IWTM UK LTD — SUMMARY VDI 2035

VDI 2035, PART 1

GUIDELINE FOR PREVENTION OF DAMAGE IN WATER HEATING INSTALLATIONS.

ORIGINAL DOCUMENT PUBLISHED BY THE SOCIETY OF GERMAN ENGINEERS

SUMMARY BY IWTM UK LTD

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VDI 2035 SUMMARY

IWTM UK'S COMPREHENSIVE CHEMICAL-FREE WATER TREATMENT (CFWT) APPROACH TO HEATING SYSTEM CORROSION PREVENTION

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IWTM UK Ltd — Summary VDI 2035
VDI 2035, Part 1

Guideline for Prevention of Damage in Water Heating Installations.

Original document published by the Society of German Engineers

Summary by IWTM UK Ltd

1) Preliminary Remarks and Background

VDI 2035, Part 1, published in March 2021, is *the* authoritative guideline in Europe for the prevention of damage in water-based heating systems. The inclusion of more detailed water requirements, concerning VDI 2035, is the most significant change to the European Standard EN 12828. This change is an indication of the growing awareness, among hydronic heating professionals in Europe, of the causes of corrosion and the means of corrosion prevention.
This guideline applies to all water heating installations inside a building where the flow temperature under normal conditions is not intended to exceed 100°C (212°F).

2) Corrosion Prevention Basics

The likelihood of corrosion damage is low when the following parameters are met.

- Proper planning and commissioning
- Proper sealing of the system from oxygen entry
- Proper design of the pressure control system
- the requirements according to VDI 2035 Part 1 for filling and make-up water and for heating water are complied with and regularly checked
- Routine maintenance

The composition of the heating water is of central importance for scaling, corrosion, and its prevention. The main influencing factors of scaling and corrosion are as follows.

1. Dissolved Oxygen present in the water
2. Electrical conductivity
3. pH
4. The total quantity of alkaline earths

For the prevention of damage, these are the principal factors that need to be controlled. The guide values given in the guide must be complied with.

3) Scale Formation

When water containing calcium and hydrogen carbonate ions is heated, scale formation (the deposition of calcium carbonate – CaCO3) can occur.

$Ca^{2+} + 2\ HCO_3^- \rightarrow CaCO_3 \downarrow + CO_2 \uparrow + H_2O$

Crucial factors in the extent of scale formation are
- water quality,
- the quantity of unconditioned filling and make-up water,
- wall temperatures at the heat-transfer surfaces and those of the rest of the system, and
- operating conditions

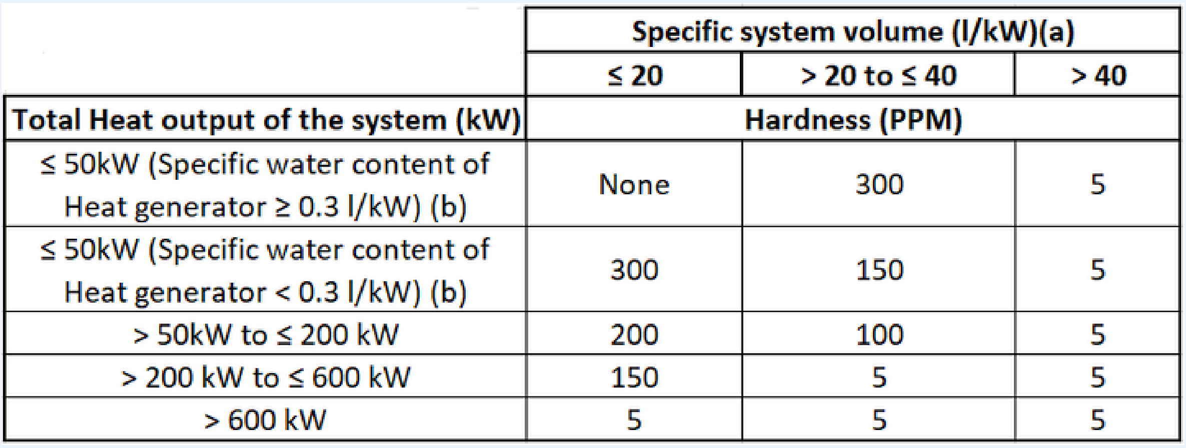
In contrast to corrosion, material properties only play a minor role in scale formation.

