WATER TREATMENT

How do you weigh up limescale protection?

With so many standards and performance regulations in the energy industry how come physical water conditioners don't require test certificates, asks Jonny Seccombe of Lifescience Products

The bowl and brush of the Biostat 2000

Energy loss due to limescale encrustation of heat exchangers used for heating domestic hot water is a problem that is at last being recognised by the Energy Saving Trust (EST). The revised Part L regulations are expected to include a requirement to treat water with hardness in excess of 200ppm calcium carbonate equivalent to reduce the incidence of limescale. Many people will turn to physical water conditioners (PWCs) for a solution but there is no UK standard by which PWCs performance can be judged so there is a risk that money could be wasted on poorly performing or largely ineffective products that have little or no effect on scale encrustation.

In hard water areas of the UK (broadly south east of a line drawn from Whitby in Yorkshire to Exeter in Devon) non chemical water conditioners or PWCs are widely specified by consultants and mechanical engineers but none of them until recently have been backed by any kind of performance data which shows how well they work and in what circumstances. In simple terms it is very difficult to design a test for a product to measure how it performs if you don't understand how it works in the first place. Many people in the industry still consider PWCs to differ only marginally from snake oil or black magic but recent scientific papers and field studies have focused attention on three mechanisms that provide many of the answers to the mysteries of PWCs.

Scale always has to form on something, which is why it is so effective at blocking pipes and heat exchangers, but if you can "seed" the water with a compound upon which the scale will preferentially form, the scale will stay in suspension in the water and be washed away with it. It is generally recognised now that most effective PWCs seed the water with either zinc carbonate, ferrous carbonate or calcium carbonate itself. The mechanism employed by most PWCs is either to release zinc by corroding an anode, to convert free Fe ions to ferrous carbonate through an electrochemical process or to generate calcium carbonate micro-crystals using cathodic stimulation.

The problem with testing PWCs has been that almost all tests have been done simulating full sized heating systems and the results have seldom been consistent enough to draw valid conclusions. Full sized systems use large quantities of water over a period of days and it is well nigh impossible to have absolute control over all the dissolved compounds in the test water. Because there can be such a large variation in the natural levels of zinc, iron and other scale attracting compounds in the water, there can be very large variations in the performance of products, so valid test conclusions cannot be drawn.

Small scale testing using controlled samples of water over a short timescale can be very helpful in proving a mechanism. A number of such tests have been conducted but few of them published. A problem still arises when converting the results up to the full sized equivalent in the field because there is less control over the water quality and interactions can occur that cause an unacceptable variation in the results. There is no doubt however that this kind of "Rapid Scaling Test" can be very helpful in researching the mechanisms and following these up with comparative product tests. The problem has been in funding this research, and, because the EST until recently has not officially recognised scale as an energy wasting problem, many sources of finance have been blocked.

Removing the heater coil from one of the water heaters of the W512 test rig

The Germans have been less reticent at developing a performance test which PWCs sold in the commercial market in Germany are required to pass. The test has been developed by DVGW and is called W-512[1]. It comprises a test rig with four independent water lines each of which discharges a controlled amount of water periodically from an electric immersion water heater that heats the water to 80°C. The PWC to be tested is installed to treat two of the test lines and the other two lines are left untreated.

Each day 130 litres of water is passed through each heater replicating the usage in a typical household. After 21 days the heaters are opened up and the amount of scale is measured in each line and compared. The device under test

is then moved to the previously untreated lines and the test is repeated for another 21 days. The results are averaged according to a set formula. To be certified under W-512 the test device must show a reduction of scaling of at least 80 per cent

The problem with W-512 is that none of the PWCs generally in use in the UK have passed the test - those that have been submitted for testing have failed. This doesn't mean these products don't work, it just means that they are not good enough to pass the test - it is a very tough test! The result has been that there has been huge resistance to having this test adopted in the UK, indeed the now defunct UK Physical Water Conditioning Association had Stop W-512" as one of their main objectives. In Germany the effect has been to limit commercial installations to only W-512 products and a side effect has been to increase the focus on the UK market for those German or Austrian products that have not passed it.

