

As published in Water Conditioning & Purification, August 1999

**Controlling Softener Biogrowth:
Field Evaluation of Inline Chlorine Generation for Media Disinfection**

By Glenn Gruett, Founder and President

Summary: *Installing a water softener on a system supplied by well water can require extra considerations be taken into account by the dealer on behalf of his or her customer. One of those is a self-disinfecting unit that eliminates any threat or noxiousness of bacteria that may breed among the resin.*

The symptoms are known by plumbing professionals and homeowners alike. A foul smell from the taps that lasts for a minute or two... or a slimy coating on the inside of toilet tanks and plumbing fixtures. It's not only an unwanted occurrence but can represent an unhealthy one, too.

These are all signs of iron and/or sulfur bacteria at work within the water system. Though they can occur in any system where bacteria has been introduced into the plumbing, it's considerably more common with well systems where water is vulnerable to contamination at several points, including the ground or the well itself. Unlike municipal settings, the water in these cases may not have been treated prior to entering the home.

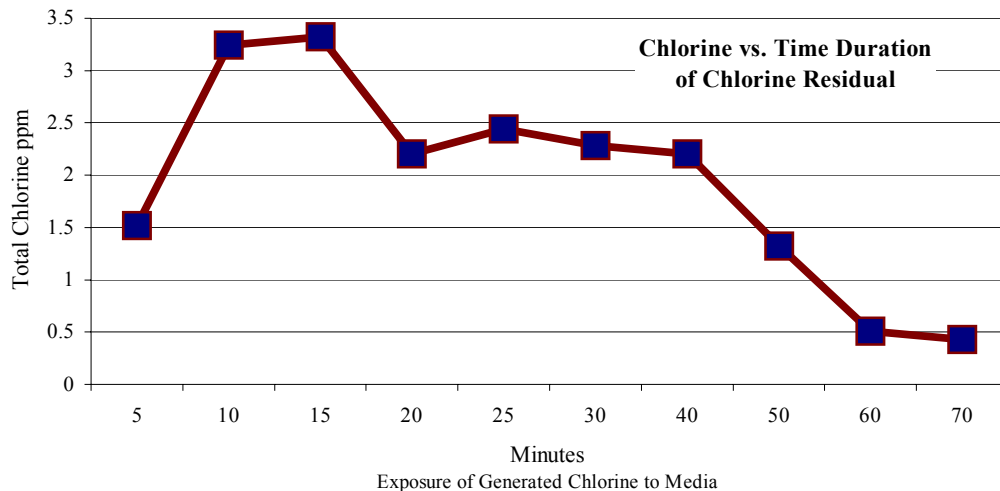
In working with health officials in Wisconsin, Water Right studied water from rural wells and corresponding household plumbing to come up with a solution. We discovered contamination at different times in both the well and the household point-of-use (POU) sources. Interestingly, we also found bacterial contamination at these sources, while the water at the point-of-entry (POE) tested clear.

This was an important discovery. It meant that, even a limited introduction of bacteria to the water entering the home, allows bacteria to remain and grow in the household plumbing system. The filtering action of the media bed within residential water softeners proved to be the main culprit as it was acting as an incubator for bacteria growth.

Chlorination of the media bed would be a viable solution (*see Figure 1, next page*). However, plastic media used in most water softeners becomes unstable when exposed to chlorine for extended amounts of time. State agencies in Wisconsin were already warning manufacturers against the sale/use of chlorine generators in combination with any softener utilizing a resin media. One agency cited that “the cross-linking of synthetic resins is destroyed at an accelerated rate when exposed to

free chlorine.” Harmful trihalomethanes (THMs), carcinogenic disinfection by-products (DBPs) created in a reaction of chlorine and organics in a water supply, can also be released in the process.

Figure 1



In addition, other existing means of chlorinating residential water systems have been anything but user-friendly. They can require constant mixing of dangerous chemicals along with use of mechanical devices that may be prone to failure or in need of constant attendance. We felt that these didn't represent the “technological” solution homeowners needed.

