

Water Softeners

Water contains dissolved mineral compounds and much of the tap water in our region is hard in character. The level of water hardness is dependent on the type of rocks or rivers from which it is collected. When you boil water in your home it can form fur or scale, depending on the hardness. This is usually noticed in kettles, but the scale itself is only calcium carbonate (chalk) which has come from the water.

It is not harmful. In fact, every day we consume calcium, common in foods such as dairy products, as part of a normal diet.

Many customers enquire about the use of softeners and magnetic water conditioners to prevent scale formation. In response to these enquiries, WRc, a leading independent research and development consultancy, has produced this detailed information note on behalf of Southern Water. This provides information on the various types of softener and water conditioner available. It is for guidance only and should not be taken as any form of endorsement of these devices by Southern Water or WRc.

Notes relating to advice concerning control of the manifestation of water hardness:

- *The mention of any proprietary devices or products in the following must not be interpreted as any form of endorsement of them by Southern Water or WRc.*
- *The following is for guidance and improvement of awareness only. Southern Water and WRc take no responsibility for any advice or recommendations implied by or interpreted from the following.*

Water Hardness

All waters contain dissolved substances. In natural waters, supplied by water undertakings, a large proportion of these dissolved substances are generally calcium and magnesium carbonates and sulphates. The concentration of these salts in the water define how hard a water is: the greater their concentration then the harder the water; the smaller their concentration then the softer the water. In practice the softer the water the less soap is needed and the less limescale forms.

The harder the water, then the more likely at least some of these salts are precipitated when the water is heated or concentrated by evaporation. Thus for example: in a kettle used regularly for boiling soft water the heating element usually remains clean and free of deposits. In contrast, in a kettle used regularly for boiling a hard water, the elements quickly becomes encrusted. Likewise water hardness manifests itself on and around taps, in water cisterns, toilet bowls, on heating elements in other appliances, etc. Hardness also manifests itself in the amount of soap or detergents used, such as in washing machines.

Softening

The situation concerning the definition of softening is more complicated than this note implies. This is because the modern scientific definition of softening concerns the replacement or removal of calcium, whilst ordinary dictionaries define softening as causing water to seem softer.

If someone has hard water but wants water that behaves virtually like a real soft water, then the hard water must be softened. This can be achieved by any method that removes or replaces the calcium (and magnesium) in the water. For householders the most convenient and cheapest method is to use a softening unit that needs to be regenerated with a solution of common salt about once a week. In this unit the sodium in the salt is used to replace the calcium in the water using the process of ion exchange. There are other methods that remove calcium but are more complex and expensive and pose other problems.

Salt-regenerated softening is unlikely to be truly cost effective, in terms of savings in use of cleaning agents and scale-induced maintenance, except for larger active families with high consumption of the hardest of waters encountered in the UK.

Since ion exchange replaces calcium with sodium, the sodium concentration in the water is increased. Water with high sodium concentration is regarded as unsuitable for drinking or cooking with, especially for the very young and those suffering from high blood pressure. Therefore, when this method of softening is installed in a property, a supply of unsoftened water should be provided to a separate third tap to use for drinking and cooking.

Local suppliers and installers of salt-regenerated softening systems can be found in Yellow Pages. More detailed information on availability of softening units in the UK and their promotional material can be obtained through the British Water – Water Quality Group (visit www.britishwater.co.uk or tel: 0207 957 4554). Some water softeners are listed in the Water Fittings and Materials Directory, Group 2450, (ISSN 0954-3643, available from the WRc Bookshop) which denotes their compliance with water fittings regulations but not their performance as softeners.

The Water Fittings Regulations requires a non-return valve to be fitted in front of a salt-regenerated softener. A softener should also be installed on a bypass loop which can, if necessary, be isolated from the mains supply in addition to fitting a separate tap for unsoftened drinking water.

Chemical Conditioning

Instead of replacing or removing calcium it is possible to make the calcium less available for formation of deposits. This can be done by adding polyphosphates (similar to using Calgon in washing machines) to the water in a liquid or solid form.

The effect of this is to cause the water to behave in some ways as if it has been softened, although the water has not been softened by the proper definition with respect to removal or replacement of calcium. A measure of this apparent softening is that such chemically conditioned water needs less soap, as reflected in the classic "soap suds test".

The polyphosphate can be easily administered to the water by installing a relatively cheap dispenser in the pipework; convenient to treat all water entering the property. This dispenser must be refilled with solid polyphosphate glass-like balls or crystals at appropriate intervals. Recent versions of this method use a cartridge which has to be replaced as necessary e.g. as marketed by Fernox (available from good plumbers merchants) (tel: 01799 550811) or Aquadial by BWT UK Ltd (tel: 01376 334200).

More simply, a small sack of polyphosphate can be hung in the cold water storage tank so that it is immersed in the water: the disadvantage with this method is that treatment is restricted to only the water that passes through the tank.

In some areas, water has been dosed with phosphate by the water undertaking to help reduce release of lead from lead pipe. Dosing polyphosphate likewise will help to minimise lead concentrations from any lead pipework downstream of the dosing point. However, this should not be the principal reason for installing polyphosphate chemical conditioning.

Physical Conditioning

There is a variety of devices on the market which generate a magnetic or electrical field for the water to pass through, or may be intended to release trace concentrations of zinc. Some of these devices must be plumbed in the pipework, whilst some devices 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 distinct 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 might affect other factors but little is known about to what these might be and the extent this might occur. Physical conditioning can produce some of the benefits of softening but without actually softening (i.e. by removal or replacement of calcium). Thus, by the modern definition, physical conditioning does not soften water, and any such claim is incorrect. However, physical conditioning can make water seem softer.

