by the weight of salt that is utilized to achieve that amount of hardness removal." In other words, salt efficiency is the amount of hardness that can be removed by each pound of salt added to the system. The voluntary salt-efficiency requirement of NSF/ANSI 44 is 3,350 grains of hardness removed per pound of salt.

WaterSense determined that salt efficiency is an important performance measure that is worth improving for two primary reasons: first, it could reduce the operating costs for the end users as they will use and purchase less salt for the same amount of hardness removed, and second, it could decrease the amount of sodium discharged into septic or municipal reclaimed water systems. For further discussion on the impact of water softener discharge, see Section IV. To address the latter issue, the California Health & Safety Code specifies a minimum salt efficiency of 4,000 grains of hardness removed per pound of salt.[3]

Available data suggests a large portion of the market may already meet the California Health & Safety Code's salt-efficiency requirement. WaterSense is considering adopting a salt-efficiency requirement of at least 4,000 grains of hardness removed per pound of salt. However, to inform the specific salt-efficiency level, WaterSense is seeking data to better understand the range of salt efficiencies of products currently on the market.

Regeneration Efficiency

To ensure that no hard water passes through the system prior to regeneration, some water softener units regenerate well before their available hardness removal capacity is reached. These units may waste additional water regenerating more frequently than is necessary. Currently, NSF/ANSI 44 does not include a requirement to test the water softener unit's ability to regenerate efficiently (i.e., within a certain margin of the actual hardness removal capacity).

The European standard for water softeners, *EN 14743:2005+A1:2007 Water Conditioning Equipment Inside Buildings—Softeners—Requirements for Performance, Safety, and Testing*, addresses this issue with an "initiation of regeneration" requirement.[4] The requirements apply specifically to DIR water softeners and are as follows:

> *For a volume controlled softener the volume of water treated between regenerations shall be within 10 % of the programmed water volume.*
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> *For a softener which regenerates on the detection of exhaustion of the resin, the exchange capacity of the softener shall not vary by more than 10 % of the rated capacity of the equipment.*

WaterSense intends to include a regeneration efficiency requirement in its draft specification and is considering requiring that the exchange capacity of the unit must not vary by more than a given percentage of the rated capacity. Before including this requirement in a specification, however; WaterSense is seeking information and data regarding the percentage of the rated

[3] Legislative Counsel of California. 2009. California Health and Safety Code §116775-116795.
[4] European Committee for Standardization. 2005. *EN 14743:2005+A1 Water Conditioning Equipment Inside Buildings—Softeners—Requirements for Performance, Safety, and Testing*.

hardness removal capacity within which units typically regenerate (e.g., 5 percent, 10 percent, or 20 percent).

WaterSense would like to determine whether regeneration efficiency is a product of water softener design or if it is a setting that users can adjust and control. Additionally, WaterSense is requesting input about how certain design factors would be accounted for during regeneration efficiency testing. For example, because twin-tank systems complete two regenerations for every regeneration completed by a single-tank system of equal capacity, twin-tank systems technically regenerate at half of their rated capacity. Other potential concerns might include how to approach volume-based DIR systems, which regenerate based on the amount of volume that passes through the system. While the EN 14743 standard requires these systems to regenerate within a prescribed percentage of the programmed water volume, WaterSense would like input as to whether these systems have the capability to meet the same requirements as sensor-based DIR systems, meaning they must be able to regenerate based not on programmed volume but on rated capacity.

Multiple Salt Dosage Settings

Water softeners typically have multiple salt dosage settings allowing for flexibility to accommodate varying water hardness levels and water use demands. The salt dosage setting, in pounds of salt, corresponds to a rated capacity, with higher salt dosage settings corresponding to higher capacities (i.e., able to remove more hardness).

NSF/ANSI 44 efficiency-rated water softeners are required to meet the voluntary efficiency requirements only on their lowest salt dosage setting. To ensure water savings and performance regardless of operating setting, WaterSense is considering requiring products to meet or exceed the performance criteria on a range of salt dosage settings. Units with multiple salt dosage settings could be tested at the minimum, maximum, and average (or closest to) setting, as is currently required when testing for softening capacity in accordance with NSF/ANSI 44. Before incorporating this testing requirement, WaterSense would like to determine if products on the market are able to meet the water-efficiency and performance requirements discussed in this NOI on their highest salt dosage setting. Alternatively, WaterSense is considering requiring the unit to automatically default to the salt dosage setting on which it was tested and certified.

ENERGY STAR® Qualified External Power Adaptor

ENERGY STAR, a program jointly sponsored by EPA and the U.S. Department of Energy, qualifies external power adapters used to convert high voltage AC electricity from a wall outlet to low voltage DC power used to power electronic products. For units using external power adapters, WaterSense is considering specifying that external power adapters must be ENERGY STAR qualified. WaterSense is interested in information regarding how prominent external power adapters are for water softeners currently on the market and whether this is a viable requirement to enhance a draft specification.

