Removing Organics With Ion Exchange Resin

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It is not too often that a water treatment problem can be fixed without spending money on new equipment, but when treating water for the removal of organics, the answer may be as simple as adding a small amount of anion resin to an existing softener.

Organic materials can cause unwanted tastes, colors or odors in potable water supplies, and can stain clothes washed in water containing these compounds. Chemically these substances are iodized by chlorine or ozone, after which the water is passed through granular activated carbon. However, chlorine or ozone systems may not be the most convenient choice for small home units. Activated carbon, when used alone, has a very limited capacity for organic removal and can actually function as a breeding ground for microbial growth. Reverse osmosis systems can do a good job of organic removal by easily rejecting the high molecular weight acids. For home use, though, special types of anion resins, sometimes called organic scavengers, can remove the organics safely and economically.

Anion resins in the chloride form exchange for the organics, which are present in water as weak acids. Anion resins will also exchange with other negatively charged ions, such as sulfates, nitrates and bicarbonates.

For an anion resin to be successful in removing organics, it must not only be able to remove the organic acid by ion exchange, it must also be able to elute the organic off of the resin during regeneration. Several types of anion resins operating in the chloride form are capable of this.

known as tannins and are high molecular weight humic and folic acids. They are aromatic hydrocarbons with carboxylic groups with multiple benzene rings. Tannins do not pose a health hazard. However, these organics can act as precursors to trihalomethanes (THM's) which are formed after an organic containing water is chlorinated.

Tannins are usually found in surface water supplies and shallow wells, and can vary widely depending on the geographic

The organics are strongly attracted to anion resin. The selectivity or degree of attraction is about the same as is that for the sulfate ion. However, the size of the organic molecules can present a kinetic hindrance because it is difficult for the large organic to penetrate inside of the bead to the interior exchange sites. This means that the ion exchange reaction between the resin and the organic occurs quickly at the surface of the resin, but proceeds slowly as the organic gradually penetrates the beads. Since most of the ion exchange sites are not on the surface of the bead, there is a limit to the rate at which the resin can exchange with organics.

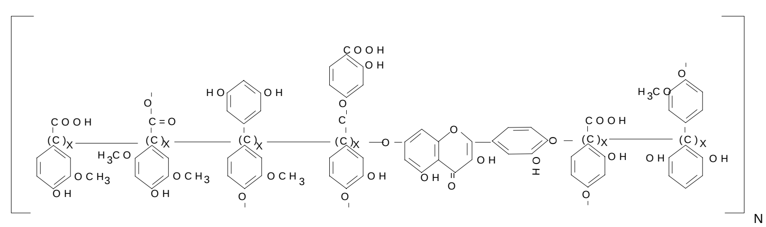

Figure 1 Proposed structure of colored humus molecule

region. They are present in water that comes in contact with partially decomposed plants. The most common types are tannic acid (from wood and tree bark) and humic acid (from leaves). Tannins tend to be yellowish or straw colored, while humic acid tends to be brown to black in color. Humic substances can form complexes with iron; when iron is complexed with the organic, it is referred to as "heme" iron or organic iron.

Methods for removal

The organics in water can be ox

The presence of other inorganic ions (sulfate, alkalinity, nitrate, etc.) can influence the removal of organics by competing for the exchange sites on the resin, with sulfates representing the strongest competition. Also, the rate of exchange for organics is slower than that of the inorganics.

Types of resins

Styrene-based gel or macroporous anion resins can be used to remove organics. However, only certain types of these resins can be used for successful operation. An important characteristic of the resin is the moisture retention, as an anion resin with a high moisture content is structurally less dense. This means that the ions being exchanged have more room or water to move around in, which is beneficial for large molecules such as organic acids that are slow-moving because of their size. The moisture-to-capacity ratio is also important because it affects the regeneration efficiency. Surprisingly, a lower capacity resin is preferable because it gives a higher moisture-to-capacity ratio.

Other resins that can be used are acrylic-based. Acrylic-based anion resins are good candidates for organic removal because of their resistance to fouling. They are more hydrophilic than the gel resins, which means that they have a lower attraction to organics. They still remove organics very effectively, but release them more readily during regeneration.

Equipment required

The simplest scheme for organic treatment in the home is to place the anion resin into an existing softener unit. Since the anion resin is lighter, it will form the upper layer in the unit after each backwash. A six-inch layer of resin should be sufficient; a single cubic foot is enough resin for two, three or even four typically sized residential units.

It is important to safeguard against loss of the anion resin through backwash because of its lower density. Most softeners that also include anion resin for organics removal have screened upper internals so that no anion resin can be lost during backwash. It is also a good idea to reduce the backwash rate to an equivalent of three gallons per minute per square foot of cross-sectional area of the unit (about one-half the backwash flow rate of a standard softener). This reduction is absolutely essential if there are no strainers or screening on the upper internals of the unit.