A) Effects of Scale Formation

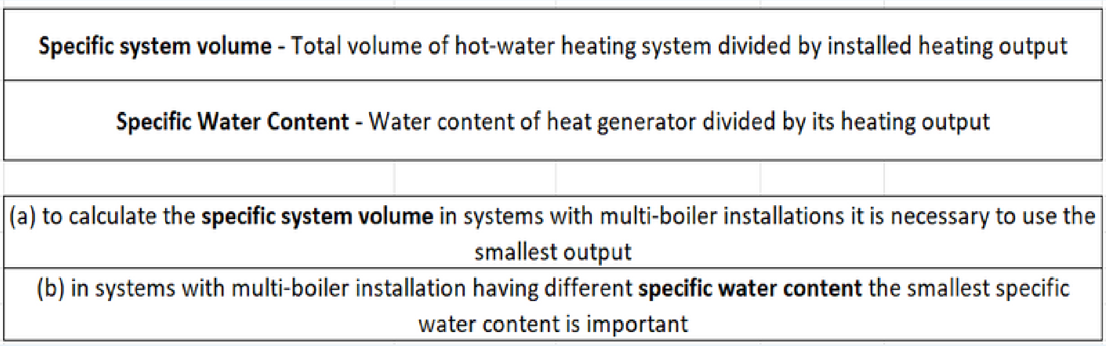
Because of scale formation, heat transmission in heat generators in hot-water heating systems is reduced by these scale deposits. Local overheating and consequent cracking as well as boiling noise may occur at directly heated heat-transfer surfaces. Scaling can also lead to a cross-sectional reduction and an increase in flow resistance. Heat output decreases because of these effects. Due to the nature of the system, the heat-transfer surfaces of the heat generators are the places with the highest temperature load and thus the places preferred by scale formation.
The water-side constrictive measures can reduce the potential for scale formation, i.e., conditioning the filling and make-up water.

B) Requirements of Water Hardness

Guide values for the filling and make-up water and heating water (in CaCO3)



	Specific system volume (l/kW)(a)		
	≤ 20	**> 20 to ≤ 40**	**> 40**
Total Heat output of the system (kW)	**Hardness (PPM)**		
≤ 50kW (Specific water content of Heat generator ≥ 0.3 l/kW) (b)	None	300	5
≤ 50kW (Specific water content of Heat generator < 0.3 l/kW) (b)	300	150	5
> 50kW to ≤ 200 kW	200	100	5
> 200 kW to ≤ 600 kW	150	5	5
> 600 kW	5	5	5



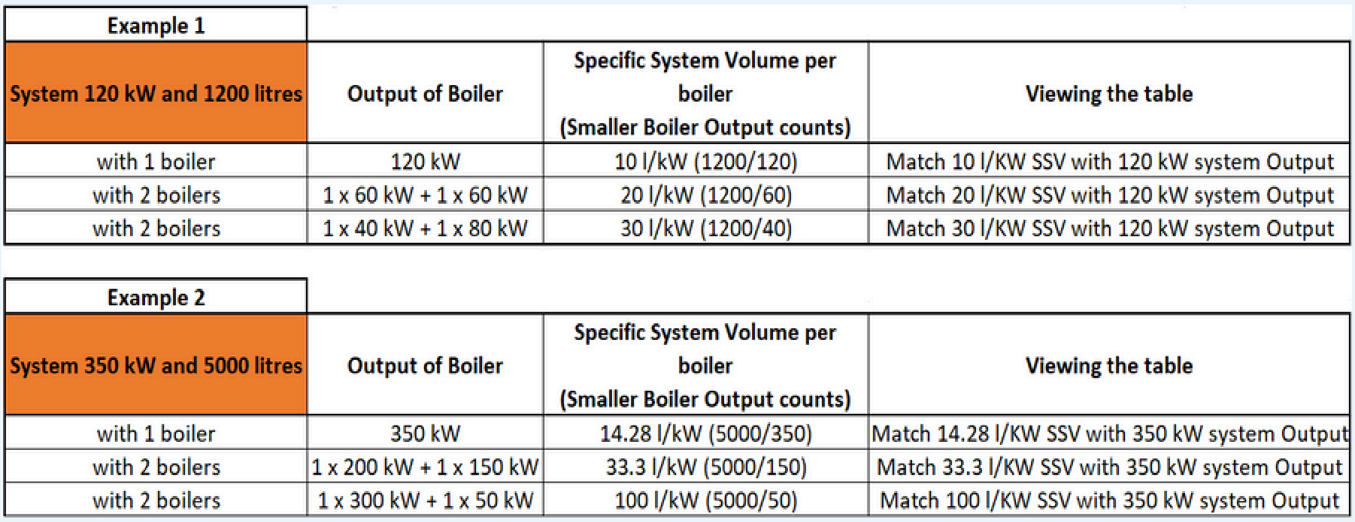
Specific system volume - Total volume of hot-water heating system divided by installed heating output

Specific Water Content - Water content of heat generator divided by its heating output

(a) to calculate the **specific system volume** in systems with multi-boiler installations it is necessary to use the smallest output

(b) in systems with multi-boiler installation having different **specific water content** the smallest specific water content is important

C) Water Hardness requirement calculations - Examples



Example 1			
System 120 kW and 1200 litres	**Output of Boiler**	**Specific System Volume per boiler (Smaller Boiler Output counts)**	**Viewing the table**
with 1 boiler	120 kW	10 l/kW (1200/120)	Match 10 l/KW SSV with 120 kW system Output
with 2 boilers	1 x 60 kW + 1 x 60 kW	20 l/kW (1200/60)	Match 20 l/KW SSV with 120 kW system Output
with 2 boilers	1 x 40 kW + 1 x 80 kW	30 l/kW (1200/40)	Match 30 l/KW SSV with 120 kW system Output

Example 2			
System 350 kW and 5000 litres	**Output of Boiler**	**Specific System Volume per boiler (Smaller Boiler Output counts)**	**Viewing the table**
with 1 boiler	350 kW	14.28 l/kW (5000/350)	Match 14.28 l/KW SSV with 350 kW system Output
with 2 boilers	1 x 200 kW + 1 x 150 kW	33.3 l/kW (5000/150)	Match 33.3 l/KW SSV with 350 kW system Output
with 2 boilers	1 x 300 kW + 1 x 50 kW	100 l/kW (5000/50)	Match 100 l/KW SSV with 350 kW system Output

4) Causes of Corrosion

Corrosion is an electrochemical process whereby two partial reactions occur concurrently.