V. Issues of Concern

During the regeneration process, sodium and chloride ions are flushed from the water softener system and discharged down the drain. Some stakeholders have expressed concern about the

impact of sodium-rich discharge if it is sent to either an on-site septic system or a municipal sewer system where treated wastewater is recycled.

WaterSense is aware of these concerns and anticipates that improvements to the efficiency of residential and commercial water softeners, through the publication of a performance specification, could help to address issues relating to water softener discharge. Products with a higher salt efficiency use less salt to soften the same amount of water compared to products with a lower salt efficiency. By using less salt, the overall amount of sodium and chloride in the discharge can be reduced. California, a state that depends significantly on reclaimed water, has recognized this fact by requiring water softeners to have a salt efficiency of at least 4,000 grains of hardness removed per pound of salt.

Additionally, water softeners that regenerate less often will discharge less sodium and chloride over time. WaterSense expects that proposed performance criteria will reduce the frequency of regeneration in two ways: first, by requiring products to have demand-initiated regeneration, a potential WaterSense specification will ensure that units are regenerating only once a flow detector or conductivity probe determines that the system has met or is approaching full exhaustion; and second, the proposed regeneration efficiency requirement will ensure that the DIR units are regenerating within a prescribed percentage of their rated capacity. These requirements will reduce the frequency of regeneration, which in turn will maximize the amount of salt used to actually soften incoming water and reduce the amount of excess salt discharged.

WaterSense recognizes that increasing the water and salt efficiency of water softeners simultaneously could have an impact on the concentration of sodium and chloride in the discharge, though the overall amount of sodium and chloride is likely to decrease. With its draft specification, WaterSense is looking to balance the water-efficiency requirement with the salt-efficiency and regeneration frequency requirements to provide an overall improvement to the water quality of the softener discharge. To determine the impact of potential specification requirements, WaterSense is seeking data to show how improvements to the salt efficiency and water efficiency of water softeners will affect the amount and concentration of sodium and chloride in water softener discharge. WaterSense is also interested in obtaining information from municipalities in California that have experience with higher efficiency water softeners as a result of the California Health & Safety Code legislation, and whether or not a reduction in the sodium and chloride contribution from water softeners has been observed.

VI. Summary of Outstanding Issues

Though WaterSense is requesting feedback on all aspects of this notice, the specific outstanding issues, questions, and concerns that require addressing prior to the release of a draft specification for cation exchange water softeners are summarized below. All interested parties are encouraged to submit information to watersense-products@erg.com.

Scope

- Are there aspects of commercial water softeners that are significantly different from residential water softeners that would need to be addressed through a separate set of performance requirements? If so, what are they?

- Is there a threshold size or capacity for commercial water softeners below which products could meet the efficiency and performance requirements discussed in this NOI?
- Is it more common for commercial water softeners to be packaged and sold as a unit or as individual components (e.g., tank, controller, valve) purchased and assembled on site? Does unit size, nominal pipe size, and/or capacity affect how the unit is packaged and sold?

Water Efficiency

- Additional market data on the water use of both residential and commercial water softeners.

Softening Performance

- How does the current NSF/ANS 44 hardness level of 1 gpg relate to consumer expectations for softened water?
- How might a less stringent softening performance requirement impact water and salt efficiency?

Salt Efficiency

- Additional market data on the salt efficiency of both residential and commercial water softeners.

Regeneration Efficiency

- Are data available regarding the percentage of the rated hardness removal capacity within which units typically regenerate?
- How can regeneration efficiency be incorporated into testing protocol for volume and sensor based units and how would units specifically designed to regenerate before their rated capacity (e.g., twin tank systems) be accounted for?
- Is regeneration efficiency a function of product design or a user controlled setting?

Multiple Salt Dosage Settings

- What are the impacts of requiring water and salt efficiency requirements to be achieved at all salt dosage settings?
- Are data available regarding the water and salt efficiency of products at their minimum, maximum, and average salt dosage settings?

Issues of Concern

- Are data available to show how improvements to the water, salt, and regeneration efficiency affect the amount and concentration of sodium and chloride in water softener discharge?

References

Bruursema, T. 2002. Water Matters. Water Softeners & Septic Tanks: A Compatible Combination? *44* (4). <http://www.wcponline.com/column.cfm?T=W&ID=1481&AT=W>.

European Committee for Standardization. 2005. *EN 14743:2005+A1 Water Conditioning Equipment Inside Buildings—Softeners—Requirements for Performance, Safety, and Testing.*

Legislative Counsel of California. 2009. California Health and Safety Code §116775-116795.

NSF International and American National Standard. 2004. *NSF/ANSI 44-2004 Residential Cation Exchange Water Softeners.*