The Lowdown on TAC Systems
Waterborne scale has met its match

If you were to overlay an annual rainfall map of the U.S with that of a water hardness map, they'd be eerily similar. The drier the area, the harder the water. The only exceptions would be the Florida Peninsula and the states that border the Great Lakes – hardness levels there are almost as bad as the Southwest.

Water is considered moderately hard at four grains per gallon, and very hard at 10 and up. Anything above 18 GPG is considered extremely hard. Not long ago, I was involved with a project in central Utah, where tests resulted in 86 GPG. With especially hard water, using salt to treat the water is an uphill battle.

There's an alternative to salt-based systems to solve scale problems, regardless of whether the water in question is mildly or outrageously hard. It's called template-assisted crystallization. TAC falls into a category of water treatment often referred to as Physical Water Treatment.

The primary goal of PWT is to reduce the negative effects of water hardness (calcium carbonate) in plumbing systems, appliances, valves and other components without the use of chemicals. The system changes the physical characteristics of the water with little or no change to the solution's chemical composition.

The science

The environmentally friendly technology behind leading TAC systems was developed in Germany about 20 years ago. It was used throughout Europe for several years before coming to the US, and continues to be the dominant form of commercial and residential water treatment there. TAC media starts out as polymeric beads (resin) in the 20 to 40 mesh size range. Catalytically active sites, or templates, are "imprinted" or coated on bead surfaces through a batch-coating process.

The template influences the water solution across bead surfaces such that hardness ions and their counter-ions (bicarbonate) combine to form inert nanometer-sized "seed crystals." This process, called nucleation, occurs when dissolved molecules or ions dispersed throughout a solution gather to create clusters in the sub-micron size range.

The seeds provide an enormous area for preferential growth of remaining hardness ions still in solution. "Low energy heterogeneous transfer" then begins. The remaining dissolved ions reach their solubility shift, attach to the seed crystals and continue harmlessly downstream.

The application

TAC systems – which typically consist of nothing more than a plastic or fiberglass reinforced housing or tank with TAC media inside - are sized by flow rate, with applications as small as 1 GPM for point-of-use scale prevention, to multiple-tank applications for larger volume needs. Fort Sill Army base, in Oklahoma, has a system capable of conditioning water at a rate of 900 GPM using 12 Watts OneFlow TAC tanks.

The systems eliminate the use of chemical additives and eliminate discharge and waste water that's a byproduct of a water softener's brine cycle. They create zero pollution while minimizing installation and maintenance costs. They also don't use any electricity.

Most TAC systems are easy to install. In a residential application, it looks like a water softener mineral tank but without a control valve and brine tank. A simple inlet & outlet connection is all that's required; no pumps, meters, valves, etc.

Another advantage that a TAC system has over a traditional water softener is the ability to operate effectively at trickle flow rates. TAC media is always used in an up-flow design, so it's not subject to low-flow channeling or high-flow pressure drops.

With traditional water conditioning systems, if the flow is considerably less than the design rate, you can get hard water bypass through channeling. This is when water finds the path of least resistance through the media, and comes in contact with minimal amounts of resin. That's avoided with TAC technology.

Third party findings

But manufacturers aren't the only ones touting the benefits of TAC products. In a project report titled Evaluation of Alternatives to Domestic Ion Exchange Water Softeners, the WateReuse Research Foundation explains the findings from an experiment they conducted to compare four different chemical free directly to ion exchange systems. The four technologies are electrically induced precipitation, magnetic water treatment, capacitive deionization, and TAC.

The experiment was set up based on the German standard protocol, "Verification of a Water Treatment Device for the Reduction of Scale Formation." A 20-day test period included an electric water heater that maintained 176°F. The test was performed with water from three different sources; Salt River water, Central Arizona Project Canal water, and Scottsdale,

AZ ground water. Each time, TAC was dramatically more effective at scale prevention than any of the alternatives, even outpacing the traditional ion exchange system.

The limitations

At first, TAC seems like the magic pill for all problems associated with hard water. In many ways it is, unless the water source harbors more than just calcium and magnesium (the predominant hardness minerals). There's compromise when other minerals are introduced, like iron and manganese, or the rotten egg stink associated with hydrogen sulfide gas.

TAC systems are designed to specifically address and control hard water scale. Salt based water softeners, on the other hand, shine when hardness is present along with light to modest levels of other minerals (like iron, manganese and copper). If the water has high levels of those minerals, or if it has a foul odor, it's likely to need a combination of technologies to treat it. The water may need to be oxidized through aeration or chlorination, and then filtered.

TAC media isn't sacrificial; it doesn't dissolve. Media lifecycle is not influenced by the amount of water being treated, or the hardness of the water. However, impurities in the water, such as chlorine, over time can degrade the template on the beads. The typical suggested media change-out is three years.

Like a water softener, TAC systems may need to be plumbed behind an effective sediment filter. If not, dirt can accumulate in the media bed, coating the resin beads so that their templates are rendered ineffective.

In areas known for hard water, a TAC system could be an effective solution or at least a key part of a multi-component water treatment system. **RJ**

Steve Callahan is the national sales manager of water treatment products at Watts Water Technologies. Callahan has 20 years in the water industry, including time at PureTech Water and Vital H20, and Cuno® (now 3M). He can be reached at (203) 581-2138 or Stephen.Callahan@wattswater.com