Maintaining a Healthy & Efficient Domestic Heating & Hot Water System

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Introduction

Heating engineers and the work they undertake in our homes is critical to ensuring heating appliances operate safely. They provide expert, trusted advice and improve heating and hot water system records. In recent consultations, the government has recognised that energy savings can be achieved and maintained by servicing and water testing heating systems annually. This helps ensure home comfort levels, optimises the working life of appliances, hot water stores, heat emitters and other system components. It could also significantly aid decarbonisation of heating systems, which in turn will help to meet the UK net zero targets.

Benchmark now has an online platform with a smart app for mobile devices. It is a tool that records all the installation details of an appliance and has the added benefit of providing a service record. Whether the heat source is a heat pump, boiler or hybrid system, and regardless of whether it is a low or high temperature system, the annual service checks include safety, water quality, checking the inhibitor, and system efficiency. With the increasing number of heat pumps being installed, and a positive move towards low temperature systems, including those with boilers, it is even more critical to ensure the whole heating system is well maintained and optimised for maximum efficiency. Installation and maintenance of stored hot water systems are also included in the Benchmark Online records.

This guide provides guidance to installers to ensure best practices are adopted, recorded and comply with the requirements of the Building Regulations and British Standards for Water Treatment of domestic heating systems. This includes supporting system components such as filters, strainers and other devices. These are all requirements for complying with product warranties, found in appliance manufacturer instructions.

Regulations & Standards

It is well known that to ensure optimal efficiency when installing a new heat generator to an existing hydronic system, the system should be flushed and cleaned, and an inhibitor added.

Water treatment and other central heating system maintenance measures help systems perform reliably and efficiently. General requirements are outlined in Building Regulations and guidance is provided in British Standards (BS 7593 2019+A1:2024). The manufacturer's installation instructions provide more specific requirements for the appliance being installed and in most cases link to the appliance warranty. If any specific variations in water treatment methods are required, they will be detailed in the manufacturer's instructions.

The Approved Document L Volume 1: Dwellings sets out guidance on what may be accepted as one way to comply with the Building Regulations - an extract from the guidance is shown below

Building Regulations: Conservation of fuel and power: Approved Document L (England) 2021 with 2023 amendments

Hot water systems for space and domestic hot water heating

8.8 Before a new heating appliance is installed, all central heating and primary hot water circuits should be thoroughly cleaned and flushed out. A suitable chemical inhibitor should be added to the primary heating circuit to protect against scale and corrosion. In hard water areas, suitable measures should be taken to treat the feed water to water heaters and the hot water circuit of combination boilers to reduce limescale accumulation. Domestic central heating systems should be prepared and commissioned to BS 7593.

Note: The Benchmark Commissioning Checklist can be used to show that commissioning has been carried out satisfactorily for the heating and hot water system and its heat generation source.

The Building Services Guide for Scotland details what may be accepted as one way to comply with the Building Regulations - an extract from the guidance is shown below.

Domestic Building Services Compliance Guide for Scotland 2022 Edition

In both, Section 2: gas fired boilers and Section 4: Heat Pumps it states:

Commissioning

Manufacturers' instructions for commissioning and BS 7593: 2019 should be followed and a commissioning record should be completed to show compliance. Where relevant, the 'Benchmark Commissioning Checklist' can be used to show that commissioning has been carried out satisfactorily for the heating and hot water system and its heat generation source. The installer should explain fully to the user how to operate the system in an energy efficient manner, and leave behind any user manuals provided by manufacturers.

In **Northern Ireland** the Building Regulations also instruct the **Domestic Building Services Compliance Guide** should be followed

The Approved Document Part L for Wales, sets out guidance on what may be accepted as one way to comply with the Building Regulations - an extract from the guidance is shown below

Building Regulations for Wales, Part L 2010, incorporating 2022 edition incorporating 2024 amendments

System specific guidance for commissioning

Hot water systems for space and domestic hot water heating

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British Standards

During 2024, the British Standards Institute has developed and published a new standard BS 9593:2024 and published amendments to BS 7593.

