7.9 Water conditioners

7.9.1 Ion-exchange softeners

It is sometimes beneficial to remove calcium and magnesium in order to prevent scaling and encrustation with limescale from very hard waters. Softening is achieved by cation exchange. Water is passed through a bed of cationic resin and the calcium ions and magnesium ions in the water are replaced by sodium ions. Unlike the carbonates and bicarbonates of calcium and magnesium, sodium carbonates and bicarbonates do not cause scale formation or increased use of soap for washing. When the ion-exchange resin is exhausted, i.e. the sodium ions are depleted, it is regenerated using a solution of sodium chloride.

Water softening can reduce the total hardness below that recommended in the UK for artificially softened drinking water (60 mg/l as Ca)[1] and could possibly result in a breach of the UK national standard for sodium (200 mg/l)[2]. Softened water should not be used for drinking but may be used for washing – water softeners of this type are not intended for the production of drinking water. Blending softened and unsoftened water can produce partially softened water, suitable for drinking. In all cases where these devices are installed, a separate unsoftened drinking water supply must be maintained.

The process of ‘de-alkalisation’ can also soften water. Water is passed through a bed of weakly acidic resin and the calcium ions and magnesium ions are replaced by hydrogen ions. The hydrogen ions react with the carbonate and bicarbonate ions to produce carbon dioxide. The hardness of the water is thus reduced without any increase in sodium levels. De-alkalisation resins are available as disposable cartridges. They must be replaced after the interval recommended by the manufacturer, otherwise they become exhausted or colonised by bacteria during periods of non-use.

[1] The UK Department of Health has stated that “in view of the consistency of the [epidemiological] evidence [of a weak inverse association between natural water hardness and cardiovascular disease mortality], it remains prudent not to undertake softening of drinking water supplies ... it appears sensible to avoid regular consumption of softened water where there is an alternative”.

[2] The UK Department of Health has advised that there should be a mandatory standard for sodium of 200 mg/l to help prevent infantile hypernatraemia (raised sodium levels in the plasma, commonly leading to permanent neurological damage) and to assist in reducing sodium intake in the general population.

7.9.2 Chemical water conditioners

Dosing the water with polyphosphate-based compounds can reduce scale formation. The hardness compounds are modified and the problems associated with temporary hardness are eliminated. It is also claimed that a thin protective film forms on the internal surfaces of the pipework, reducing corrosion.

Several devices are available which can be installed under mains pressure, treating the whole flow to a household or only part of the flow. Water contacts the slowly dissolving polyphosphate crystals, which are contained in a replaceable cartridge. The frequency of replacement depends on demand for water but is typically between several weeks and several months.

Chemical water conditioners do not usually affect micro-organisms and if such devices are used to treat water of unsatisfactory bacteriological quality it will be necessary to incorporate a disinfection stage.

7.9.3 Physical water conditioners

A variety of devices on the market generate magnetic or electrical fields for the water to pass through, or may be intended to release trace concentrations of zinc or other metals. Some of these devices must be plumbed into the pipework, whilst others are non-intrusive and can be simply clamped on or wrapped around the pipework. The effect of these devices can be to physically condition the water. The physical conditioning causes no change to the chemical composition of the water and only exerts a physical effect. Since the chemical composition is not changed, the calcium salts still precipitate when the water is heated or concentrated by evaporation. The effect of the physical conditioning, or presence of zinc, is to cause the calcium salts to precipitate differently such that they are less encrusting. Physical conditioning can produce some of the benefits of softening but without actually removing calcium.

Unfortunately there is an inadequate understanding of the design characteristics needed to secure reliable operation of physical water conditioners. There is ample evidence of the potential of magnetic fields to modify the crystalline structure of precipitated calcium carbonate. However, many other factors appear to determine the performance of specific products under defined conditions of water quality and design of the water supply system. These factors include: flowrate, magnetic field strength, temperature, time lag between conditioning and use of water and concentration of iron in the water supply. Until these devices are conclusively proven to work, it is recommended that physical conditioners should only be purchased from firms offering an extended-time money-back guarantee.

Physical water conditioners do not affect micro-organisms and if such devices are used to treat water of unsatisfactory bacteriological quality it will be necessary to incorporate a disinfection stage.