Regenerable Cartridge Filters Spur Growth in POU Systems

by C.F. "Chubb" Michaud

As we have become increasingly aware of some of the problems lurking in our water supplies, we have seen a rapid growth in Point-of-Use (POU) systems to answer such complaints. A host of counter-top and under-the-sink systems are now available in higher tech designs due to advancements in miniaturization. One such area employs the use of ion exchange for selective ion removal.

The ion exchange process focuses on the dissolved ionic species such as metal ions, hardness, nitrates, alkalinity and sulphates. Dissolved ions of higher valence and/or molecular weight tend to be more strongly attracted to ion exchange resins than the monovalent ions. Therefore, the more strongly charged ion will replace the weaker ones. This would explain the obvious choice of sodium chloride for both cation and anion regeneration. Both sodium and chloride are weakly held by the resins compared to the multivalent hardness (Ca++, Mg++) or higher M.W. nitrates (62 vs. 35.5) species.

In their list of suggested and recognized treatment techniques and procedures for meeting the current National Primary Drinking Water Regulations with POU (and Point-of-Entry) systems, **the Water Quality Association recommends the use of ion exchange for the removal of 20 primary contaminants and eight additional secondary standard contaminants.** Tables 1 and 2 list the primary and secondary contaminants that can be treated with ion exchange processes along with the type of resin and regenerant.

In addition to those listed, hardness (Ca++ and Mg++), hydrogen sulphide (H_2S), alkalinity (HCO_3^-) and

Continued on page 30 ▶

Table 1: Primary Contaminants

Contaminant	Resin to use	Regenerant
Arsenic +5	SBA	NaCl
Barium	SAC	NaCl
Beryllium	SAC	NaCl
Cadmium	SAC	NaCl
Chrome +3	SAC	NaCl
Chrome +6	SBA	NaCl
Copper	SAC	NaCl
Cyanide	SBA	NaCl
Lead	SAC	NaCl
Mercury +2	SAC	NaCl
Mercury (chloride)	SBA	NaCl
Nitrate	SBA	NaCl
Nitrite	SBA	NaCl
Radium 226, 228	SAC	NaCl
Selenium 4, 6	SBA	NaCl
Sulphate	SBA	NaCl
Thorium	SAC	NaCl
Uranium	SBA	NaCl
(SAC= strong acid cation)		KCl may be substituted
(SBA= strong base anion)		

Table 2: Secondary Contaminants

Contaminant	Resin to Use	Regenerant
Aluminum +3	SAC	NaCl
Chloride	SBA	Na_2CO_3
Copper +2	SAC	NaCl
Iron +2	SAC	NaCl
Manganese	SAC	NaCl
Silver +1 (nitrate)	SAC	NaCl
Silver (cyanide)	SBA	NaCl
Sulphate	SBA	NaCl
Zinc +2	SAC	NaCl
		KCl may be substituted

sodium (Na+) can be removed with ion exchange. In the case of sodium, KCl would be used to regenerate the resin. SBA resins are used with H_2S and HCO_{3^-}.

In most instances, it is not necessary to treat all water entering the home (POE). These standards apply primarily to drinking water. It therefore becomes more economical to **treat the drinking water only with a POU device.**