$Me \rightarrow Men^{+} + n\ e^{-}$ (Anodic partial reaction)

$O2 + 2\ H_2O + 4\ e^{-} \rightarrow 4\ OH^{-}$ (Cathodic partial reaction)

In the anodic partial reaction, the dissolution of the metal (Me) produces metal ions and electrons. These liberated electrons are consumed during the cathodic partial reaction. If the anode and cathode stabilize in different locations, as is typical in hydronic heating systems, the result is local corrosion.

The following corrosion phenomena and corrosion damage can be found:

- malfunctions and failure (corrosion failure) of components (for example, pumps, valves)
- internal and external leakages (for example, from heat exchangers)
- reduction of cross-sections and blockage of components (for example, heat exchangers, pipes, pumps)
- gas-bubble and gas-cushion formation
- Impairment of heat transfer (formation of coatings, deposits)
- noise (for example, boiling noise, flow noise).

Water quality is of crucial importance in corrosion. A suitable water quality and a proper mode of operation can reduce the likelihood of corrosion damage.

A) Oxygen

Corrosion reactions in hydronic heating systems are primarily determined by the presence of oxygen in the heating water. Dissolved oxygen consumes the electrons formed in the anodic partial reaction and the reduction of dissolved oxygen becomes a cathodic partial reaction, enhancing the corrosion processes. Thus, oxygen concentration in the heating water should be kept as low as possible. A constant or intermittent oxygen entry should be avoided.

Oxygen virtually always enters the system during filling procedures. This is because normal tap water contains approx. 8-11 mg of dissolved oxygen per liter of water. However, this gets used up (through corrosion processes) within a short period without significant damage occurring.

Oxygen can enter the heating water circuit on the one hand as a natural component of the ambient air and on the other hand with the filling and make-up water as dissolved gas.

Influencing factors are:

- partial under-pressure formation in the system
- inclusion of air during filling and refilling operations
- entry of oxygen via direct contact of the water with the air
- diffusion through permeable components (for example, seals, plastic pipes, membranes, hoses)
- the oxygen content of the filling and make-up water

If negative pressure arises consistently in the system, corrosion damage due to large quantities of oxygen will be virtually unavoidable.

If automatic top-up systems are used, they should be adequately monitored so as not to allow overly high top-up quantities.

B) Electrical Conductivity

Electrical conductivity is another factor that influences corrosion in hydronic heating systems. As a rule, lower conductivity decreases the potential for corrosion to occur as corrosion reactions happen faster in a high-conductivity environment.

Dissolved oxygen and conductivity are inversely related such that at a lower conductivity level, the system can tolerate comparably higher oxygen levels without increased corrosion occurring. Similarly, at a high conductivity level, the system will experience corrosion, even at a relatively low oxygen level.

It is always recommended to have low levels of Oxygen and Electrical conductivity in the fill, top-up, and heating water.

C) pH

The third factor that drives corrosion is pH value. The pH value is a dimensionless measure of the acidic, neutral, or alkaline reaction of the water. An alkaline pH is advantageous to most metals in hydronic systems (except for aluminum and aluminum alloys, which have a slightly reduced recommended range). Other factors like bacterial processes and carbon-dioxide entry into the system can affect the pH value and care should be taken when significant pH changes are observed.

5) Corrosion Damage

A heating system will typically be composed of metallic and non-metallic components. Failure or damage of one given component may cause further damage elsewhere in the system.

Therefore, understanding of interactions between water parameters and system materials helps heating professionals prevent, properly diagnose, and fix problems.

All metals—except for gold, platinum, and palladium—naturally experience corrosion. However, several metals used in hydronic heating systems can form protective layers or films that help protect them from further corrosion.

These films are formed through corrosion processes – oxidation of the metal. But once a film completely covers the surface of a metal, if it is undisturbed, the film will normally protect the underlying metal from further corrosion. However, protective films of various materials have optimum resistance under differing chemical conditions. Copper, for example, integrates easily into hydronic heating systems, while aluminum components require special consideration.
Corrosion itself is an electrochemical process, and as such occurs in electrochemical cells, involving an anode and a cathode. One location can function as an anode and another as a cathode primarily due to local differences in the composition of the material as well as water chemistry conditions (dissolved O2 content, pH, or other factors). Anodic and cathodic locations can also occur within the same piece of metal when thermal or mechanical stress is applied. The greater these local differences, the greater the electrode potential, and therefore the greater the potential for local corrosion. Uniform corrosion, however, may be much less damaging, and may not necessarily affect the lifetime of a system. The rate of corrosion is also influenced by electrical conductivity. Low electrical conductivity impedes the flow of charged particles necessary for corrosion; high conductivity facilitates the process.