BS 9593:2024 - Assessment for the performance of chemical inhibitors for use in domestic central heating and cooling water systems – Test method

This is a new standard, that replaces the NSF Industry test standard (formerly known as BuildCert) within the Chemical Inhibitor Approval Scheme (CIAS) for Domestic Hot Water Central Heating Systems. This provides installers and consumers with the confidence and protection of a British Standard and will be managed by BSi rather than the heating industry on its own. It is now referenced in the updated BS 7593:2019+A1:2024. The NSF Industry Test Standard may be withdrawn on publication of the new British Standard.

Performance of chemical inhibitor is tested in three stages:

- to determine the corrosion rate and pitting of standard metal coupons* in inhibitor solutions at the manufacturer's recommended strength
- to determine the tendency of the inhibited solution to form scale
- an evaluation of the effect of the inhibitor on non-metallic materials.

*Coupons means test samples of metals used in the testing procedure

BS 7593:2019+A1:2024 - Code of practice for the preparation, commissioning and maintenance of domestic central heating and cooling water systems

The 2024 amendments include references to the new standard BS 9593:2024, and some additional clarification updates. These include the website address for identifying local water hardness, clarity that an inline filter does not refer to a strainer, and guidance on microbiological growth in low temperature systems operating below 60°C.

Alternative methods of corrosion protection

Protecting a heating system against corrosion with an alternative method to the one given in Building Regulations should be considered with caution. If something goes wrong with the system after using a different approach, you need to make sure the method is supported in the UK by the Original Equipment Manufacturers (OEMs), as warranties can be linked to sufficient concentration of inhibitor.

References to alternative approaches that are published outside the UK can be found in some manufacturer's heating product instructions and often address closed systems as a method to avoid scale and corrosion. One option is where the final post-clean fill water supplied is demineralised water, deaerated and pH controlled, and only demineralised water is used to top up throughout the system's life.

This approach may reduce or avoid the need for dosing with corrosion inhibitor chemicals but may require additional system components, specified at the design stage, to manage demineralised water and with ingress of oxygen into the system.

This guidance document does not cover the measures required to achieve and maintain compliance using alternative methods to BS7593 and the Building Regulations. If pursuing an alternative method of compliance with the Building Regulations, further advice should be sought for specialist manufacturers, suppliers and installation of associated equipment.

Benchmark

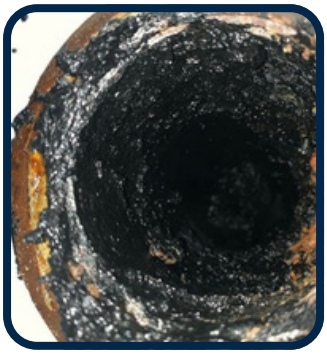
Benchmark has been in existence in the heating sector for many years in paper form. It is well known to heating engineers and is supplied with manufacturer installation instructions for completion during installation. This provides a critical record of the installation, commissioning and ongoing service record for the customer, installer and manufacturer. It is now in digital and online format with a smart App for mobile devices. The paper versions will be withdrawn as each manufacturer goes live with the online version. Benchmark Online is continually being improved and developed, and now includes heat pumps, boilers, hot water storage, hybrid systems, and low and high temperature systems. It is referenced in Building Regulations and schemes such as MCS.

Checking and recording inhibitor levels is a mandatory requirement in Benchmark, as it has a major impact on system efficiency and can adversely affect manufacturer warranties, should issues arise. Correctly recorded inhibitor information will assist heating engineers during annual servicing and maintenance visits, so they can identify the inhibitor in the system, use the correct onsite test kit and top up concentration levels if needed.

Symptoms that can affect heating system efficiency and performance

Heating systems consist of a range of different metals and non-metallic materials, for example: heat exchangers, pumps, pipework, cylinders, radiators, fittings, valves, seals. These can be subject to air ingress, whether through failed connections, radiators being drained during redecoration or other circumstances that arise, which can lead to corrosion and sludge deposits.

Cold water supplies to properties vary across the UK, as they come from different sources, with different pH and hardness levels, and this can also affect the potential for corrosion and scale formation. The move towards lower temperature systems increases the possibility of microbiological growth, which also needs to be addressed.



