Solar systems -
long lasting even with aggressive tap water?

Hot water tanks made of enameled steel have proven themselves for solar water heating for decades. Why, however, do some of these water tanks fail in some areas after a few years?

In some Mediterranean islands today enameled electric hot water tanks have an extremely bad reputation due to constant corrosion. Because of this, the general interest in solar hot water systems has dropped.

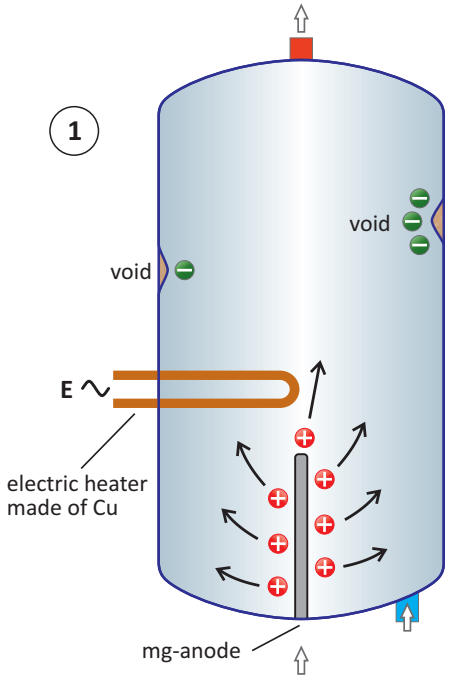
But corrosion damage to hot water tanks is often self-made.If technical rules for corrosion protection are correctly followed, such as with the SELACAL solar system, a long service life can be ensured even with critical tap water quality.

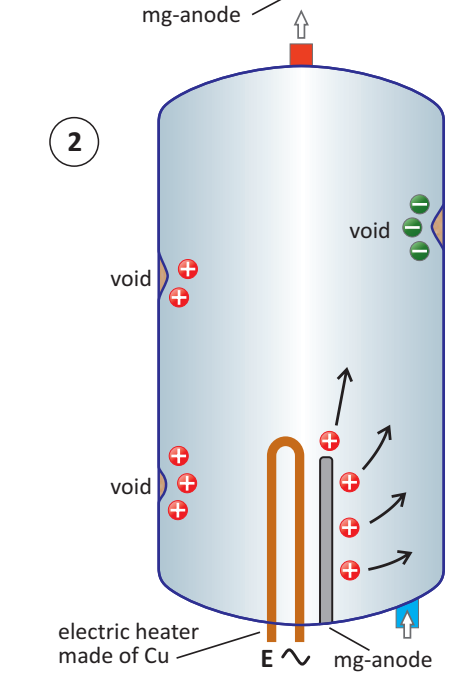
Enameled hot water tanks with a glass-enamel layer on the steel surface provide a very good defense against an oxygen-rich water supply. Despite careful preparation in the enameling process, fine hairline cracks or small flaking can occur. At these points, the steel can start to rust.

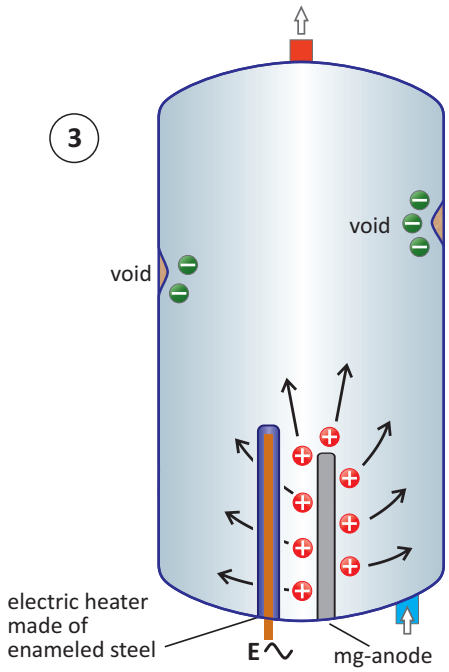
To prevent rust forming, nowadays a cathodic protection system is used. In the tank, a rod of magnesium (anode) is installed. This metal in the electro-chemical range is lower than steel. This provides a protective current with a positive electrical potential in these hairline cracks, also called "voids". Corrosion in these locations, which are the cathodes (-), is then prevented. Usually only a small protective current flow is needed, so that the "magnesium sacrificial anode" will dissolve very slowly, before needing to be replaced usually after many years in operation.

