

# Aquafacts No. 11

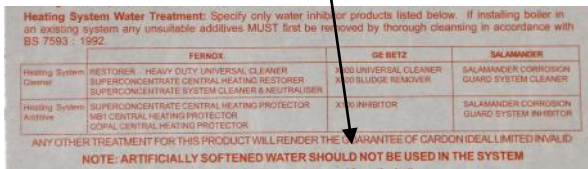
## Softened water and aluminium boilers

The following information has been researched and prepared by the UKWTA (United Kingdom Water Treatment Association) with considerable input from Mr H Bowden, Chairman of the UKWTA Water Softener Technical Group.

### PART ONE – The story so far

#### Introduction

Since 1992, boiler manufacturers have been led to believe that softened water is corrosive. Some of them even put a warning label on the inside of the boiler cover stating that: "Artificially softened water should not be used in the system." An example of such a label is shown below:



#### Boiler Manufacturer Comments

In 2004 the UKWTA contacted the boiler manufacturers to ask them why this was necessary. The association received the following response:

"We have no particular evidence, but if you refer to BS 7593:1992 you will note softened water cannot be used in a central heating system where you have an aluminium heat exchanger."

#### BS 7593:1992

The standard reads as follows:

"Water supplied via a water softener should not be used in any central heating system unless a corrosion inhibitor specifically formulated for the purpose has been added. Base Exchange softening tends to raise the pH of the system water, which is unacceptable where the system contains aluminium, and softened water should not under any circumstances be supplied to such a system."

#### BSI (British Standards Institute)

The UKWTA attended the next BSI committee meeting and asked why these comments had been included in BS 7593. The reply was: "It seemed like the right thing to do!" No evidence was submitted to support the statement.

*This is the first time ever that softened water had been accused of causing corrosion by a regulation.*

With UKWTA input the standard was revised in 2006 and BS 1593:2006 now reads as follows:

"Naturally soft waters of low alkalinity or those supplied via a base-exchange resin softener have an increased potential for corrosion and, if they are to be used in any central heating system, a corrosion inhibitor specifically formulated for the purpose should be added and properly maintained".

When asking around the industry to find out why the original standard had been written excluding softened water, it was intimated that the inhibitor manufacturers didn't want to have to spend money formulating an inhibitor that would work with softened water. It was judged more cost effective to leave it out.

#### BS 6798:2000

Once BS7593:2006 had been amended; the UKWTA once again approached the boiler manufacturers and informed them that softened water could now be used in aluminium boilers based on the amended British Standard. They responded by referring to another British Standard - BS6798: 2000 which again states that softened water cannot be used with aluminium boilers. It reads as follows:

"5.4.5.3 Water supplied by a water softener shall not be used in any central heating system unless a corrosion inhibitor specially formulated for the purpose has been added. Softened water shall not be supplied to any system that contains aluminium".

The misinformation in BS7593 had been cloned across to BS6798. The UKWTA immediately became involved with the BS committee responsible for the regulations. The new BS6798:2009 now reads that you can use softened water, provided that you use the correct inhibitor:

"6.2.1.3 Water supplied by a water softener shall not be used in any central heating system unless a corrosion inhibitor specially formulated for the purpose has been added".

#### CIG (Communities & Local Government) Building Regulations

The UKWTA consulted with the boiler manufacturers yet again and informed them of the amended rules and that softened water had been given approval. The manufacturers retorted by saying that a recently published building regulation guide suggested not using softened water. According to these Building Regulations:

"Where water is artificially softened, it is advisable to feed unsoftened water not only to the drinking water taps, but also to the boiler primary circuit".

The urban myth from the 1992 British standard 7593 had spread again via the inhibitor manufacturers through to their trade association - the Domestic Water Treatment Association (DWTA). The UKWTA again had meetings with the CIG. They agreed to change the wording so that it followed BS7593: to use the correct inhibitor.

After 6 years of hard work, all the regulatory documents in the UK now say the same thing:

"When using softened water, use the correct inhibitor".

However, there is another hurdle. The BuildCert



product certification for chemical inhibitors does not yet have a scheme for approving an inhibitor formulated for softened water. As of December 2010 we are waiting for the HHIC (Heating & Hot Water Industry Council), the boiler manufacturers association, to request this from BuildCert.