Air Source Heat Pumps – Why should I carefully consider system preparation?

As the UK transitions from fossil-fuel boilers to electrically driven heat pumps, it is important to ensure high quality system water is maintained. Heat pumps internal components, such as plate heat exchangers, have much narrower waterways than traditional boilers, which makes them more susceptible to blockages from dirt and debris in the system water. Any decline in performance due to poor system water quality can quickly lead to reduced efficiency and increased running costs.

Heat pumps typically operate with higher primary flow rates than boilers, increasing turbulence in the system. This may dislodge any residual debris even where the system has been thoroughly cleaned, and it is not unusual for strainers and filters to become blocked shortly after commissioning.

Following BS 7593 is a suitable way to mitigate these risks and ensure long-term performance and reliability of heat pump systems. New and existing systems should be thoroughly flushed and cleaned before installation. Both a strainer and system filter should be fitted to capture debris. In addition, inhibitors, glycol and biocides, should be applied where necessary and in line with the equipment manufacturers instructions.

Simple Step By Step Approach

Changes to BS 7593 introduced in 2019 laid out requirements to test the water throughout the life of the heating system. This commences with commissioning and testing the water to ensure the system water is clean, and then add adequate top up levels of inhibitor during the annual heating appliance service.

In addition to an annual system water check, the whole system should either be re-dosed at five-year intervals, or a lab test carried out to assess the quality of the water.
To comply with BS 7593:2019+A1:2024 the following steps are a best practice approach to water treatment.

It is good practice that any new appliance should not be connected to the systems until the system has been cleaned. Appliance manufacturer and critical system component instructions should also be checked with regard to isolation of the appliance or components if they are likely to be sensitive to different flushing and cleaning products and techniques. To comply with BS 7593:2019+A1:2024 the following steps are a best practice approach to water treatment.

Step 1 Cleaning: Add a cleaner suitable for use in heating and cooling systems, checking with heating appliance manufacturer's instructions, and allow it to circulate, so it loosens debris within the heating system. This provides an opportunity for identifying any system components that may require replacing/upgrading to futureproof for low temperature systems, such as radiators, balancing TRVs and hot water cylinders.

Step 2 System Flush: A range of methods are detailed further in this guidance

Step 3 Install an inline filter: A requirement since 2019, providing clarity on difference between an inline filter and a strainer.

Step 4 Protect: Add an inhibitor that has passed BS:9593 Testing requirements, following the appliance manufacturer and inhibitor guidance and allow it to circulate through the system. For low temperature systems the use of an antifreeze and biocide should be considered

Step 5 Test: Use an onsite test kit that is suitable for the chosen inhibitor to test the inhibitor level.

Step 6 Maintain: Annually test inhibitor levels, recording on Benchmark Online; every five years either carry out a full laboratory test or re-dose with the inhibitor.

Benchmark records are critical to informing heating engineers on the inhibitor products that's within the system.

Cleaning and Flushing Options

There is a range of methods for cleaning and flushing contaminants and debris from the system. Removing this will have a major impact on the system by improving its efficiency performance and the longevity of appliances and system components. The following methods are well understood within the heating industry.

Reaching all parts of the system by isolating radiators one by one to ensure they are properly flushed through, gives the most effective outcome. In some instances, for example in older systems where sludge has already developed, radiators may need to be disconnected and flushed through individually. Alternatively, a cleaner suitable for treating heavy sludge may be used.

Power Flushing

High flow, low pressure systems with reversible flow technology creates agitation and turbulence when using a power flushing machine and cleaning chemicals. Combining with an inline filter provides maximum effectiveness

Mains Pressure Clean and Flushing

Clean with heating cleaning chemicals at operating temperature, then follow with a mains pressure flushing procedure

Clean and Flushing using gravity

Clean only with cleaners suitable for heating and cooling systems, followed by repeated draining and flushing.

On-line cleaning

This is an alternative method that is more typically used in multi property developments and commercial applications. It can be used in individual residential properties, though is less appropriate for a small system which can easily be flushed and drained (without permit) and refilled (in minimal time).

