



A Consumers' Introduction to Physical Water Conditioners (Scale reducers)

“Physical Water Conditioner” is an umbrella term used to describe a group of products which can reduce, prevent or remove the formation of hard (lime) scale in areas supplied with hard water. They are generally small devices which are simple to install and are either plumbed in or externally attached to the water pipe close to the point of entry into the property; some need a mains power supply. The conditioners currently available are the result of decades of product development.

The main reason for the installation of a physical water conditioner is for scale reduction and/or scale removal – hence the alternative description of the products as “scale reducers”.

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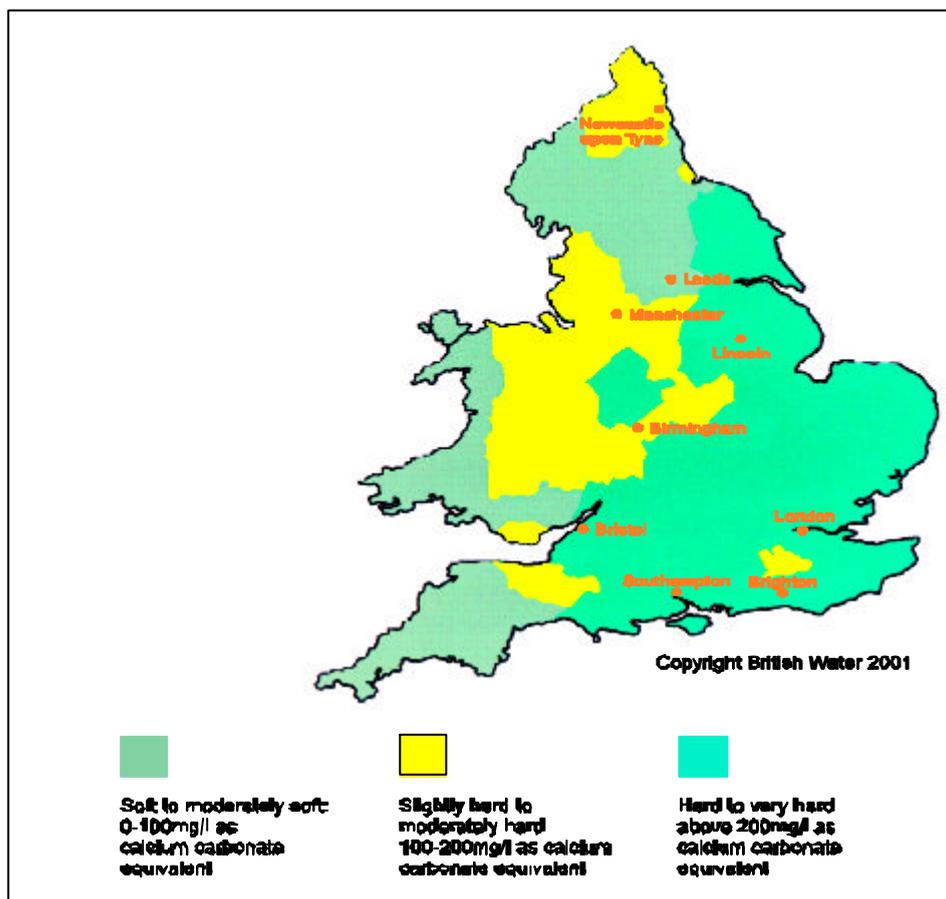
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1 Hard water - a brief description

Hard water is water that contains dissolved minerals, especially calcium and, in some cases, magnesium and silica. Rainwater is naturally soft, but as it percolates through chalk and limestone it dissolves and collects these and other minerals. Rainwater which falls on hard rock remains naturally soft. The hardness of the mains water is dependent on where you live and the source (surface or ground water) of the mains water supply. Water quality information, including hardness levels, is available from the local water suppliers' customer information services.

