corrosion

A GUIDE TO GALVANIC CORROSION

Is your asset corroding away?

Without preventative measures and proper maintenance corrosion can occur very quickly and be extremely costly

Many boat owners will be familiar with corrosion and the costly nature of attending to the issues associated with metals in water. All metals will want to corrode when exposed to oxygen and moisture and revert back to their natural basic state of raw material, or in laymans terms, dirt. Without preventative measures and proper maintenance corrosion can occur very quickly and be costly, however there are simple measures which can be taken to significantly reduce the effects of corrosion in terms of time and cost.

Metals are graded in 'The Galvanic Series of Metals' reflecting the ease at which they corrode. Softer metals corrode at an accelerated rate when compared to harder metas. The scale below (from harder to softer metals) highlights some of the more common metals in the marine industry:

- Titanium
- S/S Shaft Bar UNS 20910
- S/S Shaft Bar ASTM 630
- Bronze ASTM B62
- Naval Brass
- Copper
- Mild Steel vessels
- Maddox Anodes
- Aluminium vessels
- Zinc Anodes
- Aluminium alloy Anodes
- Magnesium Anodes

Each metal plays its own part in causing corrosion (galvanic circuit) with the harder metal being positive and the softer metal with a more negative charge. All galvanic protection requires four basic elements:

1. A sacrificial metal (anode)
2. Metal to be saved (hull, shafts, propellers, skin fittings)
3. A good electric connection (bonding wires inside hull)
4. A conductive solution (fresh or salt water) and environmental influences

A good example of the relationship between bonded metals is illustrated in the case of a stainless steel propeller shaft and a bronze propeller. A quality stainless steel propeller shaft can survive indefinitely, however when a bronze propeller is connected to the shaft an electrolytic circuit is formed. The bronze propeller will now sacrifice itself (corrode) to protect the shaft bar so we need a softer metal (anode) to sacrifice itself (corrode) before the bronze propeller.

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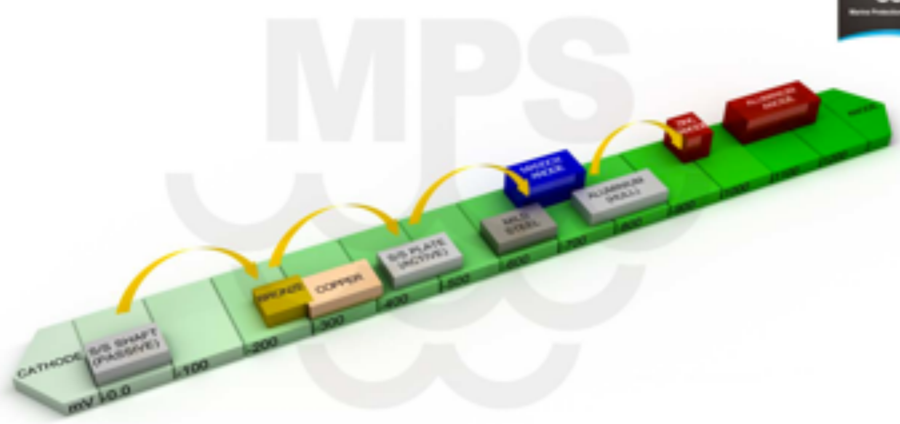
Anode Selection

Zinc anodes are commonly associated with cathodic protection and have been used traditionally since 1824 as a sacrificial anode for all submerged metals. They are effective to protect mild steel vessels as they were originally intended to do but when they are used to protect better quality or harder metals they in turn over protect.

There are two prominent methods for producing sacrificial anodes, namely casting and extrusion. Casting metal is where the metal is melted until it is a liquid and poured into a required shape (mould). Extruded metal is where a metal compound is made to required specifications and then heated (tempered) until soft enough to be pushed through the required shape. The extruded approach produces a better quality material providing a superior anode for galvanic protection. Many sacrificial anodes are produced through casting.

The correct choice of sacrificial anode will vary depending upon the vessel type and the submerged metallic fittings to be protected. In the selection of the optimal anode the vessel owner can see a significant reduction in the dissipation of the sacrificial anodes, reduced maintenance costs and improved performance. For example, zinc anodes promote crustacean growth and are a cause of paint blasting. Additionally hydrogen evolution is a common problem but more recently comprehended in the marine industry where metals become increasingly brittle and are likely to crack and whither at an accelerated rate. Again the correct choice of anode can mitigate this issue.

The case illustrated to the right highlights how the correct selection of anodes and through the use of a cathodic protection system can greatly reduce ongoing maintenance costs inclusive of the cessation of wood rot, reduced painting and growth removal costs, reduced anode costs, and improved fuel efficiency as the bronze propeller remains adequately protected.



Connection.

Sacrificial anodes are your power source for protection and must have good electrical connection

A common problem for boat owners is this electrical connection between the sacrificial anode and its retaining bolt. The submerged connection requires a star locking washer which bites into the metals and provides a better electrical connection (zinc and other anodes sacrifice themselves around bolt holes which cause the anodes to work loose, breaking or affecting the electrical connection). It is recommended to tighten bolts from time to time to ensure that a good connection is maintained.

