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Water treatment for scale prevention is a hot topic especially with carbon emissions high on the agenda. Equally heated are the discussions raging over various kinds of physical water conditioners, how they work and what they do. **Jonny Seccombe,** Managing Director of Lifescience Products, gives his views on the subject.

GASInstaller

FIRST of all, I'd like to ask the reader a question. Which of the following compounds is the main constituent of hard water?
Is it Calcium Chloride, Calcium Carbonate, Calcium Sulphate, Calcium Bicarbonate?

The answer that most people give is Calcium Carbonate, but the correct answer is Calcium Bicarbonate.

What's the difference and does it matter?

Calcium Carbonate only occurs as a solid compound - limescale or chalk, whilst Calcium Bicarbonate occurs only as a dissolved salt. The dissolved salt in the water reacts with soap so that scum is produced instead of lather and the water is considered hard. If on the other hand you put a lump of calcium carbonate (for example a piece of chalk) into soft water, there will be no reaction with the soap at all and normal lathering will occur unless or until the chalk dissolves. The water contains plenty of calcium in the form of that lump of chalk, but the water is still soft until solution occurs.

If hard water doesn't contain Calcium Carbonate, why is hardness commonly measured in terms of parts per million (ppm) of this compound?

Hard water normally contains a cocktail of many different dissolved salts and to measure the total hardness of the water would require you to list every single one of them - it could be a very long list. The index normally used is calcium carbonate, and water is considered to be hard if it contains more than 50 ppm.

Are you saying that hard water doesn't have any calcium carbonate in it at all?

Correct! There might be a few bits floating around but they won't make the water hard unless they dissolve back into the water.

Can you explain what happens when scale is formed?

In simple terms when, water is heated, pressure is reduced or pH is changed a reversible process takes place . Calcium bicarbonate ($Ca(HCO3)2$) converts to calcium carbonate ($CaCO3$), Known as limescale, with byproducts of water ($H2O$) and carbon dioxide ($CO2$). The important things to remember in this process is that the Calcium Carbonate (scale) has to form (nucleate) onto something. It cannot form on its own, but needs a solid surface to form on or around. Normally it forms on the heating element or surface of the water heater and it especially likes rough surfaces where it can get a good grip.

So how do physical conditioners prevent this happening?

By Reading the manufacturer's literature, there seem to many and varied things going on, but almost all of them seem to involve seeding the water in one way or another to create something for the scale to form on. Electronic systems stimulate the formation of nucleation seeds by putting an electric charge in the water. Magnets and electrolytic systems release seeds into the water as a byproduct of the corrosion that they create. In most cases, these seeds attract the scale that would otherwise nucleate on the heating surfaces and the resulting tiny particles of calcium bicarbonate get carried away suspended in the water. The scale still forms - but it doesn't stick.

Is the water softer?

Hot water is invariably softer than the cold water that was heated because the calcium bicarbonate level is reduced by the amount of scale that is deposited. If you heated the water long enough all the scale would precipitate and the water would be very soft - but the heater would get very scaled up.

Water-King is described as an electronic water softener. What evidence is there to support this description?

During research, the level of residual calcium bicarbonate in the hot water in a portsmouth home was studied. The cold water has around 150 ppm calcium carbonate equivalent of calcium bicarbonate (CCE). This reduces to around 100 ppm when the water is heated normally. Therefore, about 50 ppm of limescale was left in the hot water cylinder. After installation of a Water-King the CCE increases initially as the system descales, but after six weeks it settles at around 50 ppm. The water was softer by a factor of 50 per cent compared to the untreated hot water.

How does descaling work?

Limescale is never completely stable, and precipitation is a reversible process. Normally some scale will dissolve back into the water and then re-deposit where it came from. Conditioned water stops the re-depositing process by encouraging nucleation in the body of the water. The matrix of the deposited limescale is weakened and eventually it breaks away. This process can happen quite quickly, within days or weeks of installation, and can be

quite dramatic. It is a useful alternative to acid descaling.

Some manufacturers deny that their physical conditioners make the water softer. why?

To make the water softer, it is necessary to stimulate more scale formation than would normally occur. Most devices seem to do enough to attract some or most of the scale that would otherwise encrust the heaters or pipes. The more effective devices go a stage further by creating so many nucleation seeds that scale formation is actually stimulated leaving less residual calcium bicarbonate.

Can you soften water without removing the calcium?

If you remove the calcium bicarbonate, the water must be soft. Ion exchange softeners swap the calcium with sodium but an alternative is to convert some or all of the calcium bicarbonate to calcium carbonate.

Is the calcium still there?

It is still there but in a different form that does not create the effect of hard water.

How good are physical conditioners?

A They vary hugely, both in terms of effectiveness and length of life. Physical conditioner are never going to be as effective as a correctly operated ion exchange softener, but it can do most of the job required.