WaterReview
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What Is. . . Hard Water & Water Softening

According to the U.S. Geologic Survey, 85 percent of the United States has to cope with hard water, which is water with excessive levels of calcium and magnesium. While hard water is not considered to be unhealthy for people to drink, it can be very unhealthy for household plumbing, cleaning processes, and water-using appliances. The minerals present in hard water can accumulate in the form of a hard scale which can build up and eventually clog pipes and damage water-using appliances. These minerals also affect the ability of soap to clean kitchen and bath surfaces, dishware and laundry.

The problems associated with hard water have been known for quite some time. Earlier generations coined the phrase "hard water" because they found it hard to clean with. They collected soft rainwater in a barrel to be used in laundering and other cleaning operations — which is hardly an option in the modern world of indoor plumbing and automatic washing machines. Some water utilities offer municipal softening, but water treated in this manner typically falls short of being soft water. It is generally left up to the home or business owner to find their own solutions to the hard water problem.

What is Hard Water?

The U.S. Department of the Interior classifies hardness based on the grains per gallon (gpg) concentration of the hardness minerals. To put this in perspective, a typical aspirin equals about five grains of material. If the aspirin were dissolved in a gallon of water it would add 5 gpg of "aspirin" to the water. Where hardness is concerned, water containing 1-3.5 gpg of the hardness minerals calcium and/or magnesium is classified as slightly hard; water in the 3.5-7.0 gpg range it is considered to be moderately hard; at 7.0-10.5 gpg water is considered to be hard; and very hard water is classified as water with concentrations greater than 10.5 gpg. Soft water has a hardness of less than 1 gpg.

If you live in an area of moderately hard or hard water, you may not be fully aware of the problem because it is difficult to see or taste any difference between hard and soft water. However, even moderately hard water can make a noticeable difference in the ease of cleaning and the use of cleaning products. On the other hand, hard and extremely hard water can have very discernible effects in areas ranging from bathing to the noticeably shortened life of household pipes, plumbing fixtures (like faucets and toilet flushing units), and water-using appliances.

Hard Water Scale

The minerals in hard water gradually settle out forming a hard scale. Scale centimeters thick can build up over time in hard water areas. Scale build up will eventually clog pipe, and can decrease the life of toilet flushing units by 70 percent and water faucets by 40 percent according to a report published by the American Water Works Association (AWWA). Hardness scale can also shorten the life of washing equipment, dishwashers, and clothes washers by as much as 30 percent according to the AWWA report.

Another area where hard water can have a financial impact is on your household water heater. Scale tends to form on the heating elements and heat transfer surfaces in these units, which leads to a shortened operational life and reduced efficiency. A 1981 study conducted by New Mexico State University determined that scale build-up can reduce a gas water heater's efficiency by as much as 29.57 percent, and an electric water heater's efficiency by as much as 21.68 percent. Another study conducted by The Office of Saline Water, U.S. Department of the Interior, found that a water heater's useful life can be reduced by as much as 50 percent through scale build-up.

Hard Water and Household Cleaning

Hard water has a direct effect on household and business cleaning tasks. All water based cleaning and washing is less effective and efficient with hard water. Cleaning with hard water requires greater physical effort and the use of greater quantities of cleaning agents for surfaces such as floors, sinks, and bathtubs. It also leads to spotting on dishes and glassware.

A comparison of hard and softened sources of water for household use conducted by Ohio State University indicated that the time required for typical cleaning tasks was increased by almost 50 percent. This is largely due to the formation of soap "curd" which can also be known as "soap scum," or "soap film." The curd tends to build up on sinks or bathtubs where soap use is frequent. Removing heavy curd can require some "elbow grease" and may eventually require the use of specialized cleaning agents which chemically neutralize the hardness component of this film.

Curd formation can also result in streaks, spots and film on glass and dishware which can harbor bacteria. Also, some unbuilt synthetic detergents react with hard water to form soluble calcium and magnesium compounds which cut down on dishwasher cleansing action.

Hard Water in Laundry Operations

Hardness minerals affect laundry in a gradual manner which tends to get hidden in today's automated washing process. People accustomed to washing in hard water may not notice the increased detergent use, yet the waste is still there. Soap was the primary cleaning agent for laundry before the development of synthetic detergents. Soap is usually made from natural fatty acids and alkali substances, such as caustic soda, which give it excellent cleaning properties. This is particularly true with vegetable-based fabrics like cotton.

Soap works well to suspend dirt in the wash and helps "lubricate" the fabric prolonging its life. Unfortunately, hardness minerals combine with soap to produce insoluble "curds" which remains as a residue on washed laundry and washing machines, and also tends to counteract soap's alkalinity. Even "builders" added to soap to overcome this problem

Continued on Page 2

Water Softening

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tend to be less than effective.

