Quality Considerations

Examining three residential softener sizing & configuration options

By Jerry Horner

Let's take a look at three unique softener applications and some of the potential system configurations for each one. The first step is to identify the operating parameters. Does the customer need high-quality, low-leakage soft water? In that case, you likely will want to use a low-salted primary system followed by a high-salted upflow regenerating polisher. Maybe the application has a requirement for continuous softened water. In this application, you might configure with redundant, separate systems, each of which is capable of supplying all of the application's needs 24/7. Both sets of systems can be on-line all the time, splitting the workload. In case of a maintenance need or failure, one set can be taken off-line for repair while the other set handles the soft water needs. Residential softening needs can vary widely, even in the same neighborhood. Let's take a look at some important factors to consider, along with sample configurations.

An undersized softener will suffer from excessive pressure drop, inefficient use of salt and regenerant water, and premature resin attrition. An oversized softener will create issues such as low-flow channeling that ultimately lead to inconsistent performance and inaccurate regeneration initiation. When water flows too slowly through a resin bed (less than approximately 3 gal per minute [gpm] per sq ft), it finds the path of least resistance and keeps following that path. This leads to inordinate capacity depletion to a particular area of the media bed. Service flow through the resin bed should be maintained at about 3 to 20 gpm per sq ft of bed area, but intermittent peaks of up to about 30 gpm per sq ft may be tolerable. The ultimate system size and configuration needs to appropriately address the application's flow and other filtration demands. When low-salting to maximize capacity efficiency, be careful that you also adjust cycle times for the economical use of regenerant water volume. Low-salting levels require less water to regenerate, so use a controller that allows for individual cycle adjustments.

Application No. 1

Hypothetical application No. 1 requires 24/7 softened water and uses 500 to 8,000 gal per day (gpd) with an average daily use of 2,000 gal. Based on a theoretical capacity of 24,000 grains per cu ft and a consistent influent hardness of 18 to 20 grains per gal (gpg), the maximum daily capacity would require about 7 cu ft of resin.

There are no other significant contaminant issues, so the only concern is hardness. Fifty percent of the flow is in the 5- to 10-gpm range, but there is occasional need for a peak of 90 gpm. There are no space or access issues, so almost any size or configuration is up for consideration. To meet the 24/7 soft water requirement, a twin or multiple-unit system will be required. Here are some of the options.

A pair of independent time clock- or meter-initiated systems presents multiple challenges and potential problems. Because the unit in regeneration will have a no-hard-water bypass mechanism, it will provide no water to service during the regeneration period. If both independently controlled units happen to regenerate at the same time, there will be no water available to the application during that period. In addition, there are huge hurdles with regard to reserve capacity inefficiencies that will result in excessive salt use, intermittent hard water or both. This configuration should not be considered for this application.

A meter-initiated twin alternating system seems like a potential solution. To achieve the needed peak flow rate, the application will require a minimum of 24-in.-diameter mineral tanks, which provide a bit more than 3 sq ft of bed area. Practically the entire capacity of the tank in service is used before regeneration, so the system is highly efficient. The primary issue is that the application operates half the time at or below the 3-gpm-per-sq-ft parameter, potentially leading to channeling and related obstacles. To significantly mitigate the channeling issue, the mineral tank surface area would need to be 1.5 to 2 sq ft to accommodate the low flow parameter of about 5 gpm.

A third option is a multiple-unit system that brings units on- and off-line based on the flow demand. Sometimes known as stage-by-flow or demand flow, these systems can adjust to a range of flow demand specifications. Because units can regenerate at any time, these systems typically are designed to supply the peak flow requirement while one system is in regeneration. Regeneration is similar to a twin alternating system, using nearly the entire capacity prior to regeneration initiation. A slight reserve capacity adjustment often is considered in case more than one unit calls for regeneration during the same time period. A quad system with four units using 16-in.-diameter mineral tanks with about 1.4 sq ft of bed area could provide an efficient flow range of about 4 to 100 gpm with one to three units on-line, depending on the flow demand. This is a prime solution for this application.

Application No. 2

Hypothetical application No. 2 requires softened water up to 20 hours per day and uses 100 to 600 gpd with an influent hardness level of 22 to 30 gpg. Again, hardness is the only concern, so this application would require up to 0.75 cu ft of capacity per day. The service flow range is 2 to 10 gpm, and there are no space issues.

A single time clock-initiated system would be inefficient and require a large percentage of the capacity to be wasted as reserve. This option is not a consideration in this application.

A single metered unit is a possibility, but we must be cognizant of the channeling issue and reserve capacity requirement. When operating a single unit, a reserve capacity is required when using the typical delayed regeneration. Modern controllers help lessen the importance of this issue by intuitively and automatically adjusting the reserve capacity based on the actual water use patterns of the application. To help lessen this efficiency-robbing factor, use the largest system that still operates efficiently at low flow levels. A compromise may be best, and in this application, a 13-in. mineral tank is a good choice.

A twin alternating unit using 10- or 12-in.-diameter tanks is a better option than a single metered unit. Almost no capacity is lost to the reserve with both low- and high-flow parameters under control. However, with a hardness range of 22 to 30 grains, the system will normally be set to operate based on the 30-grain level, thus wasting capacity due to not accounting for hardness fluctuations. Though more expensive and complex, twin alternating units that regenerate based on actual hardness using a sensor may be worth considering when hardness levels fluctuate significantly.

Application No. 3

Application No. 3 requires softened water 24/7, using 100 to 2,000 gpd with an influent hardness level of 9 to 10 gpg. Hardness is the only concern, so we must size for up to about 1 cu ft of capacity per day. There are no space limitations; however, the service flow range can vary from 2 to a rare peak of 40 gpm.

A single time clock- or meter-initiated unit would not work in this application, as it requires soft water 24/7. Even if this was not a requirement, any kind of single unit in this application would be difficult to justify.

The ultimate system size and configuration needs to appropriately address the application's flow and other filtration demands.

A twin alternating system also is not a good fit due to the wide service flow fluctuations. For the low end, we would need no larger than a 13-in.-diameter mineral tank, but to accommodate for the 40-gpm peak requirement, we will want nothing less than a 16-in.-diameter tank.

The final option is a multiple stage-by-flow system that brings units on- and off-line based on flow demand. Practically 100% of capacity is used, so it is efficient from 2 to 40-plus gpm. In this application, a triple system using 12-in.-diameter mineral tanks with 1.25-in. control valves should do the trick. With a pair of 1.25-in. units on-line, there is more pipe area than a single 1.5-in. unit, and the system can flow efficiently at 2 to 20-plus gpm with one system on-line and 40-plus gpm when a second unit is automatically brought on-line.

In these examples, the grand prize winner appears to be the multiple stage-by-flow systems. They are effective in a range of applications and offer efficiency and flexibility. They also come at a higher initial cost, can require large amounts of space, and are more complex to program and operate. The key is to find the best long-term, efficient solution for each individual application.

A cookie-cutter approach to system design leads to poor performance and inefficient operation. Quality is not limited to the components, but also must account for the system design considerations. The bitterness of poor quality (or inferior system configuration design) lingers long after the sweetness of low price is forgotten. **WQP**

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