Fighting Corrosion with Zincs and Bonding

From Pacific Fishing, April 1997
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Only a low southerly chop ruffled Georgia Strait that autumn afternoon as an aluminum gillnetter left the broad Fraser River delta and took up a course toward Active Pass. Apparently, by the time the skipper discovered she was filling from the lazarette, it was already too late for the pumps to catch up; so he radioed for help and got ready to let her go. We got there in time to see the Canadian Coast Guard hovercraft pluck the crew from the only thing left afloat—the forepeak, where a pocket of trapped air held the hull vertical in the water like a deadhead. A few moments more and that, too, was gone.

A late-model, popular-design aluminum fish boat had filled and sunk in a matter of minutes. No one had to say it; we all knew that only one thing could split open a tough hull like that—rapid and severe corrosion.

Since mariners first started putting metal fasteners in boat hulls, they have been battling marine corrosion. Despite the tools of modern science and engineering, it's still a war of attrition.

Galvanic corrosion, often erroneously called electrolysis, is generated by galvanic action, or the flow of electrical current between dissimilar metals immersed in an electrolyte such as seawater. Every kind of metal has a different electrical potential, and when different metals are electrically connected, as through a metal hull, or by moisture in a wooden or fiberglass hull, a small current flows from the metal with a positive charge to the one with negative charge. This current—measured in millivolts, or thousandths of a volt—doesn't cause any harm. It's the return leg of the circuit, where the current returns through seawater, that causes the problem, because as ions of the negatively charged metal flow out into the water, the metal itself is consumed. Galvanic action even occurs within a metal, when the alloys that make up, for example, a bronze through hull react with one another and cause the eventual destruction of the piece.

There are two different ways you can protect your boat from galvanic corrosion: use of sacrificial anodes such as zincs, and impressed current. Impressed current systems are used by salmon trollers to get "line voltage" on their trolling wires, and by steel ships. A system consists of a set of electrical current sensors, a simple microprocessor, and voltage from the ship's batteries. The sensors detect electrical potential in different parts of the ship, and the processor sends a small amount of current to each location to essentially neutralize the normal galvanic current. Properly set up and maintained, impressed current systems virtually eliminate corrosion from the protected areas of the vessel, at no ongoing cost. But they are expensive, require careful installation, and can cause serious problems when there is a malfunction.

Usually the best protection from galvanic corrosion is the use the galvanic process itself by installing anodes of a more highly charged (less "noble") material such as zinc. Properly installed zincs of the correct size will attract the current flow from other metal parts in the water, and in doing so will "sacrifice" themselves to the sea, protecting the other parts.

The principle is well known but the implementation is often imperfect. On non-conductive hulls like wood and fiberglass, it's pointless to simply bolt a zinc to the hull. The zinc must be electrically connected to the other underwater metal parts to provide any protection. (Remember, the current flow is a circuit, with the seawater only one leg.) This is the reason for bonding, which simply means connecting the metal parts electrically, using highly conductive straps and wires. Bonding reduces the electric potential of all the metal parts and links them in the electrical circuit with the zincs. Bonding also reduces the threat of electrocution from an AC system, protects from lightning damage, and reduces radio interference.)

Good bonding requires a central bonding strap or copper pipe secured along the centerline of the hull, out of the bilge water, and feeder wires (at least #8 AWG) run from the central strap to each of the metal components, such as through hulls and rudder stocks, which come into contact with

Protecting Your Tools

- Zincs with cast-in mounting straps are better than those drilled for bolts.
- Bonding wires can be hose-clamped to through hulls and rudder stocks, but the metals must be clean and the connections should be sealed with liquid electrical tape.
- Do not use the bonding system for the vessel's electrical system ground, although the two should be connected.
- Retard rusting in "stainless" pieces above the waterline by sealing them from air and water with wax, grease, or paint.
- Never paint zincs.

seawater. Main and auxiliary engines, metal fuel tanks, stoves, and other components should be attached. Propeller shafts need to be connected by a brush or strap held in place by light spring tension.

Bonding connections must be clean and kept free of corrosion, and should be tested periodically with a volt/ohm meter for continuity. Better yet, the fittings themselves should be tested with a corrosion potential meter.

Zincs can be wired to external components like rudder, stem iron, and rudder shoe if connections are kept clean and free of rust. Check them frequently; if two-thirds consumed they must be replaced, and if they still have their new-metal shine, reinspect all the connections, because the zincs aren't doing their job.

Steel and aluminum boats don't need to be bonded, but special care is required in selecting metal components. Both aluminum and mild steel are among the least noble of metals, so it is important to match them with shafts, props, through hulls, and other parts made of materials that cause minimal electrical potential differential, and then load on the zincs to absorb the inevitable currents. A 32-foot aluminum boat may need as much as 45 pounds of zinc, and a 60-foot steel hull may require 200-350 pounds. In general, all copper alloys like brass and bronze should be left out of aluminum boats. ✥

References

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