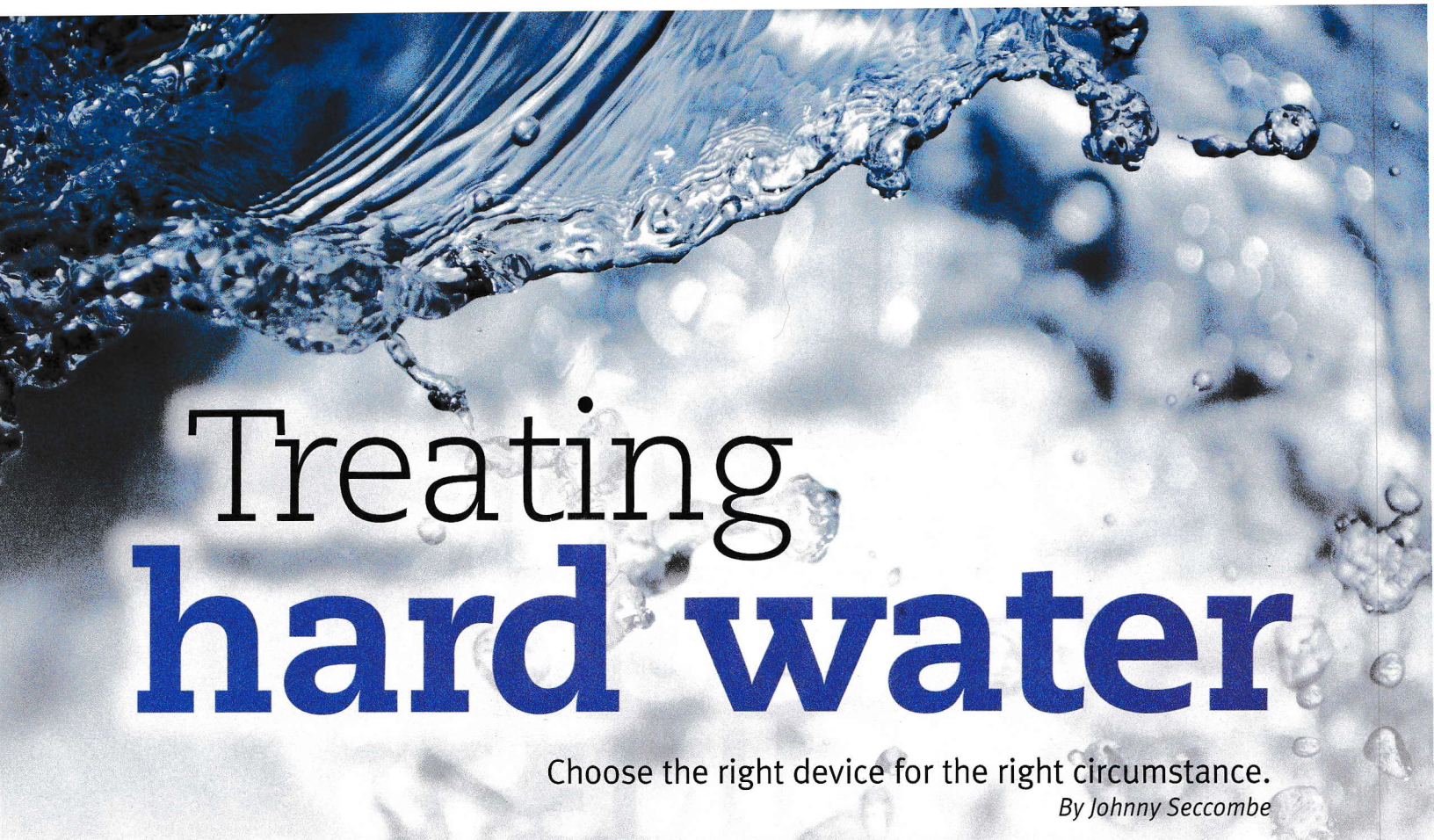


Treating hard water

Choose the right device for the right circumstance.

By Johnny Seccombe

Most people reading this article live in hard-water areas where calcium scale is going to form in water heaters and cause them eventually to fail.

Tankless heaters are even more vulnerable to scale than traditional tank heaters or boilers, so even seemingly small amounts of scale can cause a heater to fail due to heat stress.

Scale is 400 times less conductive of heat than copper so just 1/8-inch of scale can cause 12% loss of heating efficiency. That's roughly the same amount of energy you save after paying extra for a high-efficiency water heater. You can lose that extra benefit in just a few months.

The 2015 Universal Plumbing Code addresses the problem of energy losses caused by scale in Appendix L:

- L 605.0 Hard Water
- L 605.1 Softening and Treatment

Where water has a hardness equal to or exceeding 10 grains (170 mg/l) measured as total calcium-carbonate equivalent, the water supply line to water-heating equipment and the circuit of boilers shall be softened or treated to prevent accumulation of lime scale and consequent reduction in energy efficiency.

Traditional methods of treating hard water using salt-based softeners can resolve these problems but most people don't like having to maintain a softener, haul salt and the slippery feel that results from the water. The cost of buying, installing, servicing and ultimately replacing the softener is often prohibitive, even if there is space to locate it.

If you don't like the idea of putting in a softener, then what does "or treated to prevent accumulation of lime scale" mean in practice? The options come down to two basic categories: chemical dosing, commonly called scale filers or physical water conditioners.