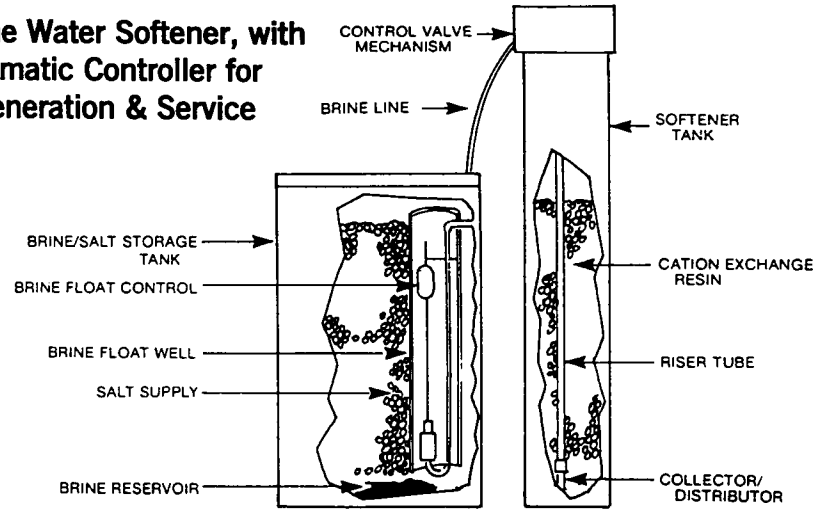
Synthetic detergents based on petroleum were introduced in the 1950s primarily to overcome hard water's soap curd problem. However, unlike unbuilt soaps which are over 90 percent active ingredients, most unbuilt detergents contain only 20 to 40 percent active ingredients and up to 50 to 65 percent neutral salts which are a manufacturing by-product. The remaining ingredients are made up of surfactants, suspension agents, whitening agents, and cosmetic additives.

Most modern detergents also contain builders to increase the alkalinity, but unfortunately, the builders tend to be consumed in softening hard water. This limits their ability to clean and requires the use of greater quantities of detergent. The latest generation of concentrated liquid detergent does compensate for this somewhat.

Hard water also influences fabric life and fading according to a 1991 Purdue University study. The study indicated that fabrics washed in hard water tend to wear out up to 15 percent quicker than fabrics washed in soft water. This is probably due to the presence of hardness residues in the fabric making it stiffer and more brittle, leading to increased friction and wear as the fabric flexes.

The Purdue study also found that hard water generally has a negative effect on colors and whites. Colors were found to fade and whites to darken more quickly in hard water. In addition, the study found that laundry washed in hard water became resoiled with greater ease.

Home Water Softener, with Automatic Controller for Regeneration & Service



Soft Water Solutions

Softening hard water typically involves the use of an ion exchange water softener. A typical water softener works on the principal of "cation exchange" in which the ions of hardness minerals (an ion is an electrically charged atom or group of atoms) are exchanged for sodium ions, effectively reducing the concentration of hardness minerals to insignificant levels. As the water enters the softener it passes over a resin bed in a special tank. The resin is made up of tiny beads of styrene and divinylbenzene which attract and hold sodium or potassium ions. The beads will exchange these ions whenever they encounter another ion such as calcium or magnesium.

After a period of use the sodium or potassium ions are completely exchanged and the unit has to be "backwashed" or "regenerated," which recharges the resin beads with sodium or potassium ions. This requires the use of sodium or potassium chloride which is loaded into a "brine tank" where it dissolves in water forming a brine used to recharge the system. The recharging is generally done by one of two common methods: Automatic softeners initiate the process on a set time cycle according to anticipated need, and the Demand Initiated Regeneration (DIR) process which uses a meter or sensor to monitor the actual hardness levels or the amount of water the unit has processed.

A note for people concerned about the presence of sodium ions in their water. Use of sodium ions does not make the water noticeably salty or cause a significant increase in a person's sodium intake. In fact, the FDA defines water that would result from softening 75 gpg hard water (where much more sodium ions would have to be exchanged than is typically the case) as a "low sodium" beverage.

Whatever type of system is used, the applications can be quite affordable and highly worthwhile for those in hard water areas. A typical household water softener costs around $1,000 to $1,500 with a monthly operating expense of around $2 to $8 if sodium is used, and $3 to $15 if potassium is used. Look for the WQA Gold Seal to find products that have been successfully tested to industry performance standards; and to Certified Water Specialists (CWS I-V), Certified Sales Representatives (CSR) and Certified Installers (CI) for advice on your treatment needs and equipment installation.

Conclusion

Hard water waste can cost hundreds of dollars each year as it impacts laundry operations, water heater efficiency, household cleaning, and the life expectancy of water—using appliances and plumbing. When it all adds up, hard water is a waste that can be done without. The solution to these problems is as easy as buying a water softener.

For more information on the benefits of water softening contact your local Certified Water Specialist (CWS), Water Quality Association member company, or write to the: Water Quality Association
4151 Naperville Road
Lisle, IL 60532 USA. □

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