Protective layers of metals can be damaged by both chemical and physical processes—e.g. low pH, vibration, high flow, and thermal stress. Too much oxygen can also prevent the normal formation of the protective film. Defects in the protective film permit local corrosion to the damaged area.

Due to the natural process of a galvanic cell (i.e. an electrochemical cell involving an anodic site and a cathodic site), the corrosion current will always be focused on the weaker, damaged area. This is the site where pitting will occur.

Non-metallic materials typically fail either due to incorrect handling during installation (e.g. insufficient sealing pressure), overstretching of polymers due to thermal expansion, improper material selection, or chemical factors such as excessively high pH or addition of chemical inhibitors.

A) Unalloyed and low-alloyed ferrous materials
Unalloyed and low-alloyed ferrous materials (black steel, carbon steel, cast iron) corrode when they are in the presence of both water and oxygen. The resulting corrosion product is an iron oxide—most typically either iron (III) oxide (Fe_2O_3) or magnetite (Fe_3O_4). Corrosion to iron is determined primarily by oxygen content in the heating water. In the case of intermittent entry of oxygen into the system, red-brown iron corrosion products are the result.

The most common type of corrosion for low alloyed ferrous materials is local pitting, where trough-shaped areas form and are covered or surrounded by corrosion by-products. These corrosion by-products may cause further harm to the heating system by clogging underfloor radiant tubing and fittings, harming circulators, or depositing in the boiler, which causes boiler damage—in particular to heat exchangers and pumps.

Galvanized steel is unfavorable in hydronic heating systems because the zinc coating easily flakes off at temperatures over 60°C, and, when dissolved in water, behaves like a water hardener.

When using unalloyed and low-alloyed ferrous materials, oxygen should be kept as low as possible, and pH should be maintained between 8.2 and 10, with an optimum pH range of 8.5- 9.5. Low salt content will also help to inhibit corrosion.

B) Copper and copper alloys

Copper and various brass (copper-zinc) alloys are largely resistant to corrosion damage as long as the oxygen content is low. Within this pH range, and in the presence of low oxygen levels, copper typically forms copper oxide (Cu2O), which functions as a protective layer against further corrosion.
At flow rates (or local turbulent zones) exceeding 2 m/s, erosion to copper may occur. This form of corrosion, however, is most common in conjunction with a constant supply of oxygen.

Copper alloys can also be vulnerable to stress corrosion cracking if tensile stresses exist in combination with the presence of nitrogen compounds, such as ammonia (NH3) or ammonium (NH -). These compounds may be formed by the reduction of nitrate by nitrate-reducing bacteria (NRBs).

Brass (as a copper-zinc alloy) may be subject to dezincification under certain water conditions. This occurs primarily in water containing oxygen. However, in areas of low pH, selective corrosion to zinc can occur even in the absence of oxygen. Dezincification causes a substantial loss in the strength of the metal.
In systems with a constant supply of oxygen, the damage is observed when sulphides are present. Hydrogen sulphide (H2S) can convert normal copper oxide films (Cu2O), which offer protection against corrosion, to copper sulphide films (Cu2S), which offer no such protection. Copper sulphide films take the form of a black crystalline covering. Sulphides may occur in the system either as a result of sulphate ions in the fill water, through microbial processes of sulphate-reducing bacteria, or chemically (for example, through introducing the oxygen-scavenging agent sodium sulphite—Na2SO3). Sodium sulphite causes the formation of hydrogen sulphide, which increases the likelihood of corrosion.

If water samples containing sulphides are mixed with dilute acid, they will produce a characteristic odour of rotten eggs.

C) Aluminium and aluminium alloys

Corrosion to aluminium is primarily determined by the pH value of the heating water. In the presence of water within the pH range of 7.5-9.0 aluminium can form a protective layer of aluminium oxide, which protects the underlying metal against further corrosion. This layer is broken up, however, in acidic water with a pH below 7 or alkaline water with a pH above 9.

Systems containing aluminium are best operated at a low saline level (demineralisation - electrical conductivity <100µS/cm) and without the use of chemical inhibitors. If aluminium is used in conjunction with other metals, such as steel and copper, the recommended pH of system water is 8.2-9. Since maintaining this pH range will likely be unfeasible, low electrical conductivity is recommended to limit corrosion damage.

Flow velocities >2m/s may also cause erosion to aluminium.

D) Stainless steel
Due to their chromium content, stainless steels typically form a chromium oxide film in the presence of water and oxygen, which protects against further corrosion of the metal.

Common stainless steel alloys experience corrosion in water with a high concentration of chloride ions. This can lead to pitting corrosion, or, in conjunction with tensile stress, to stress-corrosion cracking.

Only certain stainless steels which contain molybdenum and austenitic-ferritic duplex steels, are resistant to damage in the presence of water with a relatively high chloride content.

