

ADVANCED TREATMENT PROCESSES

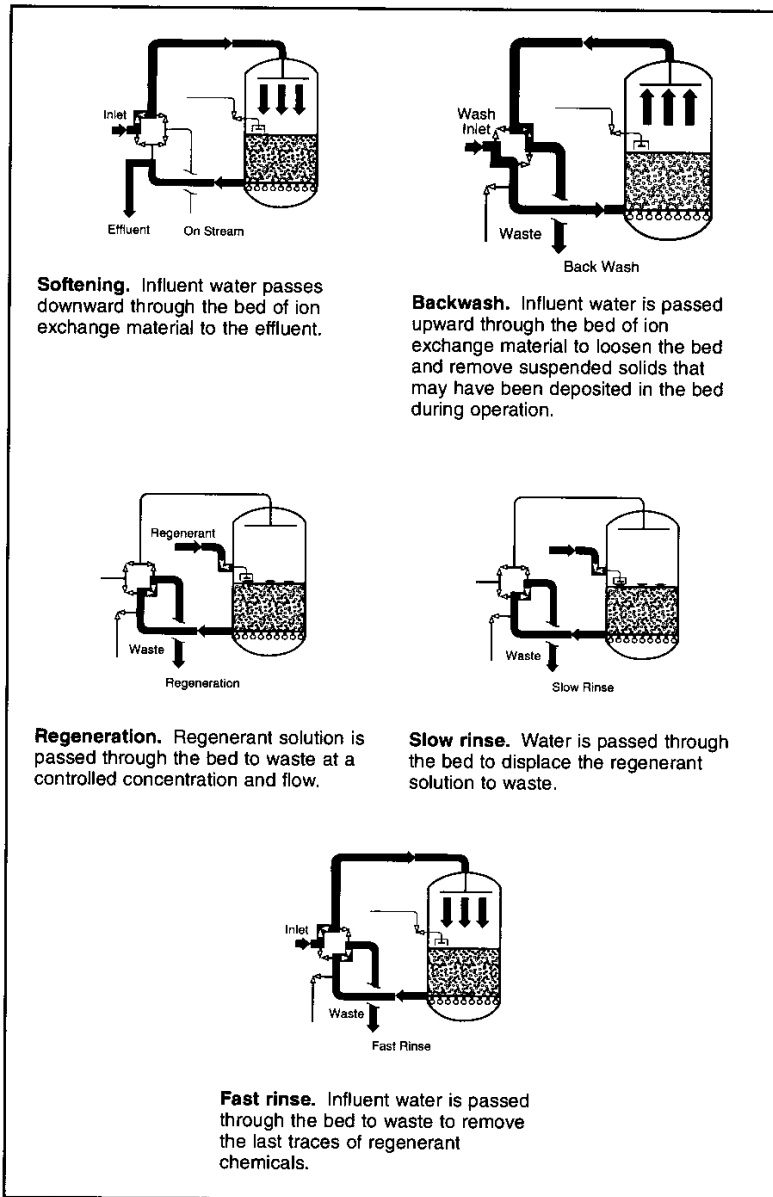
Advanced treatment processes are used to produce higher quality water than can be achieved by conventional treatment processes. They are often installed as point of use treatment. Advanced treatment processes are generally designed to reduce total dissolved solids. Some processes only reduce hardness. Others can reduce all dissolved solids including sulfates, nitrates and primary inorganic contaminants.

ION EXCHANGE PROCESSES

Systems that do not have the treatment equipment necessary conventional softening treatment may soften water using an ion exchange process. Although this is normally a point of use process, some small systems may use it as point of entry treatment. In most ion exchange processes water is passed through a filter containing zeolite granules. The zeolite granules are made of special polymers that capable of collecting and storing certain metallic ions (cations) like calcium, magnesium, and iron. This type of process is found in a water softener. Green sand filters are used for iron removal by ion exchange. Softeners are sometimes used upstream of reverse-osmosis treatment processes. The sodium ion is much smaller than the other metals it replaces and the R-O membranes don't clog as quickly.

The zeolite media must be charged or coated with sodium ions before any softening can take place. When the media is charged a reaction takes place that removes calcium and magnesium. The calcium and magnesium ions are exchanged for sodium ions. The hardness can be lowered to 0 mg/l this way because sodium (Na^+) does not cause hardness. The finished water may have a very high sodium concentration after softening. Individuals that have sodium sensitive health issues should avoid drinking water from softeners. An alternative to using sodium chloride is to use potassium chloride to regenerate the softener. Potassium (K^+), like sodium, also has a single positive charge. Potassium chloride is about four times more expensive than salt.

When the zeolite bed becomes saturated with calcium it can no longer remove hardness. This is known as softener breakthrough. When hardness is detected in the effluent it indicates that breakthrough has occurred. The amount of water a softener can treat before it becomes saturated is called the softening capacity of the unit. When a unit has reached its softening capacity, it must be regenerated. A unit can be "tuned" by changing a small plastic disk in the head unit. The disk revolves inside the head unit. There are small notches in the disk that trigger a regeneration cycle. If the softener is experiencing breakthrough prior to the current regeneration cycle, a disk that adds another cycle per revolution should be installed.