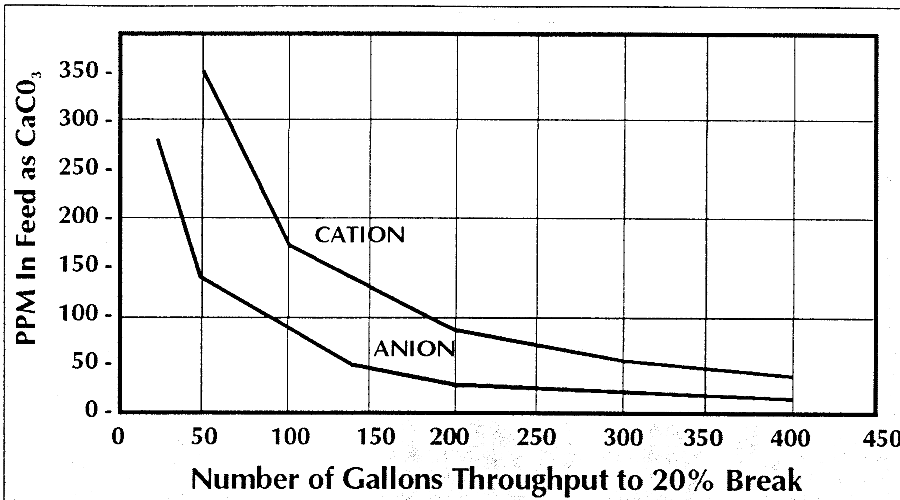

Figure 1.

Salt Brine Regeneration

Ion exchange resin(IER) cartridges have been available for many years although the knowledge of how and when to use them may be spotty. Many practitioners today still think that for applications other than softening, IERs must be regenerated with acid and caustic chemicals. The truth is that good old salt brine (NaCl), properly applied, will regenerate both strong acid and strong base ion exchangers (but not weak acid or weak base resins).

A typical 10″ replaceable cartridge represents only about 1/40th of a cubic foot of resin. At flow rates of 0.5 to 0.75 gpm (typical of counter-top filters), that is equivalent to 20 to 30 gpm/ft^3! Resin manufacturers shy away from flows above 5 gpm/ft^3. Do cartridges work at these high flow rates? The answer is yes. And, they work very well. The key is that they have to be properly designed for good distribution and high flow kinetics.

The problem heretofore with cartridges is capacity. After all, 1/40th of a cubic foot only represents 1,000 grains or less for a cation exchanger and less than half that amount for anions.

How then, can cartridges be used economically? The answer is to regenerate them — just like their tank-sized bigger brothers and sisters.

For the record, 1,000 grains is 17,000 ppm expressed as calcium carbonate. For typical waters, contaminants such as lead and other metals are present at 1ppm or less. This, however, does not guarantee that one could successfully treat 17,000 gallons. There is too much competition from other ions present (such as Ca, Mg and Fe) that will take up space on the resin beads. Detection is difficult. Typical contaminants present at higher levels such as NO_3, SO_4, Ca, Mg or Na will exhaust a typical cartridge after only 50 to 75

Continued on page 32 ▶

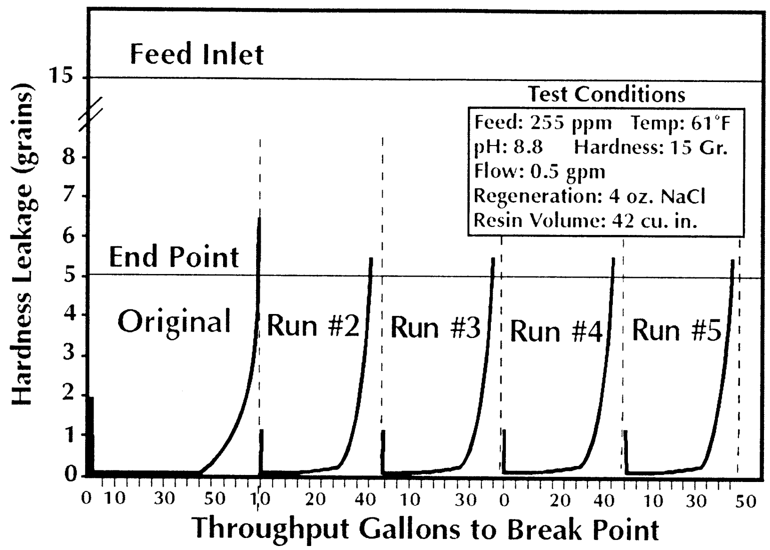

Figure 2.

gallons or so (see Figure 1). How then, can cartridges be used economically? The answer is to regenerate them — just like their tank-sized bigger brothers and sisters.

