Water quality and corrosion protection

The choice of corrosion protection for a hot water heater is often based on what has traditionally been used in a given area and what works well from experience. However, the water quality is sometimes unknown, which means that it may be necessary to perform a water analysis.

When it comes to private wells, regardless of whether they are dug or drilled, the composition of the water can vary significantly within a particular region. For this reason, it is important to investigate the water quality before purchasing a new hot water heater or heat pump.

The corrosive properties of water depend on the concentration of the constituent substances and how these interact with each other. Water quality can only be assessed following an analysis. NIBE supplies such an analysis to their customers to ensure that the correct corrosion protection is selected.

In some cases, it may be necessary to install one or more additional filters to obtain an acceptable water quality. The most important parameters that are crucial for the correct corrosion protection are presented here. NIBE does not analyse the water from a health or aesthetic perspective, because these aspects do not affect the material from a corrosion perspective.

pH value

This value is a measure of the water's hydrogen ion content. The more hydrogen ions that are present, the more acidic the water and, thereby, the lower the pH value. Water with a low pH value is aggressive, and can, among other things, dissolve metals.

Alkalinity

Alkalinity is a measure of the water's content of hydrogen carbonate, as well as its capacity to withstand acid. The higher the content of hydrogen carbonate, the more stable the pH value. The ideal situation is to have a balanced amount of hydrogen carbonate. Too low a concentration of hydrogen carbonate makes the pH value unstable. Both too low and too high a concentration can cause copper precipitation.

Total hardness

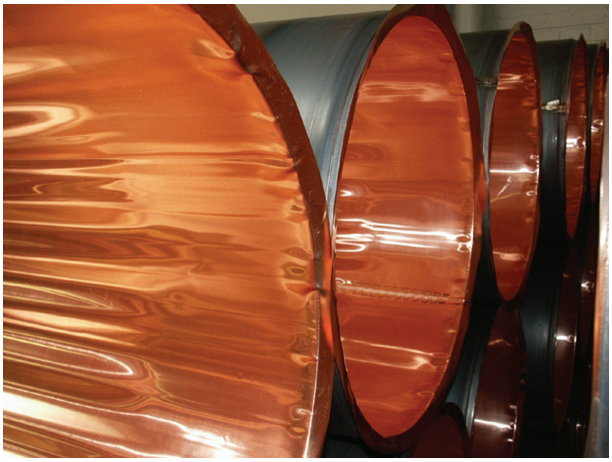
Hardness is a measure of the water's concentration of calcium and magnesium ions, and is normally measured in German hardness degrees (°dH). The higher the value, the harder the water. Water in the range 4–7 °dH usually produces a limescale coating on hot surfaces in contact with water that is beneficial and protective for copper. Soft water (0–4 °dH) has difficulty forming a protective layer, leaving the material unprotected. Hard water (>10 °dH) usually produces more limescale deposits, although it is not certain that the water will always result in significant scale formation just because the hardness is high. Parameters such as pH value, alkalinity and temperature have a major effect. The higher the values for these parameters, the more scale is formed. High levels of limescale deposits can damage hot surfaces, for example immersion heaters. In such cases, steatite immersion heaters are recommended, which is a heating element that does not come into direct contact with the water.

Chloride

Chloride occurs primarily in the form of sodium chloride, and can corrode metals in a relatively short space of time.

Copper

Thanks to its semi-precious metal properties, copper is resistant to most types of household water. Hot water heaters with a copper lining have several advantages. In addition to their good corrosion properties, their anti-microbial properties minimise the risk of legionella bacteria.



Caution with copper

At low pH values, low or high alkalinity and very soft water, copper ions can be dissolved and discolour sanitary ware and blond hair. A high chloride content can cause damage in the form of pitting or crevice corrosion. However, the risk diminishes the smaller the amount of limescale deposit that is formed in the hot water heater.