On-line cleaning chemicals combined with non-flush cleaning devices or existing system magnetic filters allow heating systems to be cleaned online, reducing the wastewater and the discharge of chemicals into the wastewater network.

On-line cleaning using the system pumps and system filter

On-line treatments and inhibitors are introduced into the system and are then circulated for a period at operating temperature. Magnetic and non-magnetic filter elements on the system filter should be cleaned at the end of the process. Systems can be left unattended in cleaning mode and operating normally for several weeks if required, reducing disturbance to the residents.

On-line cleaning using a temporary pumped high efficiency filter device

The equipment is connected to the system, often in place of the system filter or the system circulation pump. The cleaning device will enable higher velocity water to be circulated, which reduces the cleaning time. The filter device circulates all the system water through magnetic and non-magnetic filter mediums. On-line cleaning chemicals and inhibitors are dosed to the system and circulated for a period. Once the clean is complete the filter device is removed, pumps and/or system filters are replaced and the system is left operating as normal.

Cleaning gives the heating engineer the opportunity to assess the system’s performance and identify whether heat emitters and system pipework could be upgraded ready for a lower temperature system.

Clear guidance on the cleaning and flushing options, process and considerations is detailed in BS 7593:2019+A1:2024.

Inline Filters & Strainers

It is important to understand the difference between filters and strainers. Filters are designed to remove sub-micron level particles such as iron oxide, known as magnetite. Some filters use strong magnets to capture the sub-micron particles; non-magnetic filters are also available. Sub-micron particles are extremely small and cannot be captured in a strainers mesh.

Strainers separate and collect system debris, and usually involve some form of mesh that prevents debris passing though, allowing it to fall to the bottom of the device. Devices with a hydro cyclone effect to increase the separation of debris are also available. The differences have been clarified in the 2024 amendments to BS 7593:2019+A1:2024.

Filters should be installed on the return to the heating appliance, allowing enough room to access the filter for removal and servicing. They should be checked and cleaned during every service visit. Filters also provide a convenient way to test inhibitor levels and top them up as required.

Heat pump manufacturers typically require a strainer to be installed in the system to protect the narrow water ways in components such as the plate heat exchanger from debris and particulate contamination. Tight tolerances mean that even small amounts of debris can restrict flow, leading to reduced system performance or potential damage. To prevent blockages and maintain optimal flow rates, strainers and filters should be inspected and cleaned during commissioning, and then checked again shortly after the system has been in use. Strainers and filters should also be regularly inspected and cleaned as part of the ongoing service routine. These steps will help ensure reliable operation.

Water Treatments

The manufacturers' instructions for both appliances and chemicals must be adhered to, to ensure appropriate products are selected. Water Treatment products from different manufacturers should not be mixed unless the appliance manufacturers' instructions advise otherwise.

Limescale prevention

Hardness of water varies across the UK, and in hardwater areas, this can lead to limescale forming within appliances and pipework. In these geographical areas, it is important that measures are taken to treat, either to the incoming cold water supply for the whole property or to each individual water-using appliance. Measures are required where incoming water hardness is greater than 200ppm. Scale formation can significantly reduce the performance and longevity of heating appliances and cylinders, and without protection against water hardness, the manufacturer's warranty is likely to be affected.

One or more of the following methods can be used to alleviate limescale:

Polyphosphate Dosing
Inline scale reducers
Reverse Osmosis
Inline filtration
Water conditioning

Note: Specific standards include:
BSEN 14743 – Water conditioning equipment inside buildings. Softeners. Requirements for performance, safety and testing
WRAS IGN 09-07-01 Information for Installation of Ion Exchange Water Softeners for Systems Supplying Water for Domestic Purposes

Chemical Cleaners

Flushing with water can help clear loose debris; however chemical cleaners are much more effective for clearing debris, sludge and scale formation. Where acidic cleaners have been used to remove limescale, the system will need to be thoroughly flushed.

