What is a sacrificial anode

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Sacrificial anodes are normally supplied with either lead wires or cast-m straps to facilitate their connection to the structure being protected. The lead wires may be attached to the structure by welding or mechanical connections.

The materials used for sacrificial anodes are either relatively pure active metals, such as zinc or magnesium, or are magnesium or aluminum alloys that have been specifically developed for use as sacrificial anodes.

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They are made from a metal alloy with a more "active" voltage (more negative reduction potential / more positive oxidation potential) than the metal of the structure. The difference in potential between the two metals means that the galvanic anode corrodes, in effect being "sacrificed" in order to protect the structure.

In brief, corrosion is a chemical reaction occurring by an electrochemical mechanism (a redox reaction).[1] During corrosion of iron or steel there are two reactions, oxidation (equation 1), where electrons leave the metal (and the metal dissolves, i.e. actual loss of metal results) and reduction, where the electrons are used to convert oxygen and water to hydroxide ions (equation 2):[2]

As corrosion takes place, oxidation and reduction reactions occur and electrochemical cells are formed on the surface of the metal so that some areas will become anodic (oxidation) and some cathodic (reduction). Electrons flow from the anodic areas into the electrolyte as the metal corrodes. Conversely, as electrons flow from the electrolyte to the cathodic areas, the rate of corrosion is reduced.[4] (The flow of electrons is in the opposite direction of the flow of electric current.)

As the metal continues to corrode, the local potentials on the surface of the metal will change and the anodic and cathodic areas will change and move. As a result, in ferrous metals, a general covering of rust is formed over the whole surface, which will eventually consume all the metal. This is rather a simplified view of the corrosion process, because it can occur in several different forms.[5]

For this protection to work there must be an electron pathway between the anode and the metal to be protected (e.g., a wire or direct contact) and an ion pathway between both the oxidizing agent (e.g., oxygen and water or moist soil) and the anode, and the oxidizing agent and the metal to be protected, thus forming a closed circuit; therefore simply bolting a piece of active metal such as zinc to a less active metal, such as mild steel, in air (a poor ionic conductor) will not furnish any protection.

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There are three main metals used as galvanic anodes: magnesium, aluminum and zinc. They are all available as blocks, rods, plates or extruded ribbon. Each material has advantages and disadvantages.

Magnesium has the most negative electropotential of the three (see galvanic series) and is more suitable for areas where the electrolyte (soil or water) resistivity is higher. This is usually on-shore pipelines and other buried structures, although it is also used on boats in fresh water and in water heaters. In some cases, the negative potential of magnesium can be a disadvantage: if the potential of the protected metal becomes too negative, reduction of water or solvated protons may evolve hydrogen atoms on the cathode surface, for instance according to

leading to hydrogen embrittlement or to disbonding of the coating.[7][8] Where this is a concern, zinc anodes may be used. An aluminum-zinc-tin alloy called KA90 is commonly used in marine and water heater applications.[9]

Zinc and aluminium are generally used in salt water, where the resistivity is generally lower and magnesium dissolves relatively quickly by reaction with water under hydrogen evolution (self-corrosion). Typical uses are for the hulls of ships and boats, offshore pipelines and production platforms, in salt-water-cooled marine engines, on small boat propellers and rudders, and for the internal surface of storage tanks.

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