Water Quality Association
International Headquarters & Laboratory
Phone 630 505 0160
WWW.WQA.ORG
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WQA WHITE PAPER ON CATION EXCHANGE SOFTENED WATER AND CORROSION

INTRODUCTION

A common misperception in the water treatment industry is that water softeners make water more corrosive. This paper examines the latest science on this topic and reaches the conclusion that a properly configured water softener does not make the treated water more corrosive.

REVIEW OF THE SCIENCE

Corrosion is a natural process by which a material is degraded by the environment to a more stable chemical state through oxidation and reduction reactions. Corrosion is a big problem in drinking water distribution systems where metal pipes are continuously being corroded by water. Corrosion can cause many undesirable effects in plumbing, including leaks, discolored water, sediment and particulate in the water, taste and odor issues, and physical failure of the pipes. Corrosion can also cause dangerous byproducts to be released into the water, such as lead and copper.

Corrosion is an inevitable natural process that occurs in all metals exposed to water with dissolved salts, however there are certain factors that accelerate corrosion. Common corrosion accelerators in drinking water include high velocity and/or turbulence, high temperature, low TDS (total dissolved solids), dissimilar metal contact (galvanic corrosion), low pH, carbon dioxide, biofilm accumulation (microbially influenced corrosion), chemical agents such as chlorine, chloramines, and dissolved oxygen, and an elevated chloride to sulfate mass ratio (CSMR) (Edwards & Triantafyllidou, 2007; Edwards et al., 2013; Reyneke, 2017; Sand, 1997)

Clearly corrosion is a complex process with many factors impacting the rate of corrosion, and a common question that is brought up in the industry is; *does water softening cause the treated water to become more corrosive*? One common misperception is that naturally soft water is similar to cation exchange softened water. Naturally soft water and softened water are very different. Naturally soft water is corrosive. It is commonly found in surface waters of the Pacific northwest, New England, and the southeastern United States. It is corrosive due to its acidic pH, low TDS, and low alkalinity (Harrison, 2006). Cation exchange softening does not lower the pH, TDS, or alkalinity (Lytle, Schock, & Sorg, 1998).

Another common misperception is the belief that calcium carbonate scale is an effective form of corrosion control. However, there is a lack of scientific evidence supporting this claim. Scale does not form in uniform homogenous layers that would protect pipe from corrosion, and scale can be porous, soft, and highly irregular. Corrosion can still occur under conditions that are favorable to the formation of hard water scale or even when scale is already present.

Many research studies have investigated the effects of cation exchange softened water on corrosion. One such study, “Leaching of Metals from Household Plumbing Materials: Impact of Home Water Softeners”, was conducted by the US EPA National Risk Management Research Lab. Their objectives were to evaluate metal leaching from metallic pipes and faucets and determine any changes of the critical chemical characteristics of the water passing through the water softener that would accelerate the rate of corrosion. Both lime-softened tap water with a hardness of 160 mg/L (9 grains per gallon) and groundwater with a hardness of 300 mg/L (17 grains per gallon). The study concluded there is no evidence that cation exchange softened water systematically produced higher metal levels than the non-softened waters under otherwise identical conditions (Lytle, Schock, & Sorg, 1998).

The British Standards Institute for the UK Water Treatment Association examined the corrosivity of natural hard waters versus cation exchange softened water against a range of metals, including aluminum, mild steel, copper, brass and stainless steel. Two identical model central water heating systems were installed and removed after one, three, and six months for determination of corrosion rates using visual inspection and chemical analysis. This study concluded there was no significant difference in the corrosion rates for brass, copper, mild steel, and stainless steel between the two rigs (Munn, 2012).

A third study, conducted by the METALogic research institute in Belgium, “*In situ* corrosion investigation on the effect of hard and softened water to domestic copper and galvanized steel drinking water systems,” investigated the long-term effects of cation exchange softened water on corrosion. Four representative domestic drinking water installations were used: two for the behavior of copper corrosion and two for the behavior of galvanized steel corrosion. The corrosion rate was measured after six and 12 months. The study did not find any evidence that corrosion in copper or galvanized steel pipe is more severe when in contact with softened water as compared to hard water. (Nijs & Verdonckt, 2007)

CONCLUSION

Corrosion is a complex phenomenon, and for years there has been confusion surrounding cation exchange softened water and corrosion. It is important to distinguish between naturally soft water and cation exchange softened water. Naturally soft water is corrosive as it has a low pH and low TDS, however cation exchange water softening does not contribute to any factors that accelerate corrosion. In addition, there is a lack of scientific evidence supporting the claim that hard water scale is an effective form of corrosion control. Therefore, considering all these factors as well as the results from numerous research studies, it is the conclusion of WQA that a properly configured water softener does not make the treated water more corrosive.

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