The organic scavenger resin can also be designed as a stand-alone unit. These units should be sized in the range of two to 10 gallons per minute per cubic foot of resin.

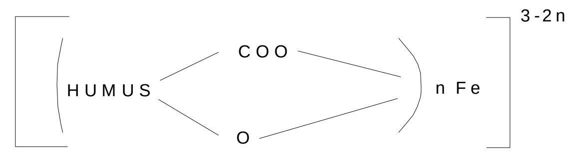

Figure 2 Proposed linkage with humus and iron

Regeneration

The chemical used to regenerate the resin is ordinary salt or brine. Organic removal resins used as the top layer in a softener need no additional brine beyond the softener's normal dosage. The anion resin utilizes the chloride ion of the sodium chloride regenerant while the softener resin uses the sodium ion.

The chloride ion concentration in brine (10 to 15 percent) is high enough to reverse the resin's selectivity for organic acids, causing the resin to exchange for chlorides and release organic acids (and other ions that were collected during the run, such as sulfate, nitrate and alkalinity). This regeneration exchange is just like that of a chloride cycle dealkalizer except that the rate of exchange for organics is very slow compared to other anions. This is because the organics that have penetrated the resin cannot quickly return to the surface of the resin where the exchange is taking place.

Organics are more easily regenerated off of the resin in a slightly alkaline environment. For tough applications, the addition to the brine of one pound of soda ash per cubic foot of anion resin (scale accordingly to the size of the unit) will help attain a more complete regeneration. The soda ash puts some of the resin into the carbonate form. Don't use too much or you might risk problems with odors from the resin during the subsequent service run.

Fouling

Anion resins used for organics removal, whether styrene-based or acrylic-based, have the potential to become organically fouled if they are run too long between regenerations. This can be minimized by regenerating frequently and on a timed cycle. Don't wait for organics to break through to terminate a service run. If a resin does become fouled, try the following procedure:

1. Perform a normal regeneration to remove the organics that are easily eluted off of the resin.

2. Prepare a ten percent solution of 10 pounds of sodium chloride, three pounds of soda ash per cubic foot, at 125 F. These amounts are for a single cubic foot, so adjust the proportion accordingly.

3. Introduce the solution to the resin at the normal brine flow rate or slightly slower.

4. Allow the final bed volume of solution to soak in the bed for a few hours or even overnight.

5. Rinse the unit.

6. Perform a normal brine regeneration before returning the unit to service.

Cleaning organically fouled anion resin requires time, elevated pH, and is helped by high temperatures. The organic ions are slow-moving and require more time than standard ions for elution, and the organic acids are more soluble at a higher pH. Also, higher temperatures increase the rate of reaction.

If a resin is severely fouled by organics, substitute sodium hydroxide instead of soda ash in the above procedure, but use only one to two pounds per cubic foot of resin. Resin that has been fouled with heme iron will benefit by the addition of eight ounces of sodium bisulfite to the solution prepared in Step 2. For anion resins that do not respond well to either treatment, a treatment with ordinary bleach (sodium hypochlorite) may clean it up. Substitute a few ounces of bleach for the soda ash in Step 2, and limit Step 4 to just one or two hours.

Always use caution while using strong chemicals on systems that are treating water intended for human contact or consumption. Always follow a cleaning procedure with sufficient rinsing and a normal (sometimes double) regeneration to put the resin back into the chloride form.

It is important to put the resin back into the chloride form to minimize the potential for odor problems. The alkaline resin cleaning treatments can leave the resin in the carbonate or hydroxide form, which imparts a fishy, or amine odor and taste to the treated water. In fact, the smell may even appear during normal service while treating an alkaline water supply (when pH is greater than eight). Some users have found that a small amount of citric acid added to the brine solution every few regenerations can minimize the odor problem.

Chemically, the fishy odor is caused by the presence of trimethylamines. This is the amine that is used in the manufacture of anion resins and gives the resin its ability to exchange ions. High purity grades of organic scavenger resins are available that have been specially pre-treated to minimize odor problems.

Summary

Special forms of anion resin operating in the chloride cycle can do an effective job of removing organics. The resin can be added as the top layer of an existing softener unit and in most cases can be regenerated with the normal softener brine. The types of resins available include gels, acrylics and macroporous versions of either. A gel resin with a high moisture-to-capacity ratio will give long life and be very resistant to fouling. An acrylic will ion exchange resins give higher initial capacity but may have a tendency to foul over time. Organics vary widely from region to region, and experience with systems operating on the same water supply give the best guidance for resin selection.

About the author

◆ *Francis J. DeSilva has been technical representative for ResinTech, Inc. of Cherry Hill, NJ, a supplier of ion exchange resins to the OEM market, for five years and a veteran of the industry for 16. DeSilva earned his Bachelor of Science degree in environmental science technology from Florida Institute Of Technology and his master's degree in environmental engineering from the New Jersey Institute of Technology.*