Hardness

In “Drinking Water and Health”, hardness is defined as the sum of the polyvalent cations present in water. The most common such cations are calcium and magnesium. Hardness usually is expressed in terms of the equivalent quantity of calcium carbonate. There are no distinctly defined levels for what constitutes a hard or “soft” water supply, but generally water is considered to be soft below 75 mg/l of calcium carbonate. Above that concentration, water is considered to be hard. There are no known health risks associated with hard water and, in fact, there is a statistical correlation noted in some studies as an inverse relationship between hardness and cardiovascular disease.

The adverse effects of hardness are aesthetic and economic rather than effect upon health. The removal of hardness by the sodium ion exchange process can be considered beneficial from an economic standpoint. However, correlation between the softness of water (sodium intake) and the incidence of cardiovascular disease have been demonstrated and the practice of zeolite softened water used for dinking or cooking should be discouraged. It is difficult, with available information, to balance the aesthetic desirability of setting a limit of hardness against the potential health risk of water softening.

Economic benefits can be realized by softening water used in heating systems and water distribution systems with provision for separate plumbing for the water used for cooking and drinking. The economic impact is based upon the effect upon piping, fixtures, and appliances.
Appreciable amounts of calcium salts break down on heating to form a harmful scale in boilers, pipes, cooking utensils, and fixtures. There will be economic loss when water is not treated prior to its use in hot water heating systems and hot water heaters. There is additional economic loss caused by the insulating effects of scale build-up in coils or boilers. The coil type heating unit frequently employs copper coils which are only a fraction of an inch in diameter and plugging is a common occurrence. Economic loss is also the result of the increased use of soap and detergents with hard water.

In establishing the calcium carbonate equivalent of the concentration of calcium and magnesium ions, it should be remembered that if other harness producing metallic ions are present in significant amounts, they should be included in the assessment of water hardness. The attached table shows the “hardness quality” with respect to concentrations, effect, and impact. It also provides recommendations for disclosure requirements.

Table on next page

Hardness

Quality (1)	Concentration (2)	Effect* (3)	Significance (4)	Treatment (5)	Disclosure
Good	< 200 mg/l	Minimal effect on plumbing or heating systems.	Minor economic impact.	Treatment may be desirable depending upon individual preference.	None
Marginal	200-400 mg/l	Hardness causes scale deposits in plumbing and fixtures. Scale deposits are accelerated in heating devices and may plug pipes, boilers, and hot water systems at higher concentrations.	Economic loss due to build-up in heating and plumbing fixtures. Economic impact on purchase, operation and maintenance of treatment equipment. Economic loss due to increased consumption of soap and detergents.	In commercial applications, special treatment is desirable to minimize scale in plumbing and heating systems. Normal home treatment is sodium ion exchange.**	1, 2, 3, 4, 5
Poor	> 400 mg/l	High harness concentrations causes severe scale deposits in plumbing and fixtures. Without treatment, scale deposits are greatly accelerated in heating devices and will plug pipes, boilers and hot water systems.	There can be severe economic loss due to scale build-up in heating and plumbing fixtures. The purchase, operation, and maintenance of treatment equipment will be more expensive as hardness concentrations increase. Economic loss due to increased consumption of soap and detergents.	In commercial applications, special treatment is required to minimize scale build-up in plumbing and heating systems. Normal home treatment is sodium ion exchange.**	1, 2, 3, 4, 5

*Statistical analyses suggest a general reduction of cardiovascular disease with increasing drinking water hardness. Conversely, there is statistically a higher incidence of cardiovascular disease with low hardness water.

**(See discussion and table on Sodium for related health effects.) Reduction of hardness elevates the sodium concentration; thus, treatment should not be applied to water used for drinking and cooking. Softened water also tends to corrode piping systems and appliances.