Industrial Water Purification
(800) CAL-WATER

Ion Exchange Resin Fouling
Diagnostics and Defouling Procedures

Common Resin Fouling and Effective Defouling Procedures

By
Dave Peairs, Cal Water, Technical Director
dave@cal-water.com - h2odave@aol.com

November 24, 2010

Ion exchange resins, both cationic and anionic, are susceptible to a variety of foulants. A foulant is anything that inhibits the efficiency or ability of an ion exchange resin to do its job.

If an ion exchanger, be it a deionizer or softener is setup correctly, fouling can usually be held to minimum. But changes in water hardness, chlorine content, organic content, city mainline pipe flow or in coming water analysis can have an adverse effect on the performance of an ion exchanger.

This paper address some of the more common problems associated with the use of ion exchange resin and resin fouling that can occur. The notes below are to assist in diagnosing problems and remedying them.

If a problem not covered in this paper is suspected, please email a description of the problem to info@cal-water.com. If the case is time sensitive please call (800) CAL-WATER and ask for technical service.

Strong Acid Cation Resin Fouling

Cation Organic Fouling

When a cation resin is exposed to oil, grease, algae or any coating organic, the cation resin can be insulated from both regenerant chemical and feed water ions and ceases to function.

Cation Organic Defouling Procedure

1. Cation resin can become coated with organic material, blinding off exchange sites reducing both capacity and quality. To address this problem the resin is subjected to detergent cleaning by adding approximately 10 ml of concentrated detergent per cubic foot of resin after the backwash (Triton X-100 resin cleaner has proved especially effective).
2. The bed is then subjected to a gentle air mix for about 20 minutes, followed by a standard fast rinse. At the end of the fast rinse a sample of the rinse water is obtained and checked for suds.
3. If suds appear, the resin is put through another fast rinse. The process is complete when the fast rinse sample shows no suds. The resin can then be regenerated normally using standard dosages of acid.

Cation Calcium Sulfate fouling

Calcium hardness should be excluded as much as possible from any water passing through the deionizer. If possible a water softener should be installed to pretreat the water going to the deionizer. Any calcium ion present in the feed water will be picked up by the cation. Upon regeneration, unless care is taken, the sulfate ion of the sulfuric acid can combine with the calcium ion to form insoluble calcium sulfate crystals within the resin bead.

If the feed water contains only trace amounts of calcium ion, fouling may still occur. The resin will begin to lose capacity on a more or less linear basis. At some point the resin will have an unacceptably low capacity and a hydrochloric acid treatment will be required.

Calcium Sulfate Defouling Procedure

1. Regenerate the cation tank substituting 10% hydrochloric acid for sulfuric acid. Use approximately 8 lb/Ft^3.
2. After the acid step and before any rinse, disconnect power to the controller and allow the cation resin to soak in the acid for 2 hours.
3. Restore power and finish the HCl regeneration. No further regeneration is required.
4. Monitor system capacity. If on the HCl regeneration the capacity is still low, and on subsequent sulfuric acid regenerations, repeat the HCl treatment.

Long Term Calcium Sulfate Fouling Prevention

If for some reason sulfuric acid must be used to regenerate a deionizer that must remove sulfate, great care must be taken to insure that the concentrations remain low for two reasons:

1. Dilution of sulfuric acid generates heat. If the regeneration chemical gets hot enough, it can deform or melt the internals of the deionizer.
2. PLC controls should be set at maximum acid draw time, and the initial sulfuric acid concentration should not exceed 2%. The acid dosage (lb/cuft) can be adjusted using a combination of flow rate and concentration, dto get to the 2%. After half the regenerant has been used, the concentration can safely be increased to 3-3.5%. (Concentrations of 4% or greater will accelerate the precipitation of any calcium ion present to the point where it takes place within the resin bead.)
3. Increase regenerant flow rates to 2 gpm/Ft^3. The Calcium sulfate precipitation rate is dependent on both calcium concentration and time. The faster the calcium is removed from the resin bed with a higher flow rate, the less likely it is to precipitate in the unit and foul the resin bed.

Strong Base Anion Resin Fouling

Hardness Fouling

Standard Method: Treat the resin with dilute HCl 1%, neutralize with NAOH or buffer, then titrate for hardness - EDTA. Notes: The test can be qualitative by simply adding indicator and looking for a red color. Red=Hardness Blue=No Fouling

Anion Hardness Defouling

Standard Method: Treat the anion with a 4-6% solution of HCl at a dosage of 2 lb/Ft^3 at a flow rate of 0.25 gpm/Ft^3. Displacement rinse at 20 gal/Ft^3 then fast rinse at 30 gal/Ft^3. Follow treatment with a double regeneration skipping the fast rinse after the first regeneration and the backwash on the second.

Iron Fouling

Standard Method: Treat the resin with 10% HC1. Look for a yellow color.
Notes: The test can be qualitative by measuring the intensity of the yellow color.
Yellow=Iron Clear=No Fouling. Double regenerate.

