Update on Anodes

When should Zincs be made of aluminum?

By Robert Buller

Annual maintenance for most boaters means a haul-out, a quick power-wash, an occasional scrape, a few choice words, a new coat of anti-fouling paint and a routine change of zincs (or anodes as they are properly known).

Most boaters, the author included, do basically what we did last year: repeat the same brand purchases and try to minimize the time and work involved. Up, down and out, as quickly as possible. We want to enjoy our boats, not just work on them.

What is actually better for the environment?

Recent advances in chemistry means we should all slow down a bit and reconsider — aren't we trying to do better for the environment? Water may look blue, but we need to keep it "green". Bottom paint chemistry keeps evolving as we look to find ways to maximize protection against marine growth on our hulls and reduce the amount of poisons leaching into our water.

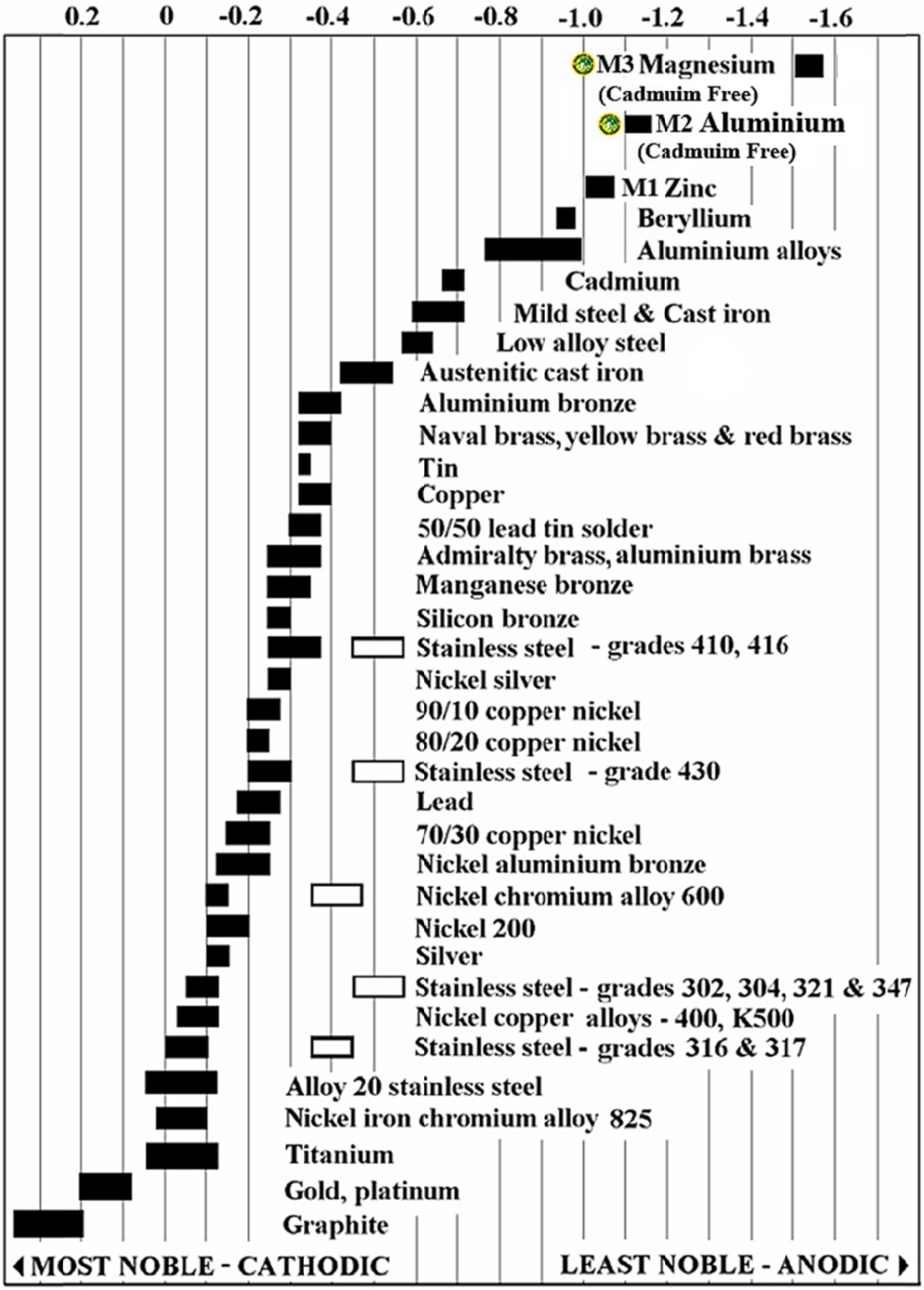
Anodes, too, need a rethink.

Recent research indicates that zinc, the most common anode material, is poisonous in high concentrations that can build up under marinas. And zinc anodes all contain small amounts of cadmium, a heavy metal, which is also well known to be poisonous, and even in small quantities is toxic. (Cadmium is actually banned in the EEC). This matters because anodes are the sacrificial metal, and they are purpose-designed to be "eaten away" so the metal particles fall into the water and settle to the bottom where they sleep with the fishes. And keep poisoning.

Environmental regulators everywhere are looking at the effects of these metals — do we need to be polluting our harbors with these poisons?

Why do we need anodes?