In enameled electric tanks or solar storage tanks with electric reheating, often copper heating elements are installed. They also act as a "void", because the electric conductivity is very high. They function like a big cathode, and it will heavily absorb the protective current. The amount of protective current needed will increases significantly. Normally the life of the magnesium anode is not greatly reduced. In a number of regions, especially around the Mediterranean, there is a high salt content in the tap water. This means a high electrical conductivity, which is also highly corrosive. In these situations, the lifetime of the Mg-anodes are significantly shortened and in the "shadow area" of the anode corrosion protection is only partly guaranteed (**Fig.1**). Sometimes you will notice the effect of hydrogen gas formation, which is released when the water tap is turned on.

Even more critical is the situation when, as with many electric boilers, the electric heating element made of copper is installed next to the sacrificial anode (**Fig. 2**). The current flow increases further, and the current emitted by the anode is no longer enough to protect the "voids". An effective remedy to the problem is to install the electric heating element in an enameled steel cladding tube (**Fig. 3**). The enameled surface is electro-chemically neutral and the cathodic protection mechanism operates optimally with minimum anode consumption * **1**. These heating elements are inserted dry and can therefore be replaced easily.







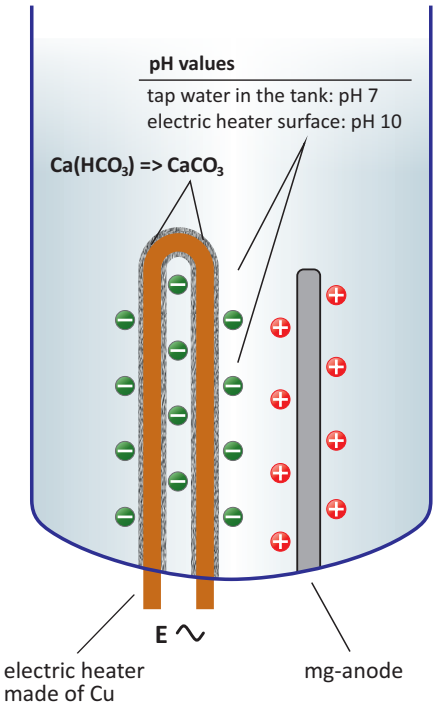
Accelerated Calcium Build-up avoided

Tap water with high calcium content, found on islands such as Cyprus, Malta or Mallorca, leads to many failures in simple electric boilers. Here, a strong protective current flows from the anode to the copper heating element, which is the cathode (negative potential). This negative potential causes changes to the pH of the water in the area near the heating surface.

The value of the tap water pH increases from e.g. pH 7 to a pH level of 10 in the area near the surface of the Cu-heating rod. The calcium, which is already dissolved in the tap water will precipitating as calcium carbonate and will eventually be converted on the heating surface to hard bicarbonate (**Fig. 4**).

The growing calcium bicarbonate in turn will inhibit the heat dissipation of the heating element. Finally it could create "hot spots" where the heating rod could burn out. With regular maintenance this problem can be avoided, but the maintenance procedures are complex and the maintenance should be performed regularly.

4 **Calcification**
on the Cu–made electric heater by electr. potential



The SELACAL Anti-calk – Principle

The SELACAL solar storage tank produces hot water with solar electricity. If necessary, additional heating can be performed with a second electrical heating rod (or with heat exchanger **Fig. 5**).

E-Heating rods are not made of copper but of enameled steel, so that there is no metallic conducting surface present in the tank. The magnesium anode is consumed much more slowly and protects the storage tank in all areas. To check the anode, the tank does not need to be opened. Instead, by pressing a button, the condition of the anode is displayed (**Fig. 6**).

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There is very little calcium formed because on the neutral enamel surface of the heating element no cathodic calcium deposits are generated. For additional limitation of calcium deposits the solar hot water temperature can be set lower. The solar module current is simply turned off at the desired maximum storage temperature. Unlike solar hot water panels there is no overheating in the PV modules.

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***1.**: as another method E-Heating elements can be electrically isolated including a special balancing resistor. So no unnecessary protective current flows to the electric heater. If the conductivity of the water is high, this principle reaches its limits.

Literature:

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