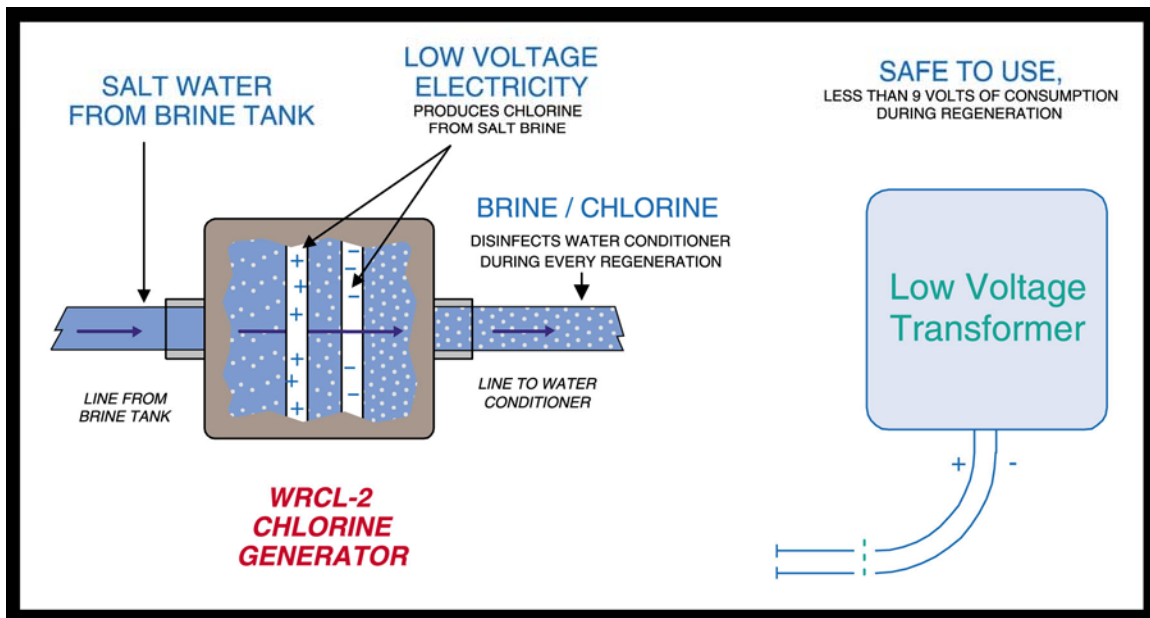
Part of the “technology solution” was already in our midst. Water-Right has used a manmade silica crystal as a softener media for the last 30 years (marketed today as Crystal-Right). It's the only media of its kind in use today. This multi-purpose crystal media not only removes high amounts of iron and manganese while softening water, it's also impervious to chlorine. In fact, it readily absorbs free chlorine during the regeneration cycle, and washes clean during backwashing.

Through the input of our product development team and state agencies, additional criteria evolved to define the ultimate solution. The chlorine generator needed to operate only during the regeneration cycle when brine was forced into the media tank. It had to generate a sufficient amount of chlorine to sanitize the media bed, yet not an excess that could possibly produce a harmful amount of chlorine. And it had to remain in the media bed a sufficient amount of time to be effective in destroying iron and sulfur bacteria, and all fecal coliform (*E. coli*) contamination (see Figure 2, next page).

Based on some of the same technology used today in Europe, a device was designed next that could produce chlorine directly from the brine solution using an electrolysis process. The device, known as the chlorine generator, utilizes a set of anode and cathode rods charged by a 9-volt, 900-mA current to free chlorine from the brine solution. Testing showed the distance between the rods directly affected the amount of chlorine generated. Once the ideal position of the rods was determined, it remained a constant. DC current also proved to be more efficient in generating

chlorine than any AC device tested. In addition, the 9-volt DC (VDC) was a “safe” current for use with consumer products.

