Preventing Galvanic Corrosion

West Marine Advisor

What is galvanic corrosion?

Galvanic corrosion (sometimes erroneously called electrolysis) can damage or destroy underwater metal parts of boats, dock hardware and other equipment. When two different metals are touching each other or are electrically connected by a conductor, and are immersed in an electrolyte (an electrically conductive fluid, like salt water) an electro-chemical reaction can occur. One of the metals (the “least noble” metal, called the anode) will corrode faster than it normally would, and the other (the “most noble” metal, or the cathode) will dissolve slower.

The seawater Galvanic Sequence lists metals in order, based on their voltage potential and tendency to corrode. More active metals, the faster-dissolving anodes, are at the top of the series. Passive metals, the cathodes, are located at the bottom. Your boat might have a collection of submerged, electrically-connected metal parts immersed in salt water surrounding the boat, in bilgewater or the water in the engine cooling system. The stainless prop shaft, for example, because it is more active (less noble) than the bronze propeller, will begin to dissolve, leaving the prop intact.

How to prevent it

Breaking the electrical circuit between exposed metals by connecting them to a sacrificial anode will prevent galvanic corrosion. A sacrificial anode is an inexpensive piece of metal that is less noble than any other metal found on the boat, and it is electrically connected, bolted or wired into electrical contact with the other metal components. Bolting a sacrificial anode made from zinc, aluminum or magnesium (located near the top of the Galvanic Sequence) to the stainless prop shaft will protect it from corrosion. The anode and the stainless shaft will form a galvanic couple, and the anode will dissolve, keeping your prop shaft spinning happily. Sacrificial anodes can extend the life of your boat’s hull, engine, rudder, propeller shaft, engine cooling system, refrigeration condenser and other metal components by protecting them from the deterioration caused by galvanic corrosion.

When to replace an anode

The effectiveness of an anode depends on a good electrical connection, and is directly proportional to its surface area. As it corrodes away its surface area and effectiveness diminishes. Some manufacturers suggest replacing anodes when they are two thirds gone, but we recommend replacing them when half-eroded or half-dissolved. If an anode is allowed to dissolve completely, the next least noble piece of metal in the circuit will start to dissolve. And that might be a part of your engine. Remember that polluted water, warm water temperatures and stray current corrosion can cause your anodes to wear away at an accelerated rate, and it’s smart to check them regularly.

The importance of marine-grade fasteners

Galvanic corrosion can also happen in a single piece of hardware, particularly alloys, which contain more than one metal. Interactions between the differing metals in the alloy will dissolve the least noble, the most common example of this being the dissolution of zinc from many zinc/copper alloys (such as brass and some bronzes) leaving a weak, spongy copper residue. That’s why it’s so important to use marine-grade fasteners (bronze, monel and 316 stainless steel) in underwater applications so they are not destroyed, allowing a hose clamp to fail or your propeller to fall off. The higher the salinity and temperature of the water, the greater the likelihood of corrosion.

Galvanic isolators protect from dockside power problems

Attaching anodes protects the metal parts of the boat from onboard sources of electrical current. Unfortunately, other boats and improper shoreside wiring are sources of galvanic current originating outside the boat. If your boat is hooked to

shore power, a galvanic isolator or isolation transformer will protect it from rapid dissolution of your anodes and the corrosion that will follow.

Getting rid of cadmium and zinc

Zinc and cadmium are elements used in traditional salt water anodes that are suspected of causing environmental damage. CMP Global, our primary supplier, has reformulated their product, removing these alloys for safer and more “green” anodes. The alloy components of the new Martyr II (Cadmium Free) anode do not include cadmium (one of six substances banned by the European Union’s Restriction on Hazardous Substances directive) and contain a fraction of the zinc used in making the traditional zinc anode (concentrations of zinc as low as two parts-per-million adversely affects the amount of oxygen that fish can carry in their blood). The two Martyr II components, aluminum and indium, are considered non-toxic. A rare bit of good news for the boater: these new formulations actually work better! They’re lighter and last longer, so they’re a plus for your boat and for the underwater life in your marina.

Which anode is right for you?

	Salt Water	Brackish Water	Fresh Water
Zinc	**YES**		
Aluminum	**YES**	**YES**	**YES**
Magnesium			**YES**

Zinc or aluminum for salt water: If you are a saltwater boater, you should install zinc or aluminum anodes to prevent galvanic corrosion on the engine and underwater parts of your boat.

Aluminum for brackish water: More active than zinc, aluminum anodes are a good compromise where fresh and salt water mix, such as the brackish water of river deltas, or if you use your boat in a variety of water types. Zinc is too passive for brackish water, where it gets covered in a zinc oxide film and becomes inactive. Magnesium corrodes too rapidly (due to the water’s salt content), leaving your boat without adequate protection.

Magnesium for fresh water ONLY: Since fresh water is much less conductive than salt water, magnesium anodes are the best choice because they’re more active (less noble) than zinc or aluminum so they will protect your engine parts more effectively. **Caution: do not use magnesium anodes in any application other than fresh water because they will corrode rapidly, exposing your boat and engine to possible damage.**