We need anodes to prevent the effects of corrosion that occur when dissimilar metals are close to each other and are surrounded by an electrolyte, such as salt water. Most boats have at least two different metals under water, stainless steel components such as struts and prop shafts, but also bronze thru-hulls and props, for example. Outboards and stern-drives have both stainless steel and aluminum parts. Any two different metals make a small battery and create a current flow; this creates metal corrosion. We might like this current flow if it occurs in a purpose-built battery. But any other current flow is very corrosive. We can at least protect the important metal parts, though.


0.2
0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
M3 Magnesium
(Cadmuim Free)
M2 Aluminium
(Cadmuim Free)
M1 Zinc
Beryllium
Aluminium alloys
Cadmium
Mild steel & Cast iron
Low alloy steel
Austenitic cast iron
Aluminium bronze
Naval brass, yellow brass & red brass
Tin
Copper
50/50 lead tin solder
Admiralty brass, aluminium brass
Manganese bronze
Silicon bronze
Stainless steel - grades 410, 416
Nickel silver
90/10 copper nickel
80/20 copper nickel
Stainless steel - grade 430
Lead
70/30 copper nickel
Nickel aluminium bronze
Nickel chromium alloy 600
Nickel 200
Silver
Stainless steel - grades 302, 304, 321 & 347
Nickel copper alloys - 400, K500
Stainless steel - grades 316 & 317
Alloy 20 stainless steel
Nickel iron chromium alloy 825
Titanium
Gold, platinum
Graphite
MOST NOBLE - CATHODIC
LEAST NOBLE - ANODIC

Any two metals plus seawater equal a low-voltage battery that will slowly destroy one of the metals. Current flowing FROM a metal is corrosive while flowing TO another metal is not. To avoid corrosion on the parts we want to protect, we learned to fit an additional metal, to become the anode, or the negative terminal, attached to hulls and under-water parts of boats. This new metal anode is the one that conducts the electricity and gets itself corroded — it performs the ultimate heroic act and sacrifices itself to protect the other metals. Anodes are inexpensive and easily replaced, unlike bronze props or steel shafts.

The boating community has used anodes for decades, and will need them as long as different metals exist in, or near, salt water.

Alternatives to zinc anodes

Sacrificial anodes are now readily available in specialized mixtures of metals — called alloys — that are very specific combinations of highly active, but non-toxic, metals. A new alloy of aluminum is now available in anode form and it is more environmentally beneficial than the common zinc/cadmium alloy that has been around for decades. This new aluminum alloy has performance and environmental advantages, and it contains no poisons, not even in trace amounts.

Aluminum is a much more benign metal to nature and it works just as well, or even better as an anode. In fact, its electrical capacity to become sacrificial is almost twice that of zinc on a pound-for-pound basis. Tests show that a similar weight of aluminum anode will provide protection at least 50% longer than an equivalent weight of zinc. And aluminum anodes have NO poisonous components.

The toxicity of zinc anodes is attracting the attention of regulators, as concern for the environment grows and now that safer alternatives are available. Maryland, for example, has been widely reported to be introducing a ban on the use of zinc anodes, and other jurisdictions are considering similar moves.

Anodes for Fresh or Brackish waters

Boaters who are regularly in both salt and fresh water, like me for example with moorage in the brackish water of a major river, must use aluminum anodes, as zinc is nowhere near as effective as aluminum in low salinity. And boaters who are permanently in fresh water must use magnesium anodes; other metals simply won’t do the job.

Developed over the past few years, these new aluminum anodes are becoming increasingly popular; already they account for the majority of manufacturer-approved replacement parts. Outboard and O/I manufacturers routinely use and now specify aluminum anodes for their motors and drives that are touched by salt water. Nothing corrodes faster than a stern-drive or outboard that is missing its anodes — and corrosion here can be fatal to important parts very quickly.

Aluminum anodes are also lighter and can give the same corrosion protection at weights half that of zinc — sail-boaters love that advantage.

Aluminum anodes once carried a price premium, but that has been reduced or even eliminated in recent years. Now our boats can get better protection, longer anode life-span, and be cadmium free. Your boat is better protected and so is the environment.

Where to buy

At the retail level a local manufacturer sells cadmium-free aluminum anodes under the Martyr brand name. A Pennsylvania-based company also markets ones under the Performance Metal brand while others sell through Original Equipment Manufacturer’s (OEM) network such as Quicksilver (Mercury), both Yahama and Suzuki marine parts, as well as BRP (Johnson and Evinrude). There is a Seattle-based company that markets theirs under a Harbor Island brand, while there is one from the Los Angeles area, Farwest Corrosion Products. See information panel below.

In North America:

Canada Metal (Pacific) Limited, Delta, BC, Canada (*Martyr* Brand), www.canmet.com

Farwest Corrosion Control Company, Gardena, California USA, www.farwestcorrosion.com

Harbor Island, Seattle WA, USA, www.harboranodes.com

Performance Metals Products, Pennsylvania USA, www.performancemetals.com

In Europe:

MG Duff, England, www.mgduff.co.uk

Recambios Marinos SL, Spain, www.recambiosmarinos.es

Seaguard Italanodi srl, Italy, http://www.seaguard.it [note corrected web address, too]

Important points to remember:

- Anodes should be inspected regularly — consumption too quickly or too slowly means a problem somewhere.
- Slow consumption may