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Cathodic protection
- An Introduction -

What is corrosion?

When it comes to Shipbuilding and repair, one could argue that corrosion starts at the same moment as the design and construction of the vessel, as materials are prepared to do the job.
There's a permanent corrosive action, under meteorological conditions, mild or severe, on submerged parts of a ship or structure.
Simply put, corrosion is the destruction of a material caused by a chemical or electrochemical reaction with its environment.
This interaction between different materials and the environment is influenced by the different electrical potentials of the metallic parts, temperatures, concentrations, etc and the result is corrosion - basically the deterioration on the metal's surface due to electrical, chemical or mechanical events that occurs.
When two dissimilar metals (electrodes) such as zinc and steel, are immersed in a conductive liquid acting as an electrolyte - sea water, for example - an electrical potential difference between these two materials (electrodes) occurs. This conjunction of materials can be called a cell.
An electrical current flows from the so called noble element (in this case steel) to the less noble metal (Zinc).
In this particular cell, the less noble metal (Zinc) is called the anode and the more noble metal (steel) is called the cathode. On the surface of both, electrochemical reactions take place.
The most important agent of corrosion between the two metals in contact is the electrical potential, which depends on the natural values of the anode and the cathode, given that the anode is attacked and dissolved and the cathode remains protected or unaffected.
The anode (Zinc) slowly dissolves in the electrolyte while it protects the cathode (steel) against corrosion.
This method of protection is called cathodic protection (CP) by sacrificial anodes.
Cathodic Protection (CP) in fact, uses the addition of direct current towards metallic objects to shift the object potential to values where corrosion is effectively suppressed.

Generally, CP is seen and applied as a secondary method to protect against corrosion.
In order to obtain a good protection in vessels and structures, it's absolutely necessary to apply a primary corrosion protection, provided by a good quality, adhesive coating (Paint on ships, mainly).
By using a proper coating, the required protection current for CP is reduced to small values.
Nevertheless, part of the surface will be affected and left without paint due to collisions against docks, tugs, defenses, anchors, etc, which will cause degradation in the protection.
Next, the diffusion of water and oxygen in these areas of the submerged steel will ignite the rusting process.
The corrosion protection with Zinc anodes increases specifically where the coating deteriorates and will safeguard from corrosion the steel surfaces.
However, cathodic protection under a disbonded coating is not possible. (**Never paint over the anodes**).

Work against corrosion – Materials and applications

Materials generally applied as sacrificial anodes are:

- Zinc and aluminium alloys for offshore installations – Ships / Rigs / Sea Pipelines
- Magnesium and zinc alloys for land installations – boats on sweet-water / Land Pipelines




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Although aluminium is also used, the most used anodes are made of Zinc, which doesn't require a tight control and delivers a continuous and efficient current.
An imperative for this to work is the composition that must be exactly to the specifications (MIL-A-18001 alloy).
They are used on a large range of situations, not only on Ships. You can find them on:

- Engines and coolers
- Submarine pipes
- Buoys
- Chains
- Tanks
- Condensers
- Cisterns
- Metal towers, bridge's foundations

When is cathodic protection required?

The application of cathodic protection on metallic objects depends mainly on the nature of the soil or water in which the object is buried or immersed. Generally speaking, cathodic protection is required (among other situations) when:

- Objects are battered by stray currents from other DC-sources
- The soil resistance of the environment is equal to or lower than 10,000 Ohm.cm
- *Two different metals that are in some way connected to each other resulting in a corrosion cell*

Positioning on ships of the sacrificial anodes

Anodes are produced in different shapes and sizes, depending on the size of the areas to protect. Metallic parts of the vessel must be in contact with an anode for which bolts are used or connection cables or simply welded to the steel.
On the external part of the vessel, the anodes must always be placed on a parallel position on the longitudinal lenght of the ship, thus obtaining the maximum performance of CP and keeping the drag on the ship's movement to a minimum.
CP protection on a ship is obtained with Zinc anodes applied to protect the following external and internal parts:

Stern, rudder and axle
Hull
Boxes and sea valves
Propellers
Ballast tanks
Machinery, hydraulic groups, etc

Amongst the elements which require special protection are:

Propeller and Transmission shaft
Metallic rudders
Metallic keels
Flaps of motor boats

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Anodes must be necessarily replaced when they get around 50 to 30 % of their original weight or as they show signs of significant wear

The Always's and Never's of the Zinc Anodes

Always

- Change your anodes when they are 50% corroded.
- Make sure they make good electrical contact – REMOVE ANY PAINT and clean the mounting surface
- On bolted anodes be sure to use news fasteners every time – even stainless bolts will probably fail as result of corrosion.
- Keep the protected areas immersed in water so that the anodes can work

Never

- Paint over the anodes. They will be isolated and simply will not work
- Mix anode types –aluminium anodes will tend to protect the zinc anodes in the same bonding circuit