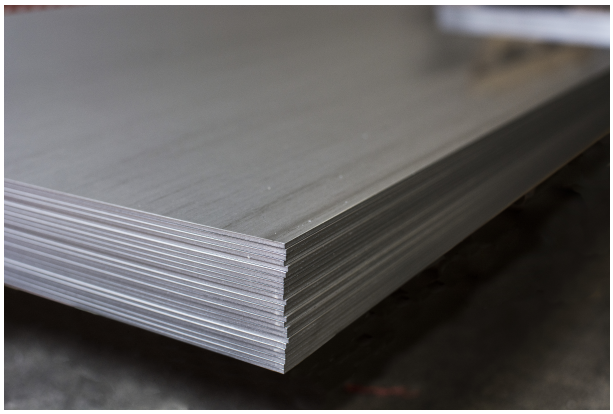
Stainless steel

Stainless steel is a material with extremely good corrosion properties in most environments. There are a large number of different alloys with varying properties. NIBE has selected an alloy that is, in principle, nickel-free, which combines good corrosion properties with good environmental and health properties. During manufacture, the various parts of the water heater are welded together. After welding, it is important that surfaces that have been subjected to heat are treated to ensure that the good corrosion properties are restored. NIBE achieves this by means of a unique chemical pickling process, which causes the surface to be cleaned of welding oxides. The surface is then passivated by recreating a very thin, uniform oxide film over the entire inner surface of the hot water heater.

Stainless steel water heaters are an excellent choice where a copper heater is not ideal, i.e. in water with a low pH value, low alkalinity and low hardness.

Caution with stainless steel

In water with a high chloride content, crevice corrosion can occur, particularly if a very large amount of scale is formed. In this case, corrosion cells are formed where corrosion attack can take place, which in turn can cause permanent damage to the hot water heater.

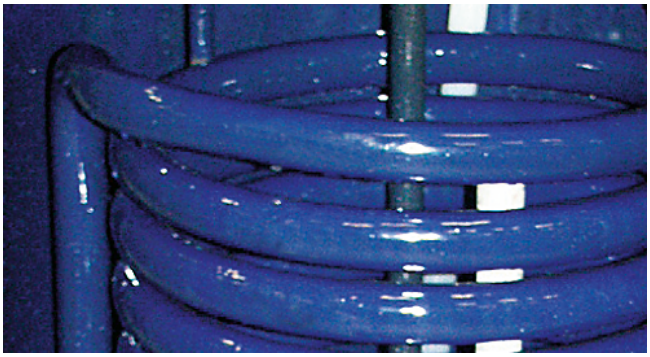


Enamel

Enamel is a glass-like material that is fused onto the inside of the pressure vessel. After fusing, microscopic pores may arise, with the result that the steel surface can come into contact with the water. To prevent corrosion in this case, there is always an anode in an enamelled water heater. The most common type is a “sacrificial anode”, which consists of a magnesium or aluminium alloy. As these alloys are more basic than iron, the anode “sacrifices” itself for the steel, which is electrochemically prevented from rusting. The pores in the enamel are eventually covered with calcium and magnesium compounds, which is favourable from a corrosion perspective. There are also anodes that do not sacrifice themselves, but rather use a weak direct current for the electrochemical process. Their advantage is that they are maintenance-free and ideally suited in confined areas where a normal anode is difficult to replace. They are also used when the conductivity is very high or very low (see the section “Caution with enamel”). Enamelled heaters are used in the first instance where the chloride content is so high that it is unsuitable for either copper-lined or stainless steel water heaters. Enamel is also recommended for water that forms sunstantial amounts of scale, i.e. water with high alkalinity and hardness. Due to the aggressive environment that scale formation combined with chloride comprises, ceramic heating elements that do not come into direct contact with the water may be necessary in certain cases.

Caution with enamel

Despite the good resistance against chloride and limescale, enamelled water heaters should not be used in extreme environments such as brackish water or seawater, as these types of water are highly corrosive. For water with a very high conductivity (>1,000 µS/cm), anode consumption can be significant, and with very low conductivity (<75 µS/cm), a sacrificial anode can have difficulty working. To use enamel heaters under these conditions, a direct current anode is recommended. Even if water with low conductivity can be used, overly soft water should not be used in enamelled water heaters, because you will lose the protective effect provided by the limescale deposits. Some waters with a high fluoride content can be aggressive to the enamel surface, although such waters are fairly uncommon.



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