Efficiency of Water Softeners Under NSF/ANSI 44

By Rick Andrew

Efficiency is so important in today's modern world. We expect our cars to be more and more efficient, especially as the price of gasoline continues to rise. We strive to use our time efficiently, practicing various techniques of time management ranging from multitasking to continuous reprioritization. Major household appliances are required by law to report their energy efficiency characteristics on special labels, so consumers can evaluate them when considering a purchase.

The same is true of residential water softeners. Water softeners use little, if any, electricity and do not take much of our time to operate. But they do consume salt and water. With these considerations in mind, the efficiency aspect of a water softener is evaluated in the following terms:

- How much hardness does the softener reduce from water, given a specific amount of salt used for regeneration?
- How much regenerant water does the softener use to achieve that hardness reduction?

This column touched on the issue of softener efficiency a few months ago, when the topic was a broad look at Standard 44. Because efficiency is such a hot topic, I thought it well worthwhile to devote this entire column to a detailed discussion. I trust this approach will result in an efficient use of your time in reading the column!

Efficiency as a function of salt dosage

The efficiency of a softener is a function of the softener design and operational parameters, as well as the salt dosage used for regeneration. Note that salt dosage is not the same as salt setting. Salt dosage is the amount of salt per amount of cation exchange resin in the system. Dosage is usually expressed in units of lbs of salt per cubic feet (ft^3) of cation exchange resin. The more salt that is used to regenerate the softener, the less hardness capacity per measure of salt. There are diminishing returns for using more and more salt. In fact, after a point, additional salt used in regeneration will not achieve any more softening capacity and will simply be rinsed out of the system. The theoretical maximum possible salt efficiency for standard styrene divinylbenzene cation exchange resin is 6,000 grains/lb, based on the chemistry involved in the ion exchange process.

Figure 1 demonstrates a hypothetical example of salt dosage versus softening capacity for a water softener. At a dosage of 1.5 lbs of salt per ft^3 of cation exchange resin, softening capacity is 6,000 grains. Let's assume that the softener referenced in Figure 1 has 1.0 ft^3 of cation exchange media, such that salt dosage = salt setting. This results in a salt efficiency for this softener at this salt setting of 4,000 grains of capacity per lb of salt (6,000/1.5 = 4,000).

At a 7.5 lbs salt setting, softening capacity of this softener is 14,000 grains. Efficiency is only 1,867 grains of capacity per lb of salt (14,000/7.5 = 1,867). Salt efficiency is less than half of what it was at the 1.5 lbs of salt setting. This inverse relationship between salt efficiency and salt setting or salt dosage is graphically displayed in Figure 2.

Measurement of efficiency under NSF/ANSI 44

The specific requirements for efficiency can be found in Table 1. Note that only demand initiated regeneration

Figure 1: Softening capacity as a function of salt dosage

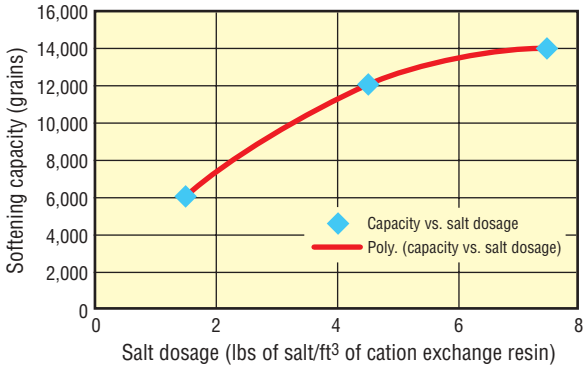


Figure 2: Softening efficiency as a function of salt setting

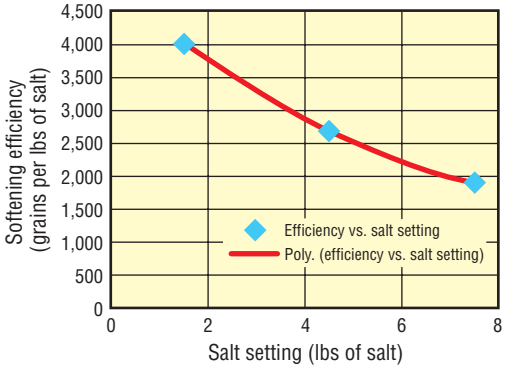


Figure 3: NSF/ANSI 44 efficiency requirements (DIR softeners only)

Parameter	Efficiency requirement
Salt efficiency	At least 3,350 grains of capacity per pound of regenerant salt
Water efficiency	At least 1,000 grains of capacity per 5 gallons of regeneration water