E) Plastics and Seals
Oxygen molecules (O2) are small enough to diffuse directly through polymer chains in standard plastic and rubber. Due to the difference in partial pressure on either side of the plastic tubing, oxygen from the outside air will seek entry into the heating water. Thus, oxygen entry through plastic components should be restricted as much as possible. Temperature changes can affect the solubility of oxygen in the heating water—gases being more soluble in water at lower temperatures—however, it is the difference in partial pressure that drives oxygen diffusion. This is in accordance with Henry’s law. An oxygen barrier is therefore recommended.

If seals are incorrectly selected or improperly fitted, water in the sealing area will escape from the system. Since the leak will be slow, water will evaporate upon escaping, which leads to the accumulation of water constituents at the outside edge of the seal. This can lead to corrosion from the outside.

Seals and packings are vulnerable to excessive alkalinity of system water, therefore a pH level above 10 should be avoided. Elastomers and plastics can also be damaged by chemical inhibitors, coating amines, and oil-like substances.

The use of coatings, such as zinc or epoxy resin, or enamelling, is not recommended.

F) Galvanic Corrosion (contact corrosion)
In mixed installations, involving different types of metals in contact with one another, galvanic corrosion may take place in systems that are not closed as regards corrosion. This occurs when two different metals are in direct contact in the presence of both oxygen and a fluid to carry ions (called an electrolyte). This form of corrosion is driven by the difference in electrode potential between two different metals. When the metals come into contact, the less noble metal acts as an anode, giving up electrons and corroding at an accelerated rate. The more noble metal functions as a cathode, consuming electrons sent from the anode and being thus protected from the process of corrosion.

The probability of damage due to galvanic corrosion decreases as water becomes less conductive. Low electrical conductivity is therefore advised. In general, the oxide of any given metal will be more noble than the base material. For this reason, any defects or breaks in a protective metal oxide film will create a galvanic cell—the metal oxide functioning as a cathodic site and the exposed metal functioning as an anodic site. This causes local corrosion to the metal.
Note – Pressure maintenance systems which include expansion vessels with a membrane are an example of such a mixed installation. If the oxygen content of 0.10 mg/L is maintained in pressure maintenance devices downstream of the point of supply in the circulating heating water, the likelihood of corrosion in downstream components is low.

G) Gas bubbles and gas cushions

Gas bubbles arise at locations of lowest pressure (e.g. the highest point of the installation) or highest temperature (e.g. heat generators). They are then transported to locations with low current velocity, where they can interrupt water circulation and, due to their low thermal conductivity, hinder heat transfer. This causes reduced output, loud noise, and areas of local overheating.

H) Biofilms and microbially influenced corrosion (MIC)

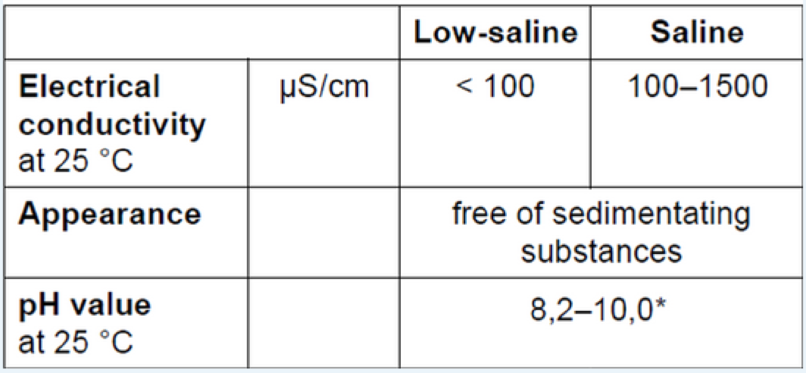
Water-carrying systems will always contain micro-organisms, which are embedded in layers of extracellular polymeric substances that hold them together and bind them to the surfaces, called Biofilms.

Biofilms form at the interfaces and bind water, can accumulate salts, locally change the pH value by several levels, and in this way interfere massively in corrosion processes. This effect is known as microbially influenced corrosion (MIC).

In practice, biofilm formation and MIC can only be reduced by reducing the supply of nutrients to bacteria.

6) Corrosion Protection

To prevent damage from corrosion, the three fundamental parameters of water composition— dissolved oxygen content, electrical conductivity, and pH—should be controlled.
Oxygen content and electrical conductivity are related such that lower conductivity permits relatively higher O2 without additional corrosion. Similarly higher conductivity may allow for corrosion damage even at relatively low O2 levels. As such the following guidelines are recommended:



		Low-saline	**Saline**
Electrical conductivity at 25 °C	µS/cm	< 100	100–1500
Appearance		free of sedimentating substances	
pH value at 25 °C		8,2–10,0*	

*For systems with Aluminium alloys; Low-saline operation and pH value 8.2- 9.0 is recommended.

A) Prevention of Oxygen entry

Care should always be taken to limit oxygen entry as much as possible. Normal air contains approximately 78% Nitrogen and 21% Oxygen. However, O2 molecules are smaller and permeate faster than N2. The concentration of O2 in normal water is 8-11 mg/l. This concentration is approximately 100 times higher than maximum O2 levels in low-saline operation, and approximately 500 times higher than maximum concentration in saline operation.
It is recommended, therefore, that systems first be sealed from large-scale oxygen entry. If oxygen entry is inevitable, other solutions must be sought. Physical air-removal devices are not highly effective, often permitting aeration as well as air removal.

