Maintaining The Performance Edge With PE Systems

By C. F. "Chubb" Michaud

For the most part, fixed bed ion exchange systems see the same water day in and day out. Seasonal swings in temperature, TOC, TDS, alkalinity, etc. are anticipated and compensated for with adjustments to the regular regeneration procedures. Periodic maintenance for relief from fouling are easily scheduled and, if the system was properly designed, proper pre-treatment is built in to reduce or eliminate most problems. In short, there are few surprises. On the other hand, portable exchange (PE) resin systems may never see the same water supply twice.

Although the intent of ion exchange systems is to remove or replace unwanted ions of measurable charge, they are, in effect, scavengers of charged particles. Some of these charged materials are ionic but they may also be colloidal, organic, bacterial, leftovers from pre-treatment (polymers, alum), residuals from the plumbing (copper, lead, solvents) and even residuals from the ion exchange manufacturing process itself (solvents, organic acids, complex amines). What may be a "tolerable inconvenience" for one customer may be a toxic contaminant when accidentally leached into the feed stream of another.

The scope of this article is to help the portable exchange dealers detect these potential contaminants (foulants) as well as alert them to their presence and establish routine procedures for inspection and treatment that will help them maintain the performance edge on their portable exchange DI and/or softening systems.

Background

In a previous WC & P article, a fairly comprehensive trouble shooting guide was published[1] as an outline for detection of and remedies for DI system ills. While many of these pointers are worth reviewing, we'll not rehash them here, but instead, will focus on those peculiar to portable exchange.

Water contaminants are numerous in nature. Simply defined, a contaminate is any undesirable material found in a feed stream. They may be ionic, dissolved or suspended organics, colloidal, microbial, natural or man made.

Those servicing PE systems do not always have access to a complete water analysis prior to taking on a new account. A recycle stream at customer "A" may contain a nutrient that gets adsorbed onto an anion resin which then causes a bacteria bloom at customer "B." Iron picked up from Farmer Jones' well on a PE softener may become a problem for Mrs. Smith's under-the-counter RO when the iron leaches off during the service run because the Smith's water source has a lower pH.

The only real solution is to treat all portable exchange systems like surgical instruments. They must be thoroughly cleaned before sending them back out on a new system. Alternatives, of course, include isolation of larger PE units and returning them to the same customer, classification of float by purity and/or end use, pre-testing of all water supplies and insisting on adequate pre-treatment, inspection of all incoming PE tanks and periodic maintenance (just in case) to eliminate problems before they become major. The best route, of course, is **all of the above.**

The Nature Of Dirt

Ion exchange beds are very good filters. Physically, they're capable of filtering silt and suspended dirt down to 10 microns or so. In addition, there are many charged particulates such as bacteria, tannins and suspended clays that can be picked up by ion exchange. This "dirt" is too large to penetrate the ion exchange bead, but it sticks to the surface and builds up in the bed. The list includes red iron, organic iron, colloidal silica, grease and oil.

Never underestimate the importance of adequate backwash to help remove surface foulants which can cause kinetic impairment and channeling of the resin. Cation resins need 5-7 gpm/ft^{2} for 20-30 minutes. Anions require 2-4 gpm/ft^{2} depending upon type.

Periodically, the backwash can be

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done with a disinfecting solution containing chlorine at 50 ppm. This should be done on cation **after** regeneration. A procedure will be given later.

Iron, Manganese and Other Metal Hydroxides

Well waters frequently contain soluble forms (clear) of metals (iron, manganese) that may oxidize during service and become insoluble. In addition, municipal treatment may include excess alum which is carried as soluble Al^{+++} ion. Cation resin removes these ions.

On DI systems, regenerating with sulfuric acid will remove aluminum (and copper). Regenerating with hydrochloric acid will remove **all** oxidized metals (including lead). However, softeners regenerated with a salt will not be cleansed of metal oxides unless the brine is acidified (use HCl, H_2SO_4 or citric acid).

Caution: Do not use HCl or H_2SO_4 to remedy home softeners - use citric only at 1 lb. per 50 lbs. salt. H_2SO_4 plus NaCl produces HCl. Make sure your system can handle acid. As an alternative, periodically add sodium hydrosulfite ($Na_2S_2O_4$) to brine (2 oz/ft^3 of resin). Hydro is a reducing agent that will convert metal oxides back to soluble form.

For maintenance in all areas prone to metal oxide fouling, run every batch regeneration with hydro every sixth month. Consider pre-treating high iron well to reduce problem.

Bacteria, Algae (Biofoulants)

Most municipally supplied waters do not pose serious threats of biofouling. However, at certain times of the year, the water temperature, reservoir level (or lack of it), organic level, etc. may bring about increased microbe levels.

