Water Softener Performance Testing

By Mark T. Unger, CWS-VI

The first performance standard for water softeners was the Water Conditioning Foundation's (WCF) *S-100 Standard*. The first version was issued in 1959 and contained structural integrity testing to ensure water softeners would not leak when installed in the field at the manufacturer's recommended operating conditions. Over the years this standard became *WQA S-100*, added various softening performance testing criteria and became an ANSI-accredited standard in the form of *NSF/ANSI 44, Residential Cation Exchange Water Softeners*. The current version of *NSF/ANSI Standard 44* contains various tests to ensure a certified softener performs as expected. Testing laboratories and certification bodies performing work to *NSF/ANSI 44* must ensure the softener meets material safety (extraction), structural integrity, softening capacity, rinse effectiveness, water consumption, salt efficiency, softening performance, brine accuracy and pressure-drop testing requirements. Water softening capacity testing is more involved than passing hard water through a softener and analyzing the water to ensure soft water is produced. The various performance tests *NSF/ANSI 44*-certified water softeners are required to be subjected to are described below.

Exhaustion

In order to ensure all products are tested at the same starting point, all softeners must undergo a resin-bed exhaustion to 10 grains per gallon. The 10-grain exhaustion passes hard water (20 gpg) through the softener at a rate of four gpm (15.14 liters/minute) per cubic foot of resin in the system. Water samples are collected and analyzed to determine when 10 grains of hardness breaks through and is found in the treated product water. From this exhausted state, softeners are regenerated at the lowest salt setting specified by the manufacturer or assembler of the system. Once this regeneration is complete, the softener is ready for pressure-drop testing.

Pressure drop

NSF/ANSI 44 allows a maximum pressure drop of 15 psi at the softener's maximum rated service flowrate. Testing is conducted at various flowrates ranging from 20 to 140 percent of the softener's maximum-rated service flow in order to establish a pressure-drop curve. Pressure-drop testing is performed on a complete system as well as a system without ion exchange media in order to allow for temperature correction of data and use of conformance/validation by calculation to other softeners. Many clients prefer systems that offer the highest flowrate allowed by the standard. In this case, the pressure-drop test must be conducted first to determine the maximum-rated service flow that provides a 15-psi drop in pressure. Softening-capacity testing could then be conducted based on this determined flowrate.

Softening capacity

Softening-capacity testing also begins from the exhausted state and softeners are regenerated at salt settings specified by the manufacturer or assembler of the system. Softeners can be tested and certified at one salt setting, but are typically tested at three or four different salt settings or doses (low, 1 or 2 middle and high). Influent water contains 20 grains of hardness, 400 to 600 mg/L of TDS, < 1 NTU turbidity, < 85.5 mg/L of sodium and a pH between 7 and 8. During a capacity run, influent water is passed through a regenerated softener at half the client's maximum service flowrate until one gpg of hardness breakthrough is detected in the treated product water. Runs are performed by collecting and analyzing influent and effluent hardness samples and measuring how many gallons of water it takes to reach the one-gpg endpoint. This data is used to create a capacity curve for a given run and to determine the run's capacity of hardness reduction in grains. After a run is complete, the softener is regenerated at its lowest salt setting and another capacity run is performed. This pattern is repeated until the calculated capacities of three consecutive capacity runs are within 10 percent of their average (the requirement of *NSF/ANSI 44*). Ideally, capacity testing at a given salt dosage is completed in three or five runs, but one individual run can fall outside of the 10-percent requirement and necessitate additional runs.

If the softener being tested is requesting more than one salt dosage to be certified, then the softener will be tested at the next rated salt dosage. The control valve must be adjusted to ensure the proper regeneration settings are set for the new salt dosage. The unit would then be regenerated at the next salt dosage and a softening-capacity test could be conducted once this regeneration is complete. Softening-capacity testing would be performed as described above. The same process would be followed for each additional salt dosage requested by the client.