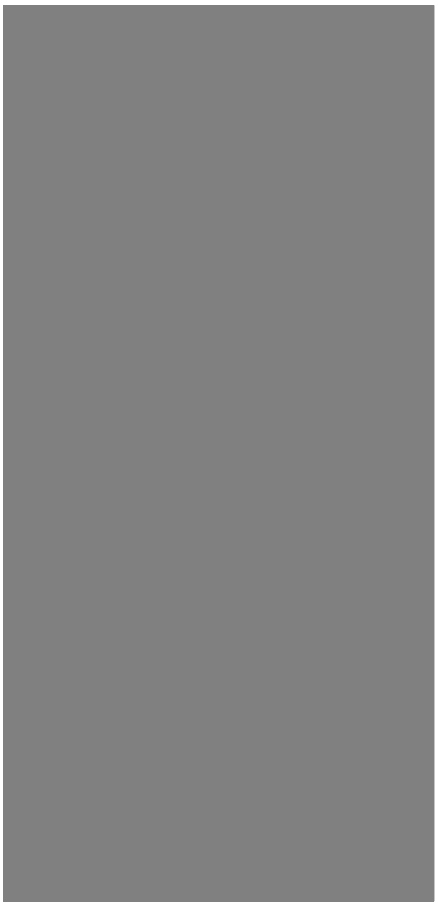
(DIR) softeners may claim efficiency. A softener must achieve both salt efficiency and water efficiency in order to be 'efficiency rated'. Standard 44 does not require softeners to be efficiency rated. Inefficient softeners or softeners that are not DIR may also be certified to the Standard, but the manufacturer may not claim that they are efficiency rated. And, as you will see below, inefficient softeners may have limited market access.

Efficiency is based on calculations of data measured and recorded during softening capacity testing. Obviously, the amount of salt used to regenerate the softener is recorded during testing, along with the resulting capacity. Additionally, the amount of regenerant water used must also be recorded in order to determine water efficiency. This may be done in practice by collecting all of the brine discharge in a tared drum, weighing the regenerant water and then converting that weight to water volume.

Guidelines for making claims

The Standard requires that the salt setting must be stated in any efficiency specifications or statements by the manufacturer. The reason for this requirement is that there is variation in efficiency with salt dosage, as illustrated graphically in Figure 2. By stating the salt setting, the operating conditions required to achieve that efficiency are as clear as possible for the consumer.

Most softeners have variable salt settings, many of which are adjustable by the consumer. Manufacturers typically advertise efficiency ratings based on the lowest salt setting, because that salt dosage results in the highest salt efficiency. This is perfectly acceptable within the requirements of Standard 44 and it gives the consumer the flexibility to operate the softener under its most efficient setting or to make the choice to sacrifice efficiency in order to have less frequent regenerations.



California dreamin'

Since January 1, 2003, the State of California has demanded a more stringent requirement for efficiency ratings, requiring at least 4,000 grains of capacity per pound of regenerant salt. This was the culmination of over 20 years of increasing efficiency requirements being slowly adopted and implemented. Softeners with lower efficiency ratings, or no efficiency rating, may not be sold in the state. The desire to gain access to this important market has proven to be a major incentive for manufacturers to develop softeners that operate efficiently.

An efficient end to this discussion

There has been quite a bit of discussion here in southeast Michigan about big changes coming to the automobile market as a result of recent increases in gasoline prices. Talk of manufacturers focusing on development and production of smaller, more fuel-efficient cars has been heard frequently (although a high percentage of large SUVs is still seen on area freeways). If you believe the hype, hybrids may prove to be a major market segment in the next few years. Their sales will supposedly overtake the sales of traditional SUVs for the first time in 2006.

The water conditioning industry has been ahead of this trend toward efficiency now for several years. The latest California requirements, building upon earlier ones, have been in place for over three years now, so manufacturers have had ample time to refine their designs and operating parameters. The days of wasted salt and water have long since passed.

Will the future bring more stringent efficiency requirements for softeners? Only time will tell. There has been increasing concern over total dissolved solids concentrations in surface waters, which has led some to focus on water softeners as a source. Much as the automakers are responding to the current push for more efficient cars and the water conditioning industry has responded to past initiatives to increase softener efficiency, I have every confidence that the resourceful manufacturers of water conditioners will be poised to accept whatever new challenges come their way.

About the author

S *Rick Andrew has been with NSF International for seven years, working with certification of residential drinking water products. He has been the Technical Manager of the Drinking Water Treatment Units Program for four years. His previous experience was in the area of analytical and environmental chemistry consulting. Andrew has a bachelor's degree in chemistry and an MBA from the University of Michigan. He can be reached at 1-800-NSF-MARK or email: Andrew@nsf.org.*