Basic Softener Operation

Technical Bulletin 4-001

Pretreatment

Hardness

Hardness commonly refers to the dissolved calcium and magnesium in water. These minerals are called hardness since their presence reduces the lathering ability of soap and makes the water hard to wash with. The water treatment industry is concerned about hardness as it is a major cause of scale deposits in heat exchange equipment. Any equipment used to remove hardness is appropriately called a softener.

Ion Exchange

Most softeners use the principle of ion exchange. This is a process where undesirable mineral ions are removed from water and replaced by desirable ones that were stored on the ion exchange medium. When the exchange medium becomes saturated with undesirable ions, the unit is removed from service and recharged by passing a concentrated solution of the desirable ions over the medium. This reverses the ion exchange process and causes the undesirable ions to be replaced by the desirable ones.

Sodium Cycle Softening

Sodium cycle softening is the most widely used method of water softening. In this process, the calcium and magnesium hardness in the raw water are exchanged for sodium ions. A bed of very small, highly porous resin beads (called softener resin) is typically used as the ion exchange medium. After the resin becomes saturated with hardness, it enters the regeneration cycle, where it is regenerated using a brine (salt or sodium chloride) solution. As the brine passes over the resin, the calcium and magnesium ions are exchanged for the sodium ions. The hardness released from the resin is flushed to the drain with the regenerant and rinse waters. The frequency of regeneration is a function of the flow rate and hardness of the raw water, the quantity and condition of the softener resin, and the brine concentration used in regeneration. Regeneration consists of four basic steps.

1. Backwash: To remove the suspended solids that accumulate on the resin bed during the downward flowing service cycle, water flow is directed to the bottom of the tank, up through the resin bed, and out the top to the drain. This backwash process expands the bed, flushes out any suspended solids, and prepares the bed for brine draw. For effective backwash, the flow rate must be sufficient to expand the resin bed by 50% for 10 minutes or until the water runs clear.

2. Brine Draw: When backwash is complete, an approximately 8-12% brine solution is directed to the top of the resin bed for about 20 minutes. This should generate an elution curve that shows about 30 minutes of contact time at greater than 30% saturation. As the brine flows downward through the resin bed, the high concentration of sodium ions causes the hardness ions attached to the resin to be exchanged for sodium ions. The flow rate should be about 0.5-1.0 gpm per cubic foot of resin for optimum regeneration efficiency. Slower flow rates can cause channeling, while faster flow rates can cause incomplete regeneration.
3. **Slow Rinse:** When the brine draw is complete, fresh water continues to be directed through the resin bed for about 20 minutes at the same flow rate used for brine draw. This slow rinse step completes the ion exchange process and pushes the brine from the resin bed to the drain.

4. **Fast Rinse:** When slow rinse is complete, a fast rinse of about 1.5-2.0 gpm per cubic foot of resin is directed to the top of the resin bed and through to the drain. This flushes the remaining hardness and brine from the resin bed and lasts about 20-50 minutes at the service flow rate. The chlorides should be reduced to about the same as in the raw water.

After completion of the fast rinse step, the piston advances to allow hard water to flow into the brine tank so the proper amount of brine is available for the next regeneration. When brine refill is complete, the softener advances to service position.