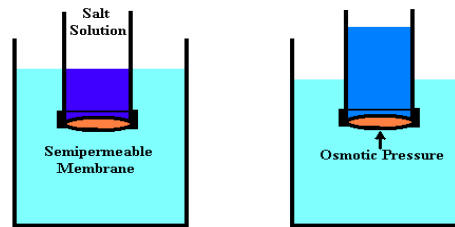
Courtesy of Inflico Degremont, Inc., Richmond, Va.

The first step in regenerating a softener is to backwash the unit to remove particulate debris. Once it is backwashed, the zeolite bed is flooded with a salt solution or brine. The zeolite granules will pickup sodium from the brine and release calcium, magnesium, and iron. Once this regeneration is complete, the unit is rinsed or flushed to remove the hardness-causing metals and excess salt. The softener can then be returned to service.

REVERSE-OSMOSIS PROCESS

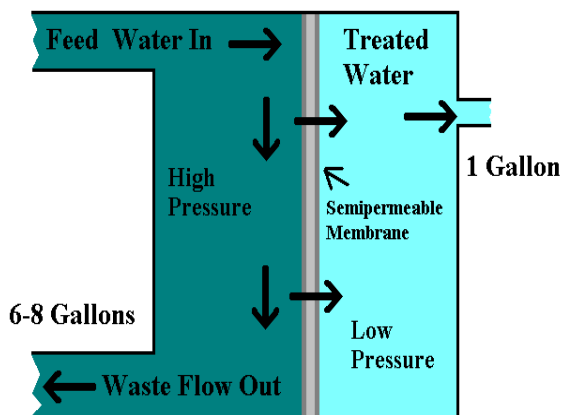
Reverse-osmosis (R-O) may also be used in cases where point of use treatment is needed. Reverse-osmosis will produce high quality finished water. It will be easier to understand reverse-osmosis if we start with normal osmosis first. Osmosis is the movement of water through a semipermeable membrane to a higher mineral concentration in an attempt to equalize the mineral concentration on both sides.

A tube, with a semipermeable membrane covering the end, is submerged in water and filled to the water level with a salt solution. Over time, water will pass through the membrane in an attempt to dilute the salt solution. This is how water is added to a ham. The ham is salted and soaked in water and water is drawn into the meat by osmosis.



Process of Osmosis

Our intestinal wall is an example of a semipermeable membrane. It allows water and nutrients to pass into the blood stream while retaining solids. Osmosis is the reason drinking salt water will eventually kill you. The salty solution in your intestines will draw water from your body and cause dehydration



Reverse Osmosis Process

R-O is a process in which water, under pressure, is forced through a semi-permeable membrane. The membrane will allow the water to pass through it but will trap the calcium, magnesium, and any other dissolved solids.

The water that doesn't pass through the membrane will carry away the minerals that are left behind. It may take 2-6 gallons of reject water or waste flow for every gallon of treated water that is produced. The treated water is called permeate or flux. The unit is backwashed periodically to clean the membrane when the permeate flow drops. The treated water from a R-O unit may be very corrosive. This is the result of removing the alkalinity from the water.

ELECTRO-DIALYSIS PROCESS

Electro-dialysis may be used when concentrations of hardness that exceed 500 mg/L are found. Water is passed between two metal plates that are electrically charged. The reaction is similar to that used in a metal plating shop. All of the metals are attracted to the plate with the negative charge and the non-metals are attracted to the plate with the positive charge and are removed from the water.

The scale that builds up on the electrodes must be removed on a regular basis. Some systems remove scale by backwashing the cells with acids and alkalis. The cleaning process will also use a great deal of water. Other electro-dialysis processes use a polarity reversal process to blast the scale loose electrically. This occurs prior to a blow down cycle where the scale is then flushed from the unit. Both R-O and electro-dialysis are very expensive from both an equipment and operation standpoint.

ADVANCED STUDY QUESTIONS

1. What two chemicals might be exchanged for calcium and magnesium in an ion exchange process?
2. What are the four steps to regenerate a water softener?
3. What does the term softener breakthrough mean?
3. Which of the following is not true regarding treated water from an R-O process?
 - A. The water is softer.
 - B. The water is less corrosive.
 - C. The water has less total dissolved solids
 - D. The water tastes better.
4. Which chemicals can be used to regenerate a water softener?
 - A. Sodium chloride
 - B. Potassium chloride
 - C. Either will work
 - D. Neither will work

ADVANCED SAMPLE TEST QUESTIONS

1. The water that passes through the semipermeable membrane of a reverse-osmosis unit is called:
 - A. Treated water
 - B. Flux
 - C. Permeate
 - D. All of the above
2. Scale can be removed from the electrodes in an electro-dialysis process by:
 - A. Using a wire brush
 - B. Reversing the polarity of the electrodes
 - C. Backwashing them with a brine solution
 - D. Super-chlorination