Generally speaking, hard water is supplied to 60% of homes in the UK: especially in central, eastern and southern areas of England. Some English cities are supplied with naturally soft water from Wales and the Lake District. The map and notes below give indications of water hardness in the different regions of the UK.

Fact Sheet 10 provides a more detailed description of water hardness and its measurement.



Scotland:

Supplies range from soft to hard, with the majority being in the soft to moderately soft category.

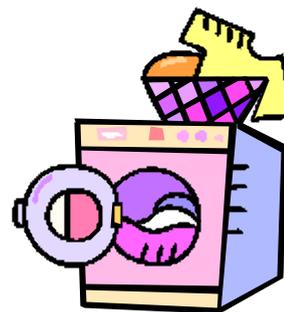
Northern Ireland: Northern Division - soft to moderately soft

Eastern Division - soft to slightly hard

Southern Division - soft to very hard

Western Division - soft to moderately hard

2 Introduction to physical water conditioners



Physical water conditioners treat water using a range of processes; they can be magnetic, electrolytic, electrostatic, electro-magnetic or electronic. The requirements of the installation, especially whether it is to be used for treating a single appliance or a whole house, influence which type to choose. The size of the property may also affect the design of the installation.

They all have a similar effect and that is to “stabilise” the hardness minerals (calcium, magnesium and silica) present in the water which leads to a reduction or prevention of the build up of hard scale. Sometimes soft scale forms but this is generally easy to remove. Some conditioners will also progressively remove existing scale in pipes, water cylinders and water-fed equipment.

There are physical water conditioners for scale and corrosion inhibition for water in central heating systems as well as for scale inhibition in water used for drinking and other uses in the home. Generally scale is not a significant problem within central heating systems, the problem is mainly of corrosion with the cause (oxidation and sludge formation) being traditionally treated by chemical means. However, it is possible to treat central heating systems with specific physical water conditioners, in which case they should be fitted to the pipework of the central heating system itself rather than to the general household water plumbing system.



3 The effects of physical water conditioners on water hardness

There is usually no significant change to the chemical composition of the hard water as nothing is removed, however, the electrolytic and some magnetic types do add minute traces of metal (usually zinc or iron) to the water. Conditioners alter the physical properties of the dissolved hardness minerals which cause scale formation. This is why they are called **physical** water conditioners.

Physical water conditioners do not remove the hardness minerals and so they will not provide softened water. This is why they are called **conditioners**. This is one of the factors which differentiate them from water softeners which change the chemical composition by replacing the calcium and magnesium with sodium from a salt (brine) solution.

There has been considerable research over many years and, although the precise scientific mechanism of physical conditioning is not well defined, there is general agreement about the way in which these products affect scale formation. It is agreed that this group of products is largely effective in domestic, commercial and industrial applications for reducing or preventing scale formation and in some situations for the removal of existing scale. There is no British Standards Institution (BSI) or European standard for physical water conditioners.

When hard water is heated the hardness minerals form crystals which accumulate on surfaces, especially heated surfaces, to form hard scale. Hardness minerals can develop into different types of crystals, cubic (box-shaped) and needle-like are the most frequent types. The relative amounts of the different types of crystals is variable and can be altered by changing the balance of minerals, the temperature and other factors in the water. If the box-shaped crystals predominate then a hard scale will develop, but if the crystals are mainly needle-shaped either a soft scale forms or the crystals remain suspended in the water.

Physical water conditioners encourage the formation of many miniscule needle-shaped, rather than box-shaped, crystals as the water flows through the conditioner or the pipework where the conditioner is fitted. When physically conditioned (treated) water is heated more of the dissolved hardness minerals attach to the suspended needle-shaped crystals rather than form box-shaped crystals. Consequently, hard scale does not develop and the needle-shaped crystals either remain suspended in the water as it flows through the pipes and appliances or settles out to form a soft scale if the water is stored or dries. The soft scale can be easily cleaned or wiped away.