B) Recommendations for Electrical Conductivity

Electrical conductivity—often equated with ‘salinity’—is a measurement of water’s ability to transport charged particles. Since the electrochemical process of corrosion consists of a movement of ions through water, electrical conductivity is essentially a measurement of the potential rate of corrosion. Conductivity should therefore be kept as low as possible.

Conductivity is primarily determined by the mineral content of the fill water. However, any additives, such as oxygen scavenging agents, will increase the conductivity of system water.

A measurement of electrical conductivity is distinguished from a measurement for ‘hardness’ in that conductivity takes into account all ions in a given sample, while ‘hardness’ only considers cations that cause scaling, such as calcium. Demineralisation of water will *also* inhibit the formation of scale, as it removes all mineral ions, including those that cause scaling. Water softeners, which exchange so-called “hard ions” such as Ca2+ and Mg2+ with softer ions such as Na+ or K+, reduce scaling but do not necessarily reduce electrical conductivity, and are therefore not suitable as a means of treatment for prevention of corrosion.

Note: Oxygen-free water tends to absorb atmospheric oxygen from its surroundings. This is due to the atmosphere “pressing” the gas molecules into the system, in accordance with Henry’s Law. However, this phenomenon only applies to gases. Systems using demineralised water are consistently observed to exhibit improved resistance to corrosion, and demineralisation is therefore recommended for fill water whose conductivity exceeds 100µS/cm.

C) Recommendations for pH

The pH value of heating water should be slightly alkaline—that is, within the range of 8.2-10 (at 77°F). However, in most cases, there is no need to alkalinise filled water. This is because of the natural process of self-alkalinisation, which is consistently observed in hydronic systems. Due to this process, system water should stabilize within the recommended range of 8.2-10 within a few weeks of operation.

When evaluating pH, heating professionals should take into account the metals used in a system. If aluminium is present, pH should ideally not exceed 9.0, to avoid corrosion damage to aluminium.

The pH value of system water may drop because of insufficient rinsing of antifreeze agents or from the addition of chemicals (e.g. ascorbic acid). If system water fails to self-alkalinize after 2-3 weeks, it should be tested after 8-12 weeks. If the pH value is still below the recommended range, contractors should alkalinize water by some other means. This may be achieved by the insertion of a sacrificial anode into the system, or using chemical alkalinizing agents. In the latter case, contractors should note that overdosing with trisodium phosphate will further mineralize water and create sludge. Alkalinization with ammonia or ammonifying compounds should also be avoided, due to the added risk to copper and copper alloys.

D) Chemical Treatment and Corrosion inhibitors

Water treatment involving chemical additives should be restricted to rare and exceptional cases. Corrosion inhibitors raise the conductivity of system water and, in the event of overdosing or underdosing, lead to additional corrosion. Underdosing can cause pitting corrosion. Overdosing can damage elastomeric materials, such as the diaphragms of expansion tanks, as well as face seals at pumps. It can also cause deposits, resulting in clogging, and can accelerate the formation of biofilms, which cause further corrosion.

The use of sodium sulphite as an oxygen-scavenging agent puts copper at special risk due to the formation of sulphide ions and the increase in conductivity. Hydrazine is highly toxic and should not be used. Organic oxygen-scavenging agents should be avoided since they contribute to the formation of biofilms.

The use of antifreeze agents does not fall within the scope of this guideline.

E) Electrochemical Treatment

Electrochemical devices use the least noble metals as sacrificial anodes. Such devices should be located downstream from the point of oxygen entry and should receive constant through-flow.

When ‘active’ metals (such as magnesium or zinc) are used, the device should allow for by-products of the anodic reaction—e.g. magnesium oxide—to be trapped and removed.

F) System Design, Planning, & Maintenance

Components that are vulnerable to oxygen permeation should be avoided. If these components are inevitable, some means of limiting oxygen should be employed.

The most important element of maintenance is to check system pressure, to ensure that states of under pressure do not arise, which permit entry of oxygen.

Conductivity and pH values should be measured and documented at least once per year. If values are significantly outside of the recommended range, system water should be flushed and refilled with demineralised water and pH should be monitored.

7) Commissioning

Commissioning in this guide includes

- Flushing
- Filling
- Heating up
- Checking/documentation

If emptying is required during commissioning, refilling must be carried out immediately. A delay of more than two days is not recommended.

A) Flushing

The system must be flushed during commissioning, mains water can be used for flushing. Conditioned water fill is preferred if flushing and filling procedures are combined, refer to the pre-commissioning specialists. An in-line filtration device (check regularly) is recommended at the time of flushing.

B) Filling

- A check must be made as to which filling water quality according to the guide values given in the guide is required for the system.
- If the mains water meets the requirements, it should be used as filling water.
- If the flushing water from the flushing operation meets the system-specific requirements, it can be left in the system as filling water. If these requirements are not met, water conditioning methods using the bypass process will be necessary. All measures should be completed before the first heating of the system.
- Complete venting of the system is necessary for preventing gas cushions and gas bubbles.

C) Heating up

A local concentration of lime deposits on the heating surfaces of the heat generator is prevented by heating up gradually, starting with the lowest output of the heat generator and with a high heating water flow rate.