New Techniques

Several techniques have been used for introducing regenerant to cartridges and/or sealed counter-top units. Granular salt can be added into the free space surrounding a cartridge or to an empty sump or pre-filter sump ahead of the cartridge. Newer developments include direct filter chamber access and cartridges with built-in chambers for regenerant. Water is passed slowly through the salt and on to the cartridge. Four ounces of salt per 1/40th cubic foot is equivalent to 10lbs/ft^3. It takes about five to eight minutes to dissolve the salt and rinse the resin. Regeneration using this technique is less than perfect because the brine passes through the resin very quickly.

Slowing the regeneration flow rates and using coarse salt lengthens the brine cycle and produces better results. Higher kinetic resin selection will greatly increase the amount of capacity recovered as well as reduced leakage.

For the sake of presentation, standard mesh and fine mesh SAC cartridges were tested on 15 grain per gallon tap water. Virgin resins were run at 0.5 gpm to a 5 grain leakage break. Regeneration was done with 4 ounces of dry rock salt. The brine and rinse cycle was 10 minutes. The salt

Ion exchange cartridges will work at high flow rates if they are properly designed for good distribution and high flow kinetics.

dissolves in about 4 minutes producing 12 to 15% brine (50% saturated). The cartridges were retested to 5 grain leakages with the following results (see Figure 2).

A regenerated cartridge was run at increasing flow rates to determine the maximum flow rate at which low leakages could be maintained. This data is presented in Figure 3.

Conclusion

Cartridges can be used as selective ion removal filters as readily as whole house tanks. However, the flow rates and relative capacities are somewhat restricted. It has been found that good results can be obtained at flow rates of 0.5 to 0.75 gpm.

Cartridges containing SBA or SAC ion exchange resins can be regenerated with ordinary salt brine with a recovery rate of 65 percent based on original capacity.

Drinking water contaminants lending themselves to treatment with regenerable cartridges include the following: arsenic, heavy metals, cyanide, hardness, iron, nitrates, nitrites, sulphates, hydrogen sulphide, radium, uranium, alkalinity and sodium.❑

Chubb Michaud is founder and president of Systematix Co. Inc. and Di-tech Systems, Inc., in Brea, Calif. The latter is a supplier of innovative disposable cartridges for residential and industrial applications. He holds a bachelor's and a master's degree in Chemical Engineering and has been involved in water purification for over 20 years.

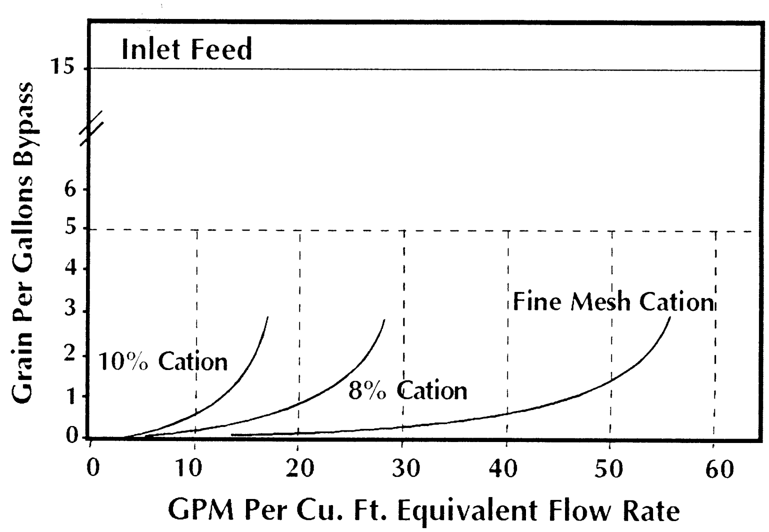

Figure 3.