## PART TWO – Do corrosion inhibitors actually work

### Fernox report

Following publication of a document by Phil Munn of Fernox, there is evidence to suggest that inhibitors themselves can cause corrosion. His report refers to corrosion being caused by the collating agents which are part of the inhibitor formula. He states:

"The chelating agents may be able to interfere with the passivation process sufficient to cause active corrosion".

A chemical inhibitor includes chelating agents, which look for calcium in the water. When it finds calcium it forms complexes, which prevents the calcium precipitating and forming scale on the heat exchanger. As there is no calcium in softened water, it looks for the next least noble metal which, of course, is aluminium. In this way the chemical inhibitor itself can cause corrosion in softened water.

This explains why the chemical inhibitor manufacturers did not want softened water in central

heating systems. It would mean that they would have to reformulate their products involving, in their eyes, unnecessary investment and high costs. The simple way out for them was just to ban softened water and spread the rumour that it caused corrosion.

## PART THREE – Further background information

### Current boiler manufacturer opinion of softened water

If the boiler manufacturers are asked whether they recommend softened water for their central heating installations, you get a mixed response. These boiler manufacturers approve:

Date: 18 May 2010 12:01  
Subject: Optimax HE 25s  
To: [shash.k@gmail.com](mailto:shash.k@gmail.com)

Dear Sir,

I can confirm that it is ok to use a water softener with the Optimax HE 25s boiler, if you are in a hard water area then this will help with the life span of the heat exchanger in the boiler by reducing scale build up.

Kind Regards

Ferrolli Technical Department

**Technical, Email Account**

Ferrolli Limited

Subject: RE: ALUMINIUM CORROSION WITH SOFTENED WATER  
Date: Wednesday, 17 September 2008 11:39  
From: RochesterTechnical <[TECHNICAL@vaillant.co.uk](mailto:TECHNICAL@vaillant.co.uk)>  
To: Harvey Bowden <[hb@harveysofteners.com](mailto:hb@harveysofteners.com)>  
Conversation: ALUMINIUM CORROSION WITH SOFTENED WATER

Thank you for your email.

Our boilers are compatible with all types of water softeners and we have tested our boilers with both Fernox and Sentinel inhibitors and cleansing products and both are compatible.

Regards

Technical dept.

This boiler manufacturer is unsure

Date: 19 May 2010 09:46  
Subject: softened water  
To: [shash.k@gmail.com](mailto:shash.k@gmail.com)

Thank you for your enquiry

We do not recommend the use of artificially softened water in the primary side of our boilers, it is acceptable for domestic use.

If at all possible the system fill point should be taken from an unsoftened source. If this is not possible it is imperative that the system corrosion inhibitor levels are correct and are monitored and replenished as necessary.

Using artificially softened water will not invalidate the warranty except for preventable defects that are directly attributable to the use of softened water

Regards

M Morris  
Technical Helpline  
heateam The service division of Baxi Group  
Brooks House, Coventry Road, Warwick CV34 4LL.  
T 0844 871 1545 E [technical.helpline@baxigroup.com](mailto:technical.helpline@baxigroup.com)

This boiler manufacturer endorses using softened water:

From: **Hugh Peate** <[PeaH@viessmann.com](mailto:PeaH@viessmann.com)>  
Date: 18 May 2010 11:15  
Subject: comp soft  
To: [shash.k@gmail.com](mailto:shash.k@gmail.com)

We recommend that our boilers and central heating systems are filled with softened water in hard water areas. The softener needs to be operating correctly.

Kind regards,  
Hugh Peate  
Technical Advisor  
Viessmann Ltd  
Hortonwood 30  
Telford  
TF1 7YP  
01952 675070  
Email: [peah@viessmann.com](mailto:peah@viessmann.com)  
web: [www.viessmann.co.uk](http://www.viessmann.co.uk)

As you can see Viessmann, a German boiler manufacturer, positively recommends softened water. Throughout their commissioning instructions they state that softening the water is all that is required when treating the water for a central heating system.

### Standard values for water quality

The service life of any boiler as well as that of the complete heating system is influenced by the quality of the water.

In any event, the cost of a water treatment facility is less than the cost of repairing defects on your heating system.

For filling and commissioning, a mobile water softening device can be hired from Viessmann.