In the case of systems with several heat generators, it is recommended that all heat generators be put into operation simultaneously so that the full quantity of lime does not precipitate on the heat transfer surface of just one heat generator.

D) Checking/Documentation

- A professional installation and commissioning of the pressure maintenance system is imperative as a corrosion protection measure.
- Operating checks for malfunctions, leaks, and noise must be carried out during commissioning, heating up, and circulation.
- The parameters like appearance, electrical conductivity, and total hardness of the heating water are to be determined.

In the case of the guide values for electrical conductivity are exceeded, measures must be taken to reduce electrical conductivity (for example, partial-flow demineralisation of the heating water).

If the heating water has a high buffering capacity, it may be possible to deal with disturbances in its acid-base balance without the pH value falling below or exceeding the guide value range given in the present standard. With a low buffering capacity, even minor disturbances in the acid-base balance will lead to significant changes in the pH value. This will not increase the likelihood of corrosion when the requirements of Section 6 are observed.

Commissioning data of the system

- system flushed (yes/no)
- filling water volume and meter reading of the filling and make-up water
- documentation of the water conditioning, if available
- appearance of heating water (visual)
- in the case of water conditioning, measurement of:

– the total quantity of alkaline earths in the conditioned heating water
– electrical conductivity of the heating water.

Operating data of the system

- annual maintenance:
    - determine make-up water quantity, document meter reading
    - heating water quality
        - appearance (visual)
        - pH value (measured)
        - electrical conductivity (measured)
        - if applicable, the total quantity of alkaline earths (measured)
- where applicable, further maintenance measures (for example, refilling make-up water with the type of water conditioning)

VDI 2035: IWTM UK’s Comprehensive Chemical-Free Water Treatment (CFWT) Approach to Heating System Corrosion Prevention

VDI 2035, a widely recognised German standard, has gained significant traction within the UK heating industry, both domestically and commercially. This standard outline specific guidelines for preventing corrosion in heating systems. IWTM UK, with its innovative product range, has demonstrated its commitment to adhering to VDI 2035 principles.

Key Parameters for Corrosion Control

According to VDI 2035, three primary factors contribute to corrosion in heating systems:

1. **Dissolved Oxygen:** The presence of oxygen in the system water can accelerate corrosion.
2. **High Conductivity:** Water with elevated mineral and salt content can increase conductivity, fostering a corrosive environment.
3. **Low pH:** A pH level below the recommended range can promote corrosion.

The IWTM UK Approach: Harnessing Natural Reactions

Unlike traditional treatments that attempt to counteract metal reactions, IWTM UK's approach leverages the natural tendencies of metals. By understanding how metals react with their environment, IWTM UK develops techniques that harness these reactions to protect the system.

A) Addressing Conductivity: Demineralisation

Many regions in the UK have hard water, characterised by high mineral and salt content. These dissolved substances contribute to conductivity, which can facilitate corrosion. IWTM UK addresses this issue by employing ProFILL demineralisation units. During the initial filling or makeup of the heating system, these units remove minerals and salts from the water, significantly reducing conductivity and limiting the pathways for corrosion to occur.

Filling and Makeup Water Treatment

IWTM UK offers a comprehensive approach to water treatment, encompassing both initial filling and subsequent makeup. For filling, mobile Prime demineralisation units can be installed in-line with the mains water supply and the heating system connection.

This process effectively removes minerals and salts, while also raising the pH to optimal levels. The Prime pH resin used in IWTM UK's mobile Prime units further enhances water quality by removing free carbon dioxide and raising the pH.

IWTM-UK Prime Range

To maintain optimal water quality throughout the system's lifespan, it is essential to ensure that any future top-up water is also demineralised. IWTM UK provides permanent installation options, such as the ProFILL units, which can be connected to the system via a pressurisation unit to demineralise incoming water.

IWTM-UK ProFill

B) Oxygen Management

Oxygen is a primary contributor to corrosion in heating systems. IWTM UK addresses this issue by manufacturing and supplying reaction tanks – Protector units, equipped with high-purity magnesium anodes. These units, available for various system sizes, effectively remove dissolved oxygen from the water.

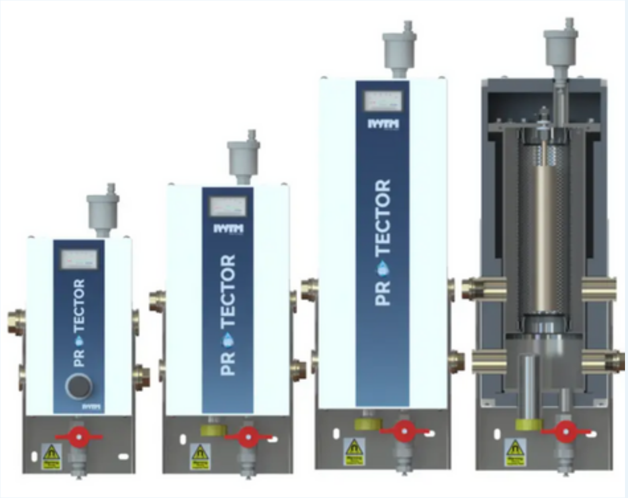
Scientific Principles

The effectiveness of IWTM UK's approach lies in the scientific principle of electrochemistry. Magnesium, being less noble than stainless steel, readily loses electrons. When connected electrically, these electrons are transferred to the stainless-steel body. This creates an environment where dissolved oxygen in the system water is drawn to the stainless-steel surface, leading to a chemical reaction that consumes oxygen and produces magnesium hydroxide. The magnesium hydroxide precipitates and is captured within the reaction tank, preventing it from entering the system. This process not only removes oxygen but also helps maintain a stable pH within the recommended range.