It would be foolish to adopt W-512 in the UK as a required standard because it would restrict the use of the many UK products which provide very effective scale prevention at a very economic cost. However, where budgets can be stretched to more sophisticated complex systems, then W-512 is a standard, albeit German, that has many merits. Some Consulting Engineers who have been frustrated by the lack of a UK performance standard for PWCs have found W-512 a very attractive alternative and cite it in some of their specifications.

Looking at the five products that are known to have passed W-512, they all appear to share a common mechanism. They seed the water with micro crystals of calcium carbonate - scale itself, derived from an electrochemical process which can be described as Cathodic. They make use of a chemical effect that occurs at a cathode in water when an electric current is passed from a non corroding anode. At the cathode the pH of the water rises significantly causing scale to precipitate on the cathode. If this scale is then released back into the water in the form of micro crystals it acts as a very effective seeding mechanism when scale is later formed as a result of increased temperature or reduced pressure.

One example of the W-512 graduates is the Judo Biostat 2000. At its core it incorporates a "bowl" around the inside of which is an Iridium coated Titanium wire mesh acting as a non corroding anode. Inside this bowl sits a stainless steel wire brush which acts as the cathode. The scale forms on the bristles of the brush and is then removed by a slowly rotating stanchion which flicks the scale off the bristles and back into the water. Roughly ten percent of the dissolved calcium bicarbonate is converted to scale by this process but these micro crystals stay in suspension in the water and then go on to seed scale as it forms in the water heater.

Unlike Ferrous seeding ions, which appear to revert back to their previous state when water is stored out of contact with the seeding process, the scale crystals do not revert back to their previous state which means that the Biostat can be used effectively on the supply to a water cistern incorporating an air gap.

For the vast majority of PWCs that are effective in the field yet fail the W-512 test there needs to be an alternative test regime by which they can be classified and compared. The "Rapid Scaling Test" is a promising alternative but it requires independent financing to get it off the ground and until recently there has been no legislative impetus to require it to happen. Part L should make a change and it would be helpful if some of the money currently being earmarked for alternative energy developments could be focused on a subject that has potential to make very significant energy savings.

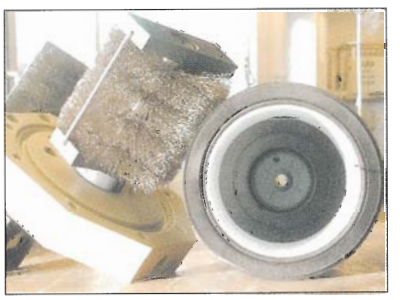
1) For an English translation of W-512 see:-
http://www.waterking.co.uk/Pdf%20Files/DVGW-W512.pdf

www.lifescience.co.uk

Above.
Two BST50 units mounted in parallel. The cold water service is protected by a Judo Profi backwash filter.

Right.
BST25 showing cutaway bowl, brush and stanchion.

Bottom.
Detail of bowl, brush, stanchion and armature. The Titanium mesh is held in place by the white liner.



Technical Specifications

Model	BST 15	BST 25	BST 50*
Pipe connection	3/4″	1″	1 1/2″
Maximum flow rate l/s	0.42	0.7	1.4
Pressure loss at maximum flow rate BAR	0:2	0.4	0.48
Max. temperature of intake water Celsius/Fahrenheit	30/86	30/86	30/86
Max. power consumption** watts	100	120	240
Width mm/inches	330/13″	330/13″	520/20 1/2″
Height mm/inches	855/33 1/2″	855/33 1/2″	855/33 1/2″
Depth to middle of pipe mm/inches	240/9 1/3″	243/9 1/2″	–
Depth to middle of pipe with JQX mm/inches	305/12″	308/12 1/4″	340/13 1/2″
Minimum clearance above and below 100mm/4"			

** incl. JQT for tandem switching 2 BiOSTAT 2000 and 2 JQX single-lever bypass valves*
*** only while drawing off water*

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