One manufacturer says different things between their UK and USA guides - see the images below:

#### UK Manual

CH water:  
Artificially softened water must not be used to fill the central heating system.

#### USA Manual

##### 3.8 Water quality

Water quality can have an impact on appliance longevity and may void the manufacturer's warranty. For water analysis data call your local water department, or if on a well, have well water analyzed periodically. If water quality exceeds one or more of the values specified below, Bosch recommends installing a water conditioner or softener.

This reflects the sheer level of confusion in the central heating marketplace with regard to the use of softened water and chemical inhibitors.

#### Tracing the Answer

Going back to the beginning of the last century (1903), the Permutit 'ion exchange' process of water softening, which is used today, was invented by a Dr. Robert Gans in Germany. Germans are often considered the best engineers in the world, with the added benefit that they like to follow the regulations and guidance from their institutes. The Institute of German Engineers publish many documents. One is entitled 'scale formation in drinking water and water heating systems'. It explains very clearly what needs to be done with regard to softening and demineralisation. There is no doubt that they recommend the use of softened water as the best method for treating central heating water.

#### 4.4.2 Water heating systems

##### Softening

Softening is a preferred method for avoidance of scaling, since it results in long-term removal of alkaline earths (Calcium and magnesium ions) from the system (see Section 5).

They also go on to say that physical water treatment can only be used if its effectiveness can be demonstrated. At present there is no reproducible evidence. For this reason they do not recommend physical water conditioners because they do not work. (See Aquafact sheet No.19).

##### Physical water treatment

Physical water treatment methods can only be used to reduce scaling if their effectiveness has been demonstrated. At present there is no reproducible evidence of the effectiveness of such methods in heating water (see Section 4.4.1).

Part II of the same document covers the 'prevention of damage in water heating installations from water-side corrosion.' Throughout the document, they recommend softening as the preferred treatment and to avoid using chemical inhibitors wherever possible.

There is a German DIN standard 14868. This is now a European norm so it is automatically a British standard. It is entitled 'The protection of metallic materials against corrosion' - BS EN 14868:2005.

#### 6 Role of oxygen

##### 6.1 General

In the systems under consideration, the corrosion processes are mainly determined by the extent of oxygen ingress into the system. Generally, oxygen reduction is the driving force for anodic metal dissolution reactions. If the ingress of oxygen can be prevented, the rate of corrosion will be minimised to the extent that corrosion damages will normally not occur.

The standard points out that the role of oxygen is the driving force for corrosion. If it can be prevented from getting into the central heating system, corrosion will be prevented under normal circumstances.

##### 8.3 Aluminium

###### 8.3.1 Leakage

Leakage caused by non-uniform corrosion will not occur if potable water without further treatment is used as filling water.

Only in very soft waters with low buffer capacity, in cases of self alkalization or when alkaline products are added, which raise the pH value above 8,5 (e.g. some alkaline inhibitors for protection of ferrous materials), is corrosion likely because of the formation of aluminates and evolution of hydrogen. In such situations, leakage is usually caused by erosion corrosion in areas of turbulent flow.

It mentions that aluminium is different and that corrosion will not occur without further treatment. i.e. "don't use an inhibitor". It also explains that when alkaline products are added, i.e. corrosion inhibitors for the protection of ferrous metals, then the pH can rise and cause problems with the aluminium.

The best solution is to not use an inhibitor at all or, alternatively, use one that has been correctly formulated.

## 10 Corrosion protection methods

### 10.1 General

The primary cause of corrosion problems in water circulation systems is ingress of oxygen from air or fresh water. Therefore, design, commissioning, operation and maintenance of systems are important in terms of minimising corrosion likelihood.

Again, this mentions that the primary cause of corrosion is oxygen.

### 10.3.2 Corrosion inhibitors

Chemical inhibitors can be used under Case II conditions to prevent corrosion damages. However, inhibitors should not be used as a substitute for physical solutions to prevent oxygen ingress. They work by adsorbing or precipitating on the metal surfaces thereby reducing the anodic and/or cathodic reaction rates. They also often contain chemicals which buffer the pH of the system water and can neutralise any residual acids. Since re-circulating heating and cooling systems contain a variety of metals including steel, cast iron, copper and copper alloys and aluminium, the corrosion inhibitor if used should be compatible with all the relevant metals in the system. Care should also be taken to ensure that the inhibitor chosen is compatible with all the non-metallic materials in the system, including plastic pipework, rubber hoses, membranes, seals, O-rings, etc.