Whilst the theoretical and practical aspects of softening and chemical conditioning are well understood and established, the scientific principles behind physical conditioning are not fully understood. It is well known that magnetic and electrical fields can affect a variety of chemical and physical processes but unfortunately it is poorly understood how such fields affect the precipitation of salts from solution in water. This lack of understanding means that it is not known fully how to exploit physical conditioning to best effect.

It also means that:

- At the present time no device can be guaranteed to work to produce an acceptable benefit, except in very specific circumstances.
- There may be no best overall device; some devices might be better for some applications and other devices for other situations.
- When a device appears not to work, this might only be perception of how well it works in that situation with respect to what was hoped for and not a case of the device not working at all.

Choice of devices

Warning: *Some physical conditioning devices have been listed in the Water Fittings and Materials Directory (Group 2410). Listing in the Directory concerns only approval for use under the Water Fittings Regulations - i.e. fittings do not give rise to waste of water or their materials of construction do not contaminate the water – and does not concern their effectiveness to do the job for which they have been designed. There is no "fitness-for-purpose" testing scheme known to exist for such devices.*

Guidance on effectiveness of PC devices is complicated partly because their efficacy depends on the quality of a particular water. However, there is a German DVGW test (W 512) that is designed to allow only the most effective methods of softening to pass. Therefore, as far as is known, examples of salt regenerated softeners and polyphosphate dosing have passed the test but no PC device, except one, has passed the test. The device that has passed is the AQA Total, which is new and is marketed in the UK by BWT UK Ltd (tel: 01494 838100). This is similar in size to a salt-regenerated softener and is likely to be as expensive to install, but with a lower operating cost, being mainly the replacement of a cartridge every couple of years. This device is designed to precipitate carbonate by electrolysis and release the precipitate to the flow of water in what might be regarded as a permanent form, thereby making it effectively unavailable for scale formation or interfering in the action of soap.

The only information in the public domain of any comparative or benchmark testing of PC devices is that in Stiftung Waruntest (January 2000 pp.59-63), the magazine of the German Consumer Association. Tests were carried out on thirteen different devices using the German DVGW test (W 512) procedure and a similar Austrian procedure. The only device that passed the tests was the AQA Total. Useful advice in the report to minimise scaling is to set boiler water temperature as low rather than as high as is tolerable.

There is a range of physical conditioning devices on the market for which similar claims are made. Therefore, before trying a particular device that has come to ones attention the claims made for others should be considered. Various devices are advertised in the newspapers and magazines. Attention is drawn to Lifescience Products (tel: 01608 811707) having established Advertising Standards Authority approval to claim their WaterKing device produces a softening effect.

PC devices might most simply be considered as three types:

Zinc release: intrusive device that has to be plumbed in, only affects behaviour of water that has passed through the device.

Permanent and electro-magnets, intrusive and non-intrusive, and some coil and electrostatic devices:

the magnetic field exists only in the immediate vicinity of the device and therefore only affects behaviour of water that has passed through or the immediate vicinity of the device.

Radio-frequency emission coil and similar devices: the signal results in a magnetic field that exists beyond the immediate vicinity of the device and affects water upstream as well as downstream of the device (e.g. Hydroflow (tel: 01923 210028) and WaterKing).

If a physical conditioner, obtained by mail-order, is tried then it is suggested one keeps in mind the money-back offer the purveyors make subject to dissatisfaction. Before a device is installed or switched on, carry out a survey of how water hardness manifests itself in the house, making a written record of the observations e.g. extent of scaling in kettles, dishwasher, washing machine, shower head, toilet bowl, taps, cisterns, scum on tea etc. Then after starting to use the device, repeat the survey every 3 to 4 weeks. Thus, as the time limit of the money-back guarantee is approached (typically 100 days but check), there will be a good basis for making a decision on the effectiveness of the device. If the device does reduce manifestation of hardness then this is likely to start become apparent after about 6 to 8 weeks with the second audit after starting to use the device. Beware of the "enthusiastic householder syndrome" i.e. because one might believe a device does work, cleaning is carried out more efficiently and consequently any reduction in the manifestation of hardness is ascribed to the PC device when it might be due to the more enthusiastic cleaning. During the approval period endeavour to remain consistent with related housekeeping practices.

Physical conditioning devices do not chemically soften water (based on the definition requiring the removal or replacement of calcium) though they might appear to provide some of the same benefits, such as reduced formation of limescale. If truly softened water is wanted then there is no alternative other than to install a salt-regenerated water softener. However, a polyphosphate dosing unit or the AQA total are possible viable alternatives.

No one can authoritatively provide advice on the efficacy of physical conditioning devices. However, physical conditioning is a real effect that has been extensively demonstrated in laboratory situations and published by various researchers. However, the extent to which a device might control the manifestation of hardness in a given situation can not be guaranteed or predicted with confidence. At least one purveyor accepts physical conditioning does not work in a few situations.

If physical conditioning appears to work, and the water system involved includes a roof tank, then the full benefit might be obtained by fitting two devices, one on the water pipe entering the property and the other on the feed from the head tank to the hot water tank (if there is one). If you try one device to start with then fit it according to where in your water system you are seeking most benefit.

Other Information

Most water companies provide brief leaflets concerned with fitting domestic salt-regenerated water softeners. Occasionally WHICH? magazine (Consumers' Association) looks at water softening and the alternatives, use of jug filters etc.