Chemical Corrosion and Scale Inhibitors

Corrosion inhibitors, sometimes known as corrosion protectors, safeguard heating systems against the formation of sludge and scale build-up. Having cleaned and flushed systems, either during installation commissioning or annual system maintenance, it is important to add a corrosion inhibitor or an inhibited antifreeze where required to prevent and minimise the build-up of sludge that will affect system efficiency and increase potential for faults and breakdowns. The Building Regulations now advise you should apply BS 7593 to comply with the must of maintaining energy efficiency, and that the system is dosed with an inhibitor and the concentration is maintained, and advising this should be recorded in Benchmark (now online.)

Microbiological and Biocide Treatments

This has been a consideration for underfloor heat emitter systems and open vented systems with low flow or stagnant water for many years. With the increase in low temperature systems operating below 60°C, such as with heat pumps and underfloor heat emitter systems, this is an increasing priority. Systems that operate below the pasteurisation temperature can lead to bacterial growth, slime and microbial induced corrosion within the heating system.

Alternative methods of disinfection procedures can be introduced, for example the use of an Ultraviolet (UV) lamp.

Leak Sealers

Heating systems can suffer from pressure losses and air ingress through minor weeps in joints and pitted pipework and the ingress of air provides the potential for corrosion. These leaks are often in difficult to locate areas, such as under floors, or within buried pipework etc., so these products can often help in challenging situations where it is difficult to make repairs. However, the preference should always be to locate and carry out permanent repairs where possible.

Water Testing and Maintenance

Onsite annual testing and monitoring of the concentration levels of chemical additives is an important requirement for ongoing system health and efficiency. Benchmark can help the heating engineer to identify the chemical product in the system. They can then use the appropriate test kit available from chemical manufacturers, to carry out annual testing, top up as required and record the results on Benchmark Online.

Laboratory Testing is an alternative option available from chemical manufacturers that can provide more detailed and accurate analysis of the system water, perhaps where ongoing corrosion issues are found. These tests are also often undertaken as part of maintenance contracts with housing associations and local authorities.

Air Source Heat Pumps - Anti-Freeze and Anti Freeze Valves

Monobloc heat pumps use a water-based system to transfer heat from the outside unit to the internal heating system. Traditionally they use water and anti-freeze (glycol) plus biocide mix to prevent damage to the heat pump and systems components when the temperature drops below freezing.

A recent development providing an alternative approach is the introduction of anti-freeze valves, which avoid the need for a glycol-based anti-freeze mix. The valve is designed to protect the heat pump system from freezing and automatically opens and allows system water to partially drain in extreme cold conditions.

When choosing anti-freeze valves, consider that in the event the valves activate the system will need topping up and resetting afterwards to restore correct system pressure and operation. System pressures should be checked as part of the on ongoing service routine to ensure long term reliability.

Water Disposal

It is incumbent on everyone involved with cleaning and flushing systems to avoid and minimise water wastage and consider environmental impacts and regulations regarding chemicals.

Whilst individual residential properties may fall below the limits for wastewater discharge permit approval, large multi-property developments, apartment complexes and housing estates when cleaned and commissioned during a set period may reach levels that require a wastewater discharge permit.

It is advisable to seek the permission of the property owner before discharging heating system water to foul drain and in certain circumstances the local authority, or utility company should be notified.

Heating systems that include biocides must not be flushed and discharged to surface water drainage or septic tank systems and reed beds.

Wastewater treatment companies may have their own, unique policies area by area; however in practice the following approach by heating engineers has proved acceptable.

- Concentrated chemicals (glycol or otherwise) should always be disposed of via a licensed contractor
- Chemicals (including mono-propylene glycol OR mono-ethylene glycol), which are at in-use ‘dilute’ levels within domestic systems, can be disposed of via the foul drain

Summary

Cleaning and flushing heating systems when installing new appliances or during servicing is more important than ever to maximise system efficiency, achieve lower energy bills, reduce carbon emissions and increase the longevity of heating appliances and system components.

Education, training and applying best practices are essential, and with the introduction of lower temperature heating systems, regardless of whether the heat source is a boiler or heat pump, the cleaning, flushing and testing of the heating water systems is an annual requirement. Using Benchmark Online to record this critical information will be beneficial to the householder, heating engineers and manufacturers.

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