Inhibitors which function purely by anodic action can increase the likelihood for pitting attack in restricted areas, such as in crevices or under debris. Therefore, the use of inhibitor blends which contain both cathodic and anodic inhibitors is preferred. It is favourable to use products with low toxicity and environmental impacts.

This explains that inhibitors can be used in a Case II condition, when you cannot prevent oxygen entering a heating system. This would apply to a large commercial installation over multiple storeys where it is impossible to keep air out of the system altogether.

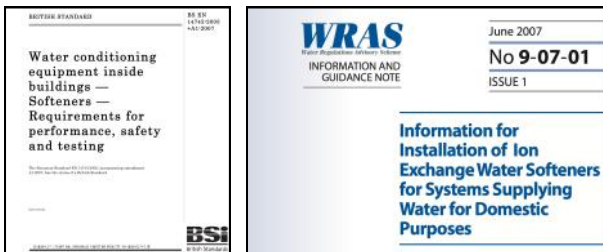
In a Case I condition referring to a standard domestic system (with an expansion tank in the loft or preferably a sealed system with expansion vessel) then no oxygen can enter the system and so there is never a problem.

### Findings

In summarising, Germany, where water softeners were invented, the Institute of Engineering and DIN standards state that you should not use chemical inhibitors and you should only use softened water and keep the oxygen out. On the other hand, Fernox and Sentinel in the UK state that softened water cannot be used and that you should use a chemical inhibitor.

A further search of documents shows the European standard BS14743:20, the standards for water softeners, do not mention anywhere that softened water causes corrosion.

The UK WRAS (Water Research Advisory Service) installation guidelines for water softeners do not mention corrosion at all.



### USA Situation

In America, there are well over 10 million water softeners installed. If corrosion was a problem statistically it would have shown up by now.

Guy Franklin, the Managing Director of BuildCert Ltd, wrote to the NSF (National Sanitation Foundation),

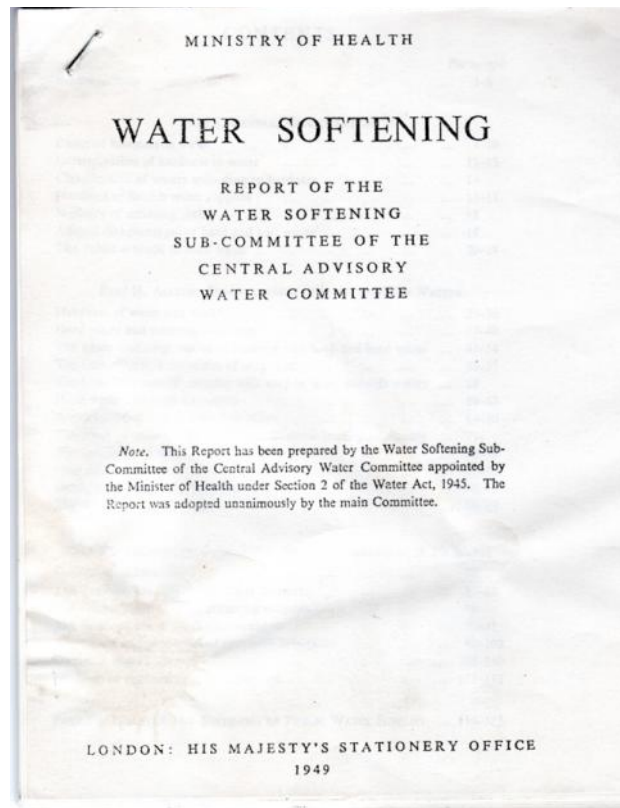


With respect to corrosivity, NSF/ANSI-44 has no methods for evaluating this condition and no requirements of performance. If the committee was of the opinion that the product created a condition of corrosivity or had identified problems in the field with these products causing corrosion, it is reasonable to expect that there would be requirements in the standard with respect to product design and performance. The absence of such requirements suggests it has not been identified as a concern.

which carries out the standards work in America for water softeners and requested any information they had about corrosion and softened water. Their response indicated that they'd never had a problem with corrosion caused by softened water.

