Main Factors that Effect Softening Resin Performance and Life

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When operated correctly in a well-designed system, softening resin employing a premium strong acid cation resin can give reliable operation for over ten years. Two frequently encountered problems can greatly shorten the resin's life.

1. The attack of the resin matrix by oxidative chemicals dosed into the water supply to sterilize the supply.
2. The effect of iron fouling. Experience tells us that many sites suffer from both problems to a lesser or greater effect.

In some extreme cases, there are sites where the units are worked hard and performance is critical. When these issues are not addressed, resin life can be reduced considerably, to less than one year.

In addition to potable water, many other supplies are dosed with sterilization chemicals. Many of these chemicals are sold under proprietary names. They are all strong oxidizing agents designed to make water supplies suitable for both potable and non-potable applications.

All oxidizing chemicals attack synthetic ion exchange resins, negatively impacting the crosslinking of their resin backbone. At low levels, the effect on resin life is relatively small. For example, at a level of 0.3 mg/l (0.3 ppm) "free chlorine," there is little reduction in resin life in cold water applications. When chlorine, chlorine dioxide, hypochlorite, peroxide or any other oxidizing agents are dosed at levels resulting in a higher oxidizing potential, they can cause quick and irreversible damage to the resin. The higher the water temperature, the faster the breakdown and loss of performance.

Resin manufacturers can provide general guidelines. For example, for a premium grade softening resin, for each 1 mg/l (1 ppm) of chlorine present in the incoming water supply, the life of the resin will be reduced by 50%. For each additional mg/l (ppm) of chlorine, the resin life will be reduced by a further 50%. Others suggest that having 1 mg/l free chlorine present in 15 °C water temperature reduces softening resin life to less than two years. The life of softening resins can vary considerably on different manufacturing sites and plants within the same location.

Some of the differences can be explained by the water temperature and oxidizing potential of the water, but a major factor is cation resins are available with different crosslinking content. The higher the crosslinking (DVB content), the greater the resistance to oxidative attack and the longer the resin life in the duty.

Some lower price softening resins have only 6% DVB content or less, which means they will have good kinetic performance, but the lowest resistance to oxidative attack.

Chlorine Dioxide
Chlorine dioxide has become commonly adopted on many sites as the sterilization reagent, as it is easy to handle and apply. It has strong oxidative potential and can last long in water systems.

Iron Fouling
Iron is present at relatively low levels in surface waters, but iron can be considerably higher in some groundwater sources. Unfortunately, strong acid cation resins have a high selectivity for iron, which creates a strong bond to the resin, making it impossible for the brine regenerant to obtain a good reversible removal. Iron consequently builds upon the resin slowly and reduces the resin’s capacity for calcium and magnesium.

When very high iron levels are encountered as the water contacts air or sterilization chemicals are dosed, some of the iron can be precipitated. This process forms iron-based suspended solids that need to be removed by filtration before the softener, or more vigorous backwashing of the softener, is required. If not, the bed becomes blocked, and performance is lost.

Both dissolved and iron particles can become a problem. In both cases, it has been reported that iron will also act as a catalyst, accelerating the effect of an oxidative attack on the resin and further shortening resin life.

Resin Testing
We strongly recommend having resin samples tested when an oxidative attack or iron fouling is suspected. Two clear signs show if an oxidative attack is occurring.

1. Analytical testing of a resin sample from the bed will show a reduction in the resin's total capacity of the resin and this will be combined with a significant increase in the intrinsic moisture content (or water retention) within the resin beads. As the oxidative attack continues, the resin beads near the inlet to the bed will become physically weak and soft, and — in severe cases — they become "jelly-like," causing increased pressure-drop and further loss of performance from the bed.
2. Iron fouling can be monitored and quantified based by routinely taking resin samples from the bed and testing them. By monitoring oxidative attack and iron fouling combined with the loss of performance on the plant, it is possible to predict when resin will require replacement.