After SB1006:

Factors Affecting the Brine Efficiency of Softeners

Part 1 of 2

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Summary: *With the June passage in California of Senate Bill 1006, water conditioning manufacturers and dealers are going to be searching more than ever for ways to make their equipment operate with greater brine efficiency. One of the requirements will be installation of only softeners with demand initiated regeneration valves after Jan. 1, 2000. But more will be required than that. Here we offer the first part of a two-part series to discuss the subject, concentrating on the salt setting and the water analysis.*

Brine efficiency for a water softener is defined as the number of grains (gr) of hardness removed per pound of salt used for regeneration.[1] This, of course, also assumes a fixed breakthrough end-point—usually 1 grain (17.1 parts per million, or ppm, of total hardness, or TH, as calcium carbonate, or $CaC0_3$). The theoretical maximum efficiency is 6,000 grains per pound (gr/lb). This would mean that every ion of sodium (Na) or potassium (K) in the regenerant brine finds its way onto a reactive site on the resin matrix and the regenerant waste is pure hardness with no sodium or potassium ions. Many hybrid modern softeners are very highly efficient, but none are 100 percent. Typical softeners operate with recoveries of 22,000-to-25,000 grains per cubic foot (gr ft^3) on 8 lbs of salt, or a brine efficiency of 3,000 gr/lb—about 50 percent efficient. To calculate efficiency, one simply has to multiply the grains per gallon (gpg) in the feed by the total gallons processed between runs and divideby the number of pounds of salt per cubic foot used to regenerate. A 2-cubic-foot softener that processes 3,100 gallons of 15.5-grain water removes 48,050 grains of hardness. If that system regenerates with 14 lbs of salt (7 lbs / ft^3), we have an efficiency of 48,050/2 x 7 = 3,432 gr/lb, or 57.2 percent efficient. If that same softener was used for boiler feed with a maximum hardness breakthrough tolerance of 2 ppm (TH as $CaC0_3$), it may only process 2,800 gallons and require 24 lbs. of salt for regeneration. Our efficiency, therefore, becomes 2,800 x 15.5/12 x 2 = 1,808 gr/lb, or 30.1 percent efficient. This also means that 69.9 percent—100 -30.1—of the salt used or about 16.8 lbs goes down the drain as salt discharge. This excess salt is very soluble and passes through sewage treatment unchanged. The processed sewage is eventually discharged into a waterway, reinjected into the ground or sold as reclaimed water for non-agricultural irrigation. It will have a higher total dissolved solids (TDS) count than the original feed source because of the added salt.

The brine discharge issue

Sooner or later, excess salt discharge becomes a concern. Often, it's the chloride content that draws attention—and even a 100 percent efficient softener discharges all of its chlorides. In sodium chloride (NaCl), the chloride represents 66 percent of the total weight of the salt. Potassium chloride (KC1) is still 48 percent chlorides.

At least two states, California and Wisconsin, have enacted legislation to set the minimum brine efficiency at 3,350 gr/lb (now set to take effect in California on Jan. 1,2000) and require meter or demand initiated regeneration (DIR). No time clocks will be used on new systems. The Water Quality Association (WQA) has also adopted the 3,350/DIR standards.[2] California also has passed legislation that will raise the bar to 4,000 gr/lb effective Jan. 1,2002. No doubt, others will follow. The driving force for higher efficiency is to reduce TDS creep (which may limit the ability of municipalities to resell reclaimed water from sewage for other uses) and other environmental issues.

Understanding the variables

Those of you who install and service softeners may have experienced a

Table 1.
Factors to consider in brine efficiency

1. Salt setting—capacity and leakage
2. Water analysis—fixed total hardness and total dissolved solids, iron compensation
3. Valve controls—timer, up- or downflow
4. Injector selection—brine concentration and flow rate
5. Tank configuration—bed depth, head space, underbedding
6. Resin selection—size and function
7. Service flow—gpm/ft^3 of resin