Figure 2



The brine solution provided a ready source of chlorine. During testing, we concluded the “free” chlorine generated in-line was more effective in sanitizing the media bed than other types of added chlorine. Though not scientifically proven, it was speculated that the effectiveness of external chlorine additives was diminished somehow through contact with air and other substances prior to actually reaching the media bed.

It was determined that over 20 parts per million (ppm) chlorine generated in a standard 10-inch diameter media tank could be harmful. Less than this was considered insufficient in sanitizing the media bed. Tanks this size typically have an injector rate of approximately a half gallon per minute (gpm). With the added water from the injectors, chlorine enters the softener tank at 8-to-10 ppm. Exposure time to the media bed is about 60 minutes—again, a calculated time necessary to achieve proper sanitizing.

With higher injector rates, such as on tanks up to 16-inches in diameter, more chlorine is needed to perform proper sanitizing. Here, a 3-probe generator is used. It still produces 20 ppm, but at higher flow rates. The generator is not offered on larger vessels with higher flow rates and larger injectors than 1 gpm due to the risk of creating too much chlorine.

Government officials also requested that the softener provide a fail-safe warning against system failure—either failure to regenerate or any timer/cycle failure that might cause the system to “stick” in the regeneration cycle and continue generating chlorine indefinitely. These were all “control” criteria. No existing water softener control device in the industry had the ability to meet these control requirements. The next piece of the puzzle in the “technological solution” was missing.

The development of a new microprocessor-based control followed. The control first needed to draw brine for four minutes to generate enough chlorine to sanitize the bed. A four-minute timer is built into a processor that senses the voltage used in generating chlorine. This sensor will not activate until four minutes into the brine cycle.

Voltage decrease during regeneration is directly proportional to the amount of chlorine produced. Thus, if voltage drops far enough, not enough chlorine is being generated. (Brine solutions of less than 20 percent will not produce enough chlorine to sanitize the media bed.) This indicates a problem. In most instances, lack of brine would be the cause of the problem (usually from low salt in brine tank). An indicator warning light was added to the control head to alert homeowners. The light indicates to the owner that the chlorine generator isn't working and the brine will be too weak to soften the water during the next regeneration without adding salt to the system.

Here again, government officials advised us well. Since water softeners sit unseen in basements, in garages, and outside of homes, they suggested an additional warning device. As a result, an audible chirp was added to the control system that would remain active until the user resets the system by unplugging/replugging the power cord.

If the softener didn't advance itself out of the brine cycle (a mechanical failure of the softener), electricity could be running to the generator electrode for an indefinite amount of time. To solve this risk, a 20-minute timer was engineered into the control. After 20 minutes of brine draw, the generator shuts off.

The control valve operates under 24 volts. The chlorine generator uses 9 volts. A custom step-down transformer supplies power for both needs. This transformer meets UL, CE and other electronic approvals. The entire softener system uses a typical transformer module that plugs into the home's 110-volt AC outlet. The control circuitry board is now patent pending.

Conclusion

Clean Water Testing Inc., a state-certified laboratory now owned by Water Right, conducted product testing. They concluded that the new system, appropriately named The Sanitizer™, sanitized the water softener's media bed with every regeneration. Chlorine levels—measured throughout the tank—rate as high as 10 ppm total chlorine at the top of the tank and 2.5 ppm at the bottom. A chlorine residual was held through 10 gallons of effluent water after regeneration. The laboratory test conclusion: “Chlorine concentrations this high will require little time to kill all fecal coliforms (*E. coli*). The data points showing fecal coliform growth and total chlorine residual show definitely that the bed is sanitized.”

With over 4,000 Sanitizer units in use without failure throughout the world since 1999, the statistics speak for themselves. Properly engineered, the self-chlorinating system has a definite benefit and place in the water treatment industry.