Anion Organic Fouling

Standard Testing Method: Treat a 100 ml sample of anion resin in a 250 ml Erlenmeyer flask with hot causticized brine, 100 F - 1% NAOH - 10% brine. Swirl, agitate then let stand for an hour. The presence of a tan-to-brown color indicates the presence of organic fouling.
Notes: The test, while qualitative can be used quantitatively by measuring the intensity of the color. Organic fouling can come from living and non-living organics.

Silica Fouling of Strong Base Anion

Standard Testing Method: Soak resin in hot 5% NAOH for 1 hour. Neutralize with HC1. Add Molybdate Reagent. Look for a yellow color. Notes: Phosphate interferes with this test. Citric acid and Amino Acid are required to complete the test. This test procedure is purely qualitative but if phosphate is not present, it can be quantitative by measuring the intensity of the yellow color. Yellow=Silica Clear@No Fouling

Anion Silica Defouling

The caustic soda anion injection time on the strong base regeneration procedure is extended by 90 minutes at a concentration of 4%. Use hot water in all steps (100 F) if available. The purpose of this long injection time is to allow the dissolving of colloidal silica. Follow with a normal displacement rinse and fast rinse.

1. Standard Treatment Method:
2. Treat the anion bed with hot causticized brine, 100 F - 1% NAOH - 10% brine for two bed volumes.
3. Agitate with an air spike, then let stand for 24 hours or more.
4. Fast rinse the bed, and retest as described under testing, above.
5. If color is still present, repeat the defouling procedure.
6. Once color throw has been eliminated, double regenerate the bed, skipping the fast rinse after the first regeneration and the backwash on the second.

Mixed Bed Resin De-Fouling Procedures for Organics and Hardness

1. For portable exchange resins, Load Mixed Cation-Anion resin into a Hi-Purity Separator. If an in place deionizer, go on to the next step.
2. Run Hot Caustic @ 1% concentration at 0.25 GPM/Ft^3 of resin. At the same time, run 10% Brine at 0.25 GPM/ Ft^3 of resin. (a slow continuous flow of hot causticised brine is the goal)
3. Air mix occasionally during the treatment if possible.
4. Run the brine/caustic for two hours and take a sample of the waste water.
5. Stop all flow and let the resin soak in brine/caustic overnight.
6. After sitting overnight put unit into a slow rinse. If after 5 minutes you are still getting the same color off the resin as the ample, repeat steps 1,thru 4.
7. Continue to run brine/caustic until no color is coming off of resin.
8. Rinse treated resin with 3 BV of clean water at 1 GPM/Ft^3
9. Run Diluted Acid @ 6% - 8% at 0.5 GPM/Ft^3 for 20 min.
10. Rinse acid treated resin with 2 BV (Bed Volumes) of clean water at 1 GPM/Ft^3
11. Brine or hydraulically separate the resins and proceed with two standard regenerations, omitting the fast rinses from the first regeneration.

Unfortunately There are certain types of fouling that are irreversible.

There are however certain steps that can be taken to minimize the damage.

Chlorine oxidation

When chlorine or other oxidizer attacks an ion exchange resin, several things occur. First there is a loss of capacity. Depending on the strength of the oxidizer and the duration of the attack, a number of the active exchange sites are destroyed, reducing the capacity of the resin. Note: this also reduces the amount of chemical needed per regeneration. However because of the loss of capacity, regenerations must be more frequent and ion leakage is usually increased to borderline acceptability.

Second, the affected resin is shattered and breaks down into random small pieces causing fines. Again, the amount of this shattering effect is dependent on the strength and duration of the oxidation attack. The result is increased pressure drop, lower flow rates, and spot channeling during both regeneration and service cycles. Note: fines can be backwashed out of the bed.

In some cases the affected bed capacity can be restored to 80%+ effectiveness by extended backwashes to remove fines. Resin fines are resin beads that have been de-crosslinked by oxidation, broken up and have lost most of their of exchange sites. By long monitored backwashes where the fines are allowed to escape until only whole beads are coming out, a majority of the capacity loss due to oxidation will go out with the fines.

Once the fines have been removed the amount of resin loss should be calculated and new resin is added to replace the backwashed fines. Note: if the backwashed fines represent more that 25% of the bed, it is recommend that the entire resin bed be replaced.

If you have any difficulty or questions, questions, please call me at (800)CAL-WATER or Email me. Dave Peairs, Technical Director. H2odave@aol.com or dave@cal-water.com

For immediate help, call
(800) CAL-WATER
(800) 225-9283
AND ASK FOR TECHNICAL SERVICE

Cal Water
1961 Petra Lane
Placentia, CA 92870
(800) CAL-WATER
(800) 225-9283
Local: (714) 835-7878
Fax: (714) 792-0794