Additional data is gathered during the capacity runs to determine compliance to the standard. This data is collected at various times throughout a run, so it is extremely important for laboratory staff to be aware of when and how this data should be collected. A piece of missing data will require additional testing, which wastes the client's time and money. The additional tests performed during a capacity run are as follows.

Rinse effectiveness

Rinse effectiveness is a check of the softener's ability to rinse chlorides to drain during the regeneration process. An effluent water sample is collected after the final rinse or backwash step to determine the amount of chlorides remaining from the regeneration. An influent water sample is also collected and analyzed to determine how many chlorides were already in the feedwater. Each regeneration between capacity runs is checked for rinse ef-

fectiveness and cannot add more than 100 mg/L of chlorides to the treated water to meet the requirements of *NSF/ANSI 44*.

Salt efficiency (efficiency rated)

Salt efficiency is a mathematical calculation to determine how much hardness-exchange capacity is obtained per pound of salt used for regeneration. For example, a hardness-capacity run with a calculated capacity of 15,000 grains at a three-pound (1.36-kilo) salt setting has a 5,000-grain-per-pound salt efficiency. *NSF/ANSI 44* stipulates a requirement of at least 3,350 grains per pound to be considered efficiency rated, but the state of California has a salt efficiency requirement of 4,000 grains per pound in order to sell softeners in that state. Salt efficiency was typically only claimed on a softener's lowest certified salt setting, but as technologies have improved many manufacturers are able to achieve salt efficiency ratings on higher salt settings as well.

Water consumption

Water consumption is a requirement that limits the amount of water used during regeneration by softeners at their efficiency-rated salt dosages. In order to meet the requirements of water consumption, a softener cannot use more than five gallons (18.92 liters) of water per 1,000 grains of capacity. For example, a run with a 15,000-grain capacity would need to consume less than or equal to 75 gallons (283.9 liters) of water during regeneration. Water consumption is determined during regenerations in between capacity runs by collecting the water that goes to drain during the regeneration cycle.

Softening performance

Softening-performance testing is conducted to show the softener can provide soft water when operated at its maximum-rated service flow (for example, when multiple taps are opened in the home at the same time). This test sends water with 20 gpg of hardness at the manufacturer's maximum-rated service flow to the softener for a period of 10 minutes. Product water samples are collected every minute and the softener must provide soft water (less than or equal to one gpg) over the entire 10-minute period. The softening-performance test is conducted after the softener has been regenerated at the lowest-rated salt dosage only.

Brine accuracy

Brine-accuracy testing is conducted to ensure that a water softener delivers the correct amount of salt during regeneration. *NSF/ANSI 44* requires that a softener deliver within 15 percent of its specified salt dosage over three consecutive brine-accuracy runs. For example, a softener claiming a three-pound salt setting must deliver between 2.55 and 3.45 pounds (1.15 and 1.56 kilos) of salt to qualify for that setting. *Standard 44* offers different testing options, depending on the whether the system is a time- or float-controlled brine system and the percentage of salinity produced two hours after refill, but the theory behind the testing is the same. How much salt is removed from the brine tank during regeneration?

Conclusion

Water-softener testing has come a long way since 1959, when only structural integrity testing was required. Our industry standard for water softeners has evolved into a complex series of tests that push softeners to their limits in order to measure their performance. Softeners that bear a Certifier's Mark for *NSF/ANSI Standard 44* certification go through rigorous testing to ensure the softener is safe to use, provides soft water and operates as expected. The next time you see a certified water softener, I hope you appreciate all the testing it took for that softener to earn the certification mark it bears.

About the author

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About WQA

♦ *WQA is a not-for-profit association that provides public information about water treatment issues and also trains and certifies professionals to better serve consumers. WQA has more than 2,500 members internationally and provides Gold Seal certification for products that remove a variety of contaminants. These products are tested according to independently developed standards of the highly respected ANSI (the American National Standards Institute).*