Protector Units: A Comprehensive Solution

For smaller commercial systems, IWTM UK offers the Protector P1-P5 range, which provides degassing, oxygen consumption, and magnetic protection.

Protector P1-P5



For larger commercial systems, the Protector P10-P1500 range is available, featuring the same three-tier protection approach. These units are designed to capture sludge and debris, ensuring optimal system performance.

Protector P10-P70

Protector P120-1500

Conclusion

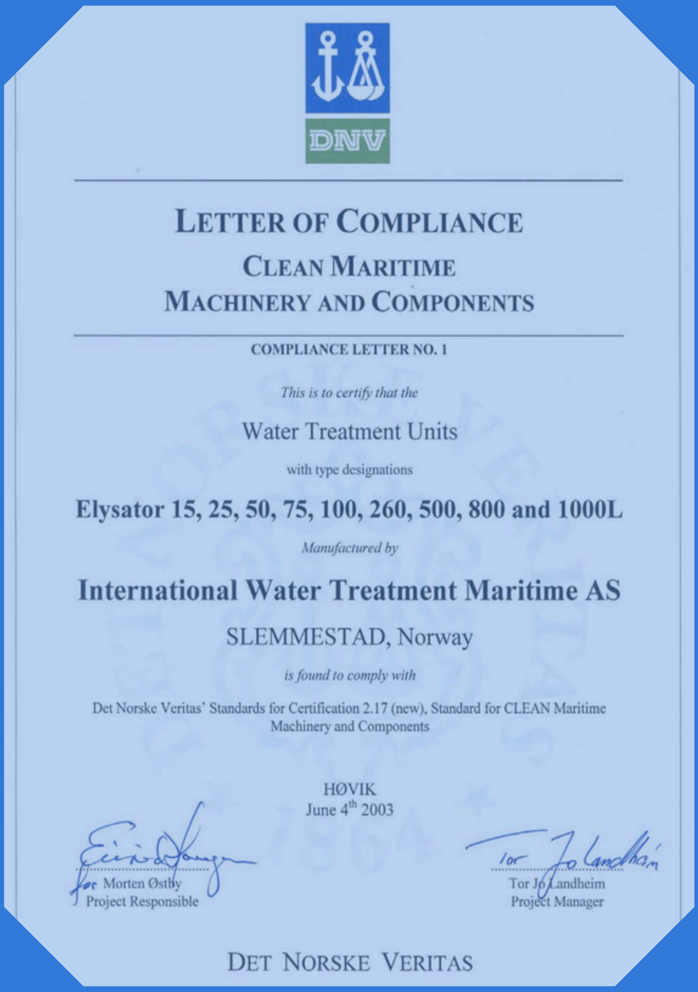
By addressing the key factors that contribute to corrosion in heating systems, IWTM UK's innovative approach offers a comprehensive solution for maintaining system integrity and longevity. Through demineralisation, oxygen removal, and pH management, IWTM UK ensures that heating systems operate efficiently and reliably, minimising the risk of costly repairs and replacements.

Environmental Culture Change

be a part of it

clean | protect | prevent

IWTM
water by design



DNV

LETTER OF COMPLIANCE

CLEAN MARITIME
MACHINERY AND COMPONENTS

COMPLIANCE LETTER NO. 1

This is to certify that the

Water Treatment Units

with type designations

Elysator 15, 25, 50, 75, 100, 260, 500, 800 and 1000L

Manufactured by

International Water Treatment Maritime AS

SLEMMESTAD, Norway

is found to comply with

Det Norske Veritas' Standards for Certification 2.17 (new), Standard for CLEAN Maritime Machinery and Components

HØVIK
June 4th 2003

for Morten Østby
Project Responsible

Tor Jo Landheim
Tor Jo Landheim
Project Manager

DET NORSKE VERITAS

Founded in 1992, IWTM have been working with chemical free water treatment using electrochemistry for over 30 years and have offices in Norway, UK, Finland, Sweden, Canada, USA and a worldwide presence in the Marine sector.

We have developed models specifically suited to the higher demands of the marine industry operating at higher pressures and higher temperatures.
The marine products are provided worldwide on the world's largest cruise ships working with the leading operators in this sector.

Having secured DNV approval in 2003, we are still the only chemical free water treatment manufacturer to have this certification and approval. DNV is a globally leading quality assurance and risk management company operating in more than 100 countries.

The IWTM Protector™ is our most recently developed product. The Protector range is now available to our land-based customers.

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In line with continued product development, we reserve the right to make any changes to this document without any given notice.