### Historical references

In 1949 the British government published a long report on softened water. There was no mention of corrosion anywhere.



Back the 1920's when 'Permutit' was part of United Water Softeners Ltd, they had the following to say:

"A water which is naturally soft is more than likely to be corrosive, not because it is soft, but because it is probably acid owing to the ground through or over which it has passed; this is very different from a water which is soft because it has had the hardness forming salts removed in a water softening plant".

They go on to say that the idea that the boiler feed water can be rendered too soft is proved to be a relic

of the days before the introduction of the scientific softening of hard water”.

One thing we do know is that science does not change; the physics remains the same.

*In 100 years of the technology of softening water, the industry has never had a problem with corrosion.*

## PART FOUR – Where we are now

### The Energy Saving Trust (EST)

For a while now our industry has been discussing support from The Energy Saving Trust in connection with the many advantages of using softened water in the home. The EST insists that they will not endorse water softeners until there is a chemical inhibitor available that has been officially approved. Currently there are no standards set for chemical water inhibitors.



#### 1. INTRODUCTION

Product Group	Water Treatment	Sector	Heating
Author	Mathias Hessler		
Panel Meeting Date	22.03.2010	Version No; Date	13; 01.04.2010
Agenda Item	3.2	Status	FINAL

#### 2. EXECUTIVE SUMMARY

A general summary of this proposal	<p>This standard specifies the certification criteria for several types of water treatment products under the Energy Saving Recommended product labelling scheme.</p> <p>Water treatment products can be grouped according to their application to the <b>primary</b> heating circuit or the <b>secondary</b> heating system of a domestic heating installation. The primary circuit is the closed loop from the boiler (or other heat source) to the radiators (or other heat distribution system e.g. underfloor heating) and the hot water heating coil, and back. The secondary system is the domestic hot water system, which supplies mains water through the heat source and/or storage vessel to taps and appliances.</p> <p>Included in this standard are devices and products which:</p> <ol style="list-style-type: none"><li>1. Inhibit corrosion and/or limescale deposition within a heating system's primary circuit</li><li>2. Soften household water (primary and secondary systems)</li></ol>
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Many of the problems associated with this requirement have now been overcome. All the British Standards and guidance notes now say the same thing:

BS7593 — states the use of a correct type of inhibitor.

B56798 — states the use of a correct type of inhibitor.

BS14648 — states the use of a correct type of inhibitor.

CLG Building Regulations — states the use of a correct type of inhibitor.

### Situation as of December 2010

In early December 2010 there was a meeting of the boiler manufacturers trade association, the HHIC, at which time The UKWTA made representation on the findings we have disclosed here.

It was generally agreed that there was a requirement

for a chemical inhibitor, for heating systems, for use with all types of water, including softened. The HHIC will now be asking BuildCert (see [www.buildcert.com](http://www.buildcert.com) reference Buildcert Approval) to produce a standard to be instigated as soon as possible.

### Situation as of November 2011

Following a meeting of the HHIC it was agreed by the boiler manufacturers to support an chemical inhibitor standard for softened water - BuildCert T11 0369. This is a important move forward to seeing general acceptance of softened water in heating systems.

### 2012 update

The following was received from the UKWTA chairman in connection with official testing of softened water in heating systems:

*We are to build, with the BSi, two full-size central heating test rigs to carry out testing on all system materials. The proposal is to construct two rigs filling one with hard water and one with softened water and then evaluating corrosion over a period of time in an accelerated test simulating 12 months use under normal domestic circumstances. Efficiency of the primary and secondary circuits of the boilers will be measured at regular intervals along with weight loss on coupons (as per the Buildcert test). Proposed test duration is currently 3 months (1008 hours burner-on time) but can be extended to 6 months (2 years normal operation) after which time we would section the heat-exchangers and evaluate condition directly. BSi would validate the findings (including performance benefit of fitting water softener re energy savings) regardless of outcome. This is an opportunity to 'once-and-for-all' definitively resolve the issue of whether softened water increases corrosion in a central heating system in tests carried out by a world recognised institution.*

It was confirmed in March that the test rig was up and running. We should have the results within a couple of months.

This Aquafact sheet will be updated as more news on this subject becomes available.

Aqua-Nouveau acknowledge the assistance given by the UKWTA and Mr H Bowden in providing this information for publication.

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