Scale filers

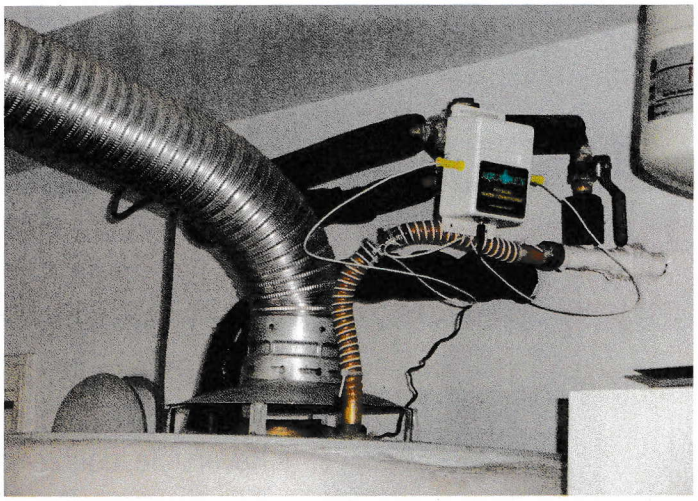
Chemical dosing falls into two categories: polyphosphate and citric acid. Both have to be plumbed into the system using what looks like filter housings but actually they contain a chemical released into the water supply, sometimes in a pretty uncontrolled fashion. Polyphosphates coat the surfaces that would normally scale while citric acid drops the pH below the level where scale would normally form. The inherent risks of potential corrosion in a low pH water supply need no elaboration. The introduction of an organic acid into a domestic water supply can encourage growth of bacteria.

Both systems require regular cartridge replacement, sometimes two or more times a year and this is a costly and time-consuming business for the plumber and therefore the homeowner. This is good repeat business but eventually the homeowner probably will be looking for a low-maintenance alternative.

Physical water conditioners

Looking at PWCs there are basically three options. Template-assisted crystallization uses a tank-based media to release scale particles into the water. There are various brands of TAC, some of which have been tested under the German DVGW protocol

This photo shows a tankless water heater heat exchanger that has failed due to scale buildup. Surprisingly, small amounts of scale can cause this kind of failure in less than a year.



An electronic physical water conditioner installed on the inlet of a tank heater.

PHOTO COURTESY: AQUA-REX

with excellent results, but all media-based systems suffer from the risk of contamination. This can clog the media and stop it working in quite a short time. Phosphates, iron, copper and chlorine are the major contaminants, and to protect the media it will require front-end filtration.

The second category of PWC can be defined as zinc dosing. These use magnets or electrolytic processes to dose zinc in the water, which acts as a nucleation seed. They can be very effective, but they suffer from a problem known as passivity. The corroding anode scales up itself and the zinc corrosion slows down and stops. They are therefore short-lived unless cleaned regularly.

The third category of PWC can loosely be defined as electronic. Generally these work by modifying the state of the iron in the water so the scale sticks to that as a nucleation seed instead of a surface. The scale particle then grows by attracting more scale precipitation.

Many of these devices look similar, boxes with two or more wires coming out of them and wrapping around a pipe, but there is a very important difference in their methodology that has a significant bearing on their performance in a plumbing system.

Electronic PWCs

One type has the wire coming out of the box, it goes around the pipe a few times and then back into the box. It uses a low voltage and relatively high current to generate what could be described as a pulsating electromagnetic field locally to where the wires are installed.

The other main category has open-ended wires that wrap around the pipe. There is a relatively high voltage but no current — it has nowhere to go. These are, in effect, radio antennae and inject a radio frequency into the water.

These radio signals travel in the water both upstream and downstream and can travel significant distances, more than 3 miles in one example. The advantage of this system is that instead of treating the water only as it passes through the wires, it treats *all* the water *all* the time, whether moving or static.

These devices are dependent on a very small quantity, probably 10 parts per billion, of iron in the water, but it is very rare to find zero iron. Water-quality testing frequently stops at 50 ppb, so although a water-quality report may show "ND" or not detected, it doesn't necessarily mean there is no iron there. Naturally zero iron occurs in Lubbock,Texas, and parts of Oklahoma, plus anywhere reverse osmosis is used at the water-treatment plant such as the lower Santa Ana valley in California.

Test protocol

One of the common drawbacks with PWCs has been the lack of a U.S. test protocol to measure their effectiveness. Recently IAPMO published a new protocol, *IGC 335 Rapid Scaling Test* that can accurately measure the performance of a descaling device. It uses a small volume of water over a short period of time so a range of different waters can be tested on different devices.

Aqua-Rex has published the results of the IGC 335-2018 test protocol using an Aqua-Rex WK1-E unit treating Las Vegas water which was heated to 180° F for 23 hours. The average of four runs with and without the device working showed a reduction of scaling of 83%.

When translated to normal water-heater temperatures this implies a pretty negligible amount of scale. The significance of using Las Vegas water, which is more than 18 grains hardness, is 90% of the source is the Colorado River, which itself supplies roughly 40 million people in the Southwest. **RJ**

Jonny Seccombe is chairman and owner of Lifescience Products, the parent company of Aqua-Rex in the United States. He specializes in investigating alternatives to conventional water softeners and has worked in the water treatment industry for more than 20 years. He has a degree from Oxford University in geography and geology.