Many users notice an improvement in the quality of the water treated by some magnetic and by electronic conditioners. This is shown by a reduction in the use of detergents in washing machines and, to a lesser extent, reduced scum formation and an increase in lather development. It is acknowledged that the assessment of some aspects of water quality can be very subjective and personal, consequently any changes in water quality should be regarded as extra benefits rather than being part of the main reason for installing a physical water conditioner. The main reason for the installation of a physical water conditioner is for scale reduction and/or scale removal.

4 Types of Physical Water Conditioners

Physical water conditioners can be grouped according to whether or not they require a mains electricity power supply:

- ❖ those which do not require a mains power supply: magnetic, electrolytic, electrostatic,
- ❖ those which do require a mains power supply: electro-magnetic, electronic. The connection to the mains supply is via a transformer which provides a low power output.

All types of conditioners can be used to treat water for individual appliances when the water is used within a short time after treatment and most types can be used for whole house treatment as their effects are longer lasting. The non-electric devices are suitable for individual appliances with the electrolytic and electrostatic types also being applicable to whole house treatment. The mains powered electro-magnetic and electronic types are especially suitable for whole house treatment and, although one unit is usually sufficient, it may be beneficial to fit two units in larger properties and when water is stored in a roof tank. If two units are fitted one should be close to the mains entry stopcock and one on the exit pipe from the storage tank or cold feed to the hot water system.

5 Installation and use of physical water conditioners

Physical water conditioners are easy to fit, correct installation is important and they are usually maintenance free with low or zero running costs. Although magnetic and electrolytic conditioners may require periodic replacement to maintain the level of protection, other products have a life expectancy of many years as fit and forget products. It is acknowledged that in some circumstances conditioners do not work or are not as effective as expected. It is therefore important that, as with all domestic products, the type of conditioner that is purchased comes with a manufacturer's performance-linked money-back guarantee.

6 Summary

Physical Water Conditioners are installed to reduce, prevent or remove the formation of hard (lime) scale in domestic hot and cold water systems or for scale and corrosion inhibition in central heating systems in areas which are supplied with hard water. It is acknowledged that the assessment of some aspects of water quality can be very subjective and personal, and so any other changes in water quality should be regarded as extra benefits rather than being part of the reason for installing a physical water conditioner.

The main reason for the installation of a physical water conditioner is for scale reduction and/or scale removal.

For more information on these devices see British Water **Fact Sheets numbers 1 and 3.**

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Information on water treatment in the home

HARD WATER: COST AND ENERGY IMPLICATIONS

Hard water causes two major problems for the domestic consumer:

- ❖ **hard scale formation in the hot and cold water systems, this reduces efficiency of boilers and appliances which heat water, and causes unsightly deposits on taps and sanitary ware**
- ❖ **scum formation and increased use of soap, along with a difficulty in producing an acceptable lather with soaps and detergents.**

Fact Sheet 10 contains more general information on water hardness.

Hard Scale: 1.6mm of scale in heating systems causes a 12% loss in heat transfer from the energy source (gas, electricity) to water, ie in heating efficiency. In areas with a hard water supply scale gradually builds up in boilers and on heating coils in hot water tanks, this causes the heaters and boilers to run longer and hotter using (wasting) gas or electricity. Scale also accumulates as a sediment in hot water storage cylinders and consequently the capacity of the cylinders to store hot water, ie hot water immediately available for use, will be reduced.

Hard scale gradually builds up in hot water pipes and reduces the flow of water, this makes pumps work harder and can ultimately block the pipe. It will shorten the life of showers (heaters and shower heads), washing machines and water heaters, particularly immersion heaters, reduce their efficiency and increase maintenance and repair costs. It can form in taps and valves causing them to leak and forms hard unsightly deposits on taps, baths, basins, sinks, toilets and on shower heads and fittings, making all of them difficult to clean.