Before

After (12 months)

Bonding.

Protect your bonding system from atmospheric corrosion

All bonding systems must be treated as any other professional electrical wiring harness, with extra precautions to protect the electrical connections from atmospheric corrosion. Atmospheric corrosion is one of the most damaging forms of corrosion affecting all electrical terminations that are not sealed. Fly bridges and bilge areas are severely affected by atmospheric corrosion. Atmospheric corrosion is very common in vessel engine rooms and will eventually cause fatigue and voltage loss in the bonding connections. The bonding circuit carries only very small amounts of voltage and current. Thus a voltage loss in excess of -30mV has a detrimental effect on the fittings that are meant to be protected.

Location.

Its all about location, location, location

Having the sacrificial anode too near or directly above our propellers allows gravity to pull the sacrificial metal onto the propellers. This will cause the heavy metal ions to complete the galvanic circuit and reduce the quality of our expensive metals to the value of the cheaper sacrificial metal. Eventually shafting bars can sheer or break and propellers can throw a blade!

There are numerous dissimilar metals to consider when addressing the anode requirements. In the wiring diagram the wiring diagram (below) the shaft grounding strap and buss bars are being used as a design to keep the location of the anode away from the precious metals.

Water and Environmental Influences

Sea-water is a great electrical conductor and can be a major contributor to the rate of corrosion. Anode selection should consider the environment, the type of water the vessel resides, and the vessel construction type. For example, extruded anodes should be used in saltwater to protect non-metallic hull vessels as they are a harder compound. Zinc anodes should be used to protect metallic hull vessels.

Softer cast sacrificial anodes are suitable for vessels in fresh water environments. Aluminium alloy anodes should be considered near a river source and further upriver, and magnesium anodes are suitable in environments where there are numerous dissolved minerals, for example a clay water bed or fresh water.

In warm water a harder sacrificial anode is appropriate, and in cold saltwater more sacrificial anode surface area is required to achieve adequate protection. The flow rate of the water will also affect the consumption rate of sacrificial anodes. Soft cast sacrificial anodes will be consumed by water erosion and may not achieve the required protection levels for the expected lifetime. Additional anodes or a harder extruded sacrificial anode will be required in areas of increased water flow rates.

There are many permutations when considering the type of sacrificial anode suitable to protect a vessel in numerous environments. The briefly described scenarios highlight the importance of considering the environment that the vessel resides to achieve the greatest efficiency and performance of a sacrificial anode.

Additionally the outer metal surface area of the precious metal is where the corrosion will occur and where primary protection must be achieved. It is therefore crucial to protect the metallic fittings with a good protective coating and not solely rely upon the anode to provide complete protection.

Other Environmental Considerations

The immediate environment is a significant factor when determining the required protection method and levels. Water type, water pollutants, marina structures, other vessels and the water bed all impact on the expected life-time of protection. Some man-made environments (marinas) can affect vessels in differing ways. Therefore it is necessary to adjust the vessel's protection method to suit the particular environment.

Shore power is an extremely common cause of corrosion. Imagine that all the vessels connected to shore power are taking part in one big battery. It is necessary to remove your vessel from what is commonly called the "daisy chain" effect in order to not be part of the battery which is contributing to the anode consumption. There are simple methods easily employed to mitigate the instance of the daisy chain, most notably the use of a galvanic isolator or electrolysis blocker.

Every vessel without an electrolysis blocker is at risk.

Shore Power

Electrolysis Blockers (galvanic isolators)

Every vessel without an electrolysis blocker is at risk of galvanic corrosion, and can lead to excessive anode loss and corrosion beyond the capacity of the boats cathodic protection system. The highest risk vessels within a marina are vessels with sterndrives or saildrives. This is due to the metal being softer compared to other conventional vessels.

The Daisy Chain Effect

The instance of electrolysis is prevalent in marina environments with increased connectivity to shore power. The dissimilar metals on the vessels are electrically connected through the individual connections to shore power outlets with all vessels sharing a common electrolyte, the water. A circuit is created between vessels with whichever vessel having to softest metal fittings or equipment underwater suffering the highest instance of corrosion.

Shaft Grounding Straps.

Increase bonding

The award winning Shaft Grounding Straps completes an internal hull electrical circuit to protect submerged metallic fittings. Maximum electrical contact is achieved from the sacrificial anode to the shaft assembly and propeller.

Better than the rest

Traditional methods of grounding shafts, as brushes and bushes, to protect propellers have not been adequate. Other methods for cathodic protection are often excessive, costly and lose compression. Tested in excess of 4,000 hours, they also greatly reduce running vibrations through removal of shaft anodes.

Logix Group & the environment

Logix Group are committed in helping to reduce the carbon footprint and marine pollutants exerted by current practices of cathodic protection. The use of a properly functioning galvanic protection system:

- maintains vessel efficiency
- reduces anode consumption

The Maddox Anode is the 21st century in anodes. The heavy metal fallout experienced with zinc anodes is significantly less with the Maddox system. Heavy metals pollute our waterways and can enter the foodchain.

Through education, products and correct practices - the carbon footprint of individual vessels and marinas can be greatly reduced.