It is the nature of organics to adsorb onto plastic surfaces - especially resin beads, pipe and hose walls, and plastic storage tanks. Microbes that lacked sufficient nutrient now have a field day and can multiply rapidly. Biomasses colonize on these surfaces and produce a jelly-like coating that protects from routine chemicals such as acid and caustic. Once inoculated, they can become very persistent and spread throughout your plant and be carried out to every customer's plant. Learn to recognize biofouling.

Instruct service reps to check the inside of pipes and fittings for the presence of slime or any telltale odor that may suggest bacteria (algae has a fishy odor). Check transparent hoses and pipes for greenish or blackish deposits. Be particularly sensitive to closed loop systems with recirculating lines and softeners on untreated wells. Regen plant operators should take note of any odor, slime or jelly-like deposits in tanks as they are dumped. Also, look for discoloration and make note of any dramatic drops in capacity. Resins coated with slime will not regenerate well and short runs with poor quality will result.

Once infected, the entire system must be treated. Flush all hoses, tanks, pipes, storage tanks, etc. with a strong disinfecting solution of 100-200 ppm chlorine for one to two hours. Then rinse.

Backwash resins with a 50 ppm chlorine solution for one hour. The simplest way to do this is with a recirculating pump. Immersible pumps for fountains or sump pumps are fine. Drop the pump into a five-gallon bucket and run the hose into the bottom of the regen tank. Run to over blow back to the bucket to close the loop. Start pump and keep a bucket filled with a hose until the overflow takes over.

(If resin is dirty, you may wish to sewer the initial discharge water.) Once the water clears, add one pint of liquid bleach (5.25% NaOCl) for every 20 cubic feet of resin in the regenerator. After 15 minutes, check the residual chlorine in the discharge and maintain at 5-10 ppm by adding extra chlorine to the bucket. Continue for 60 minutes. Remember, chlorine will precipitate metals and should only be applied to regenerated cation resins. Since the OCl- ion will be picked up by the anion resin, it should only be applied to exhausted resin which will be subsequently regenerated.

Since biofouling usually accompanies organic fouling, check anion resins with a caustic/brine solution. Mix 1 oz. dry NaOH or 2 oz. of 50% NaOH plus 1 lb. NaCl and dissolve in one gallon of soft water. Fill a beaker half full of this solution and one quarter full of suspect anion. Soak for 20 minutes. Look for color leaching as an indicator of organics, pale yellow is mild, tea color is bad. Treat organically fouled resin by standard procedure.[1] Another indicator is an unexplained low pH from a two-bed demineralizer.

Advice On The Use Of Sulfuric Acid For PE Regeneration

Don't!!!

Sulfuric acid is less corrosive and less expensive than hydrochloric. However, it is wrought with problems when used for PE regeneration. Calcium precipitation and incomplete regeneration as well as lower capacity are only a few. If you must use sulfuric acid, use 10 lbs./ft. and feed at no more than 2% concentration and 1 gpm./ft^3 throughout. Polishing mixed beds can usually handle stronger solutions (6%) due to the fact that they rarely see calcium or other metals.

Working mixed beds (those that see more than 10 ppm TDS or 5 ppm hardness) **should be regenerated with HCl.**

An Ounce Of Prevention

As this old saying implies, it is more cost effective to prevent a problem than to cure it. Applied to PE, this means proper pre-treatment and preventative maintenance. You should know your customers' water system at least as well as his credit line. Ion exchange systems work best when they are called upon to exchange ions only.

If the feed water has visible dirt or turbidity above 5 NTU's, use a prefilter.

If the feed water has free chlorine above 0.5 ppm, use a GAC filter or chemical feeder to reduce it.[2]

If the feed water has soluble iron above 5 ppm, use an iron removal filter. At 3-5 ppm, use an additive to the brine as routine. At 1-2 ppm, use an additive every six months.

If feed water has red iron, use a prefilter.

If the feed water has hardness accounting for more than 30% of total cation, do not use sulfuric acid for regen.

If TOC from grease and oil is greater than 3 ppm, use a prefilter (usually multimedia, GAC and/or cartridge or bag filters).

If organics from surface waters exceed 10 ppm, use an organic scavenger or precede SBA with WBA. An organic scavenger is usually a salt regenerated special SBA used in a prefilter position. They're designed to "foul" with organics and do not perform an ion exchange function per se.

Be aware of possible temperature excursions on DI systems. Elevated temperature (170° F) can destroy a Type II anion in a few months. Type I's are more stable but still cannot tolerate temperatures above 140° F for more than a few months. (See Fig. 1)[3]

Maintaining An Effective Float

While many of the problems encountered in PE deal with pre-treatment at the customer's plant, most of these can be avoided simply by doing one's homework.

In a nutshell, know and understand your customer's system and his/her needs. Be aware of the potential for fouling and learn to recognize it before it shuts down your entire system. Fouling is generally a gradual occurrence and may not be easily recognized. Don't wait for it to show up. Institute routine prevention modifications to your regeneration process to lessen the impact.