Scum and lather: hard water increases the amount of soap, shampoos and detergents used, especially the amounts needed to produce an acceptable lather. The use of soaps, etc in hard water leads to the formation of an unpleasant scum on the water or as a soft deposit remaining as a watermark on basins and baths.

Physical water conditioners reduce the build up of hard scale and can remove it, a soft scale may be deposited on visible surfaces which can be easily wiped away. **Fact Sheet 3** gives details of types and effectiveness of physical water conditioners.

Phosphate dosing significantly reduces the deposition of scale in heating systems and hotwater pipes

Ion exchange water softeners will prevent both hard scale and scum formation and also improve lather development. A softener can reduce by up to 50% the amounts of soaps and detergents used. **Fact Sheet 9** gives details of types and effectiveness of water softeners.

To summarise: if you live in a hard water area doing nothing to counter the problems that it causes is probably the most expensive option due to reduced efficiency of water heaters, extra energy and maintenance costs. Scale formation is affected by regional differences in the water supply, variations which also may influence the effectiveness of some water treatment equipment used to minimise the effects and costs of hard water. The assessment of the effects of water quality (scaling, lathering, taste) is subjective and, as well as cost, can influence the selection of which treatment or model to use to minimise specific hard water related problems.

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PHYSICAL WATER CONDITIONERS & SCALE PREVENTION

Physical water conditioners cause the hardness minerals to precipitate as minute invisible particles within the water rather than on the surfaces of heating appliances and pipework. There have been many years of academic and applied research into the effect and operation of the technologies. The various types of physical water conditioners work in different ways to produce similar effects, scale formation is much reduced and hard scale is replaced with a softer scale.

Physical water conditioners encourage the formation of a multitude of miniscule crystals of scale as the water flows through the device. When the treated water is heated more of the dissolved hardness minerals attach to the small suspended crystal, which tend to be needle shaped, rather than onto the heated surfaces and pipework.

Also, the needle-shaped crystals are much less likely to form hard scale on metal surfaces and will usually remain suspended in the water flow. Consequently, hard scale does not form when conditioned (treated) water is heated, when it dries a soft scale may form which can be easily cleaned or wiped away.

There are five types of physical water conditioners which use different methods to condition the water.

- ❖ **Magnetic** devices use a magnetic field to initiate needle-shaped crystal formation and are suitable for protection of individual appliances, the effect is not long lasting
- ❖ **Electrolytic** devices deliberately add very small quantities of dissolved metal (usually zinc or iron) which promotes the formation of the needle shaped crystals
- ❖ **Electrostatic** devices use the flow of the water through the device to create an electric field in the water to promote the development of needle-shaped crystals.
- ❖ **Electromagnetic** devices develop stronger magnetic fields in the water than the magnetic devices.
- ❖ **Electronic** devices use a very low power electrical current and microprocessor technology to develop a variable electrical field in the water to generate their effect.

Magnetic, electrolytic and electrostatic devices do not require an external mains electricity power supply which is required by the electromagnetic and electronic conditioners. All conditioners can be used to protect individual appliances. Electrolytic, electrostatic, electro-magnetic and electronic can be used for whole house protection, for which the mains powered conditioners especially are suitable. In larger properties and when water is stored in a roof tank it may be beneficial to install more than one device, one close to the mains entry stopcock and one on the exit pipe from the storage tank or on the cold feed to the hot water system. Replacement of the magnetic and electrolytic devices periodically may ensure that protection is maintained.

Physical water conditioners alter the crystal structure of the hardness minerals which form hard scale when the water is heated. They do this without altering the chemical content of the water.

The performance of all water treatment devices can be variable and is dependent upon a number of factors including the way in which they work and the characteristics of the water supply in the area where they are to be used. It should also be remembered that the assessment of water quality can be subjective and personal. The quality and characteristics of water can and does vary widely across the UK and so can influence the performance of physical water conditioning devices. Consequently it is advisable to check that the device chosen is covered by a manufacturer's performance money-back guarantee.

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