Maintenance of an effective float goes beyond the chemical treatment. Maintenance includes the actual planning and management of how a resin float is to be worked. Here are some do's and don'ts for maintaining an effective float:

Do not offer your PE services to

anyone with a system suspected of containing heavy metals.

Do segregate your cleanest float for your cleanest customers.

Do not use a polishing mixed bed on a system containing more than 5 ppm hardness or more than 10 ppm TDS. And - never exhaust a polisher.

Do use working mixed beds to protect polishers.

Do not intermix ultra-pure float with anything else.

Do not introduce float of unknown sources with your own without thorough testing. You may find out why the other guy got rid of it.

Do shy away from used resin.

Do use a thorough backwash. It is ok to remove fines **and** some whole beads with each regeneration.

Do not allow ion exchange resins to freeze. Ship exchange tanks in trucks heated or otherwise protected from freezing.

Do use pulse dampeners if your PE system will be subjected to water hammers (rapid closing valves.)

Do not try to pump ion exchange resins with high shear pumps.

Do not use the first one-third of the waste caustic from SBA to regenerate WBA. You can cause silica fouling on the WBA.

Do remember - organic iron complexes are anionic and resist most iron removal techniques.

Do remember that surface waters may contain up to 100-200 ppm of organics and that some forms of "tannins" are irreversibly adsorbed onto anion resins. Such organic acids may have molecular weights of over 100,000.

Do isolate critical float resin and use it only for that one application or customer.

Do maintain at least two quality levels of mixed bed - one for ultrapure water and one for general purpose low TDS needs.

Do not expect ion exchange resins to be totally taste and odor free - even so-called "FDA" grades. Resins degrade with use and the products of degradation have taste and odor. Always follow drinking water DI with GAC. This is not as critical with salt regenerated systems.

Do establish a regular replacement program for "retiring" DI and softening resins. Expected life of DI cation is 10 years, anion is five years, mixed bed is three years for critical applications. Retire float by down grading into less critical uses as it ages. Eliminate through generous backwashing. Softening resins seem to last forever, but plan on replacing 5-8% of your float annually. If it backwashes out with the dirt, so be it.

Do operate your regeneration under pressure (25-50 psi) to avoid resin losses due to gas bubbles floating out the resin during backwash.

Do periodic preventative maintenance such as acid washing, caustic brining and disinfection of anion resins to avoid surprises. Cation resins should be periodically treated for iron fouling and disinfected.

Do not use hard water for any DI anion backwashing, rinsing or regeneration, including salt regeneration of dealkalizers and nitrate removal systems.

Do have annual analyses run on your float to assess condition and spot potential problems.

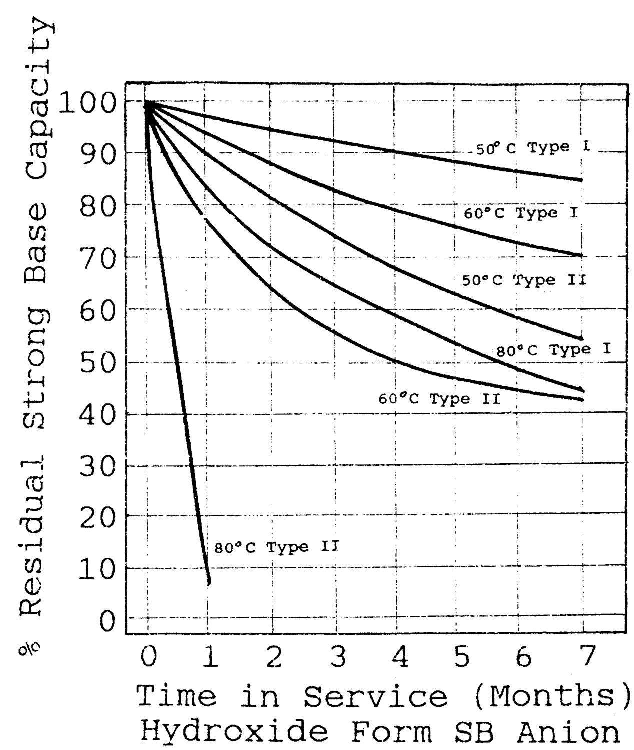

Figure 1
Thermal Degradation Rates Of SBA Resins

Conclusion

The listed do's and don'ts could fill another volume. There is not "always" a correct way to treat ion exchange resins and there is no real way to make them last forever. Get to know your customers' application and use the right resin for the job. Maintain it as you would any other piece of equipment. Even screwdrivers "wear out." Change your ion exchange resin when it ceases to be cost effective. Ion exchange resins do many jobs well, but the one they do best is removing ionic species from low TDS water. ❑

References

1. Michaud, C.F., "Designing Ion Exchange Systems - Part IV", *Water Conditioning & Purification.* November, 1990.

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3. Kunin, Dr. Robert, *Amber Hi-Lites,* #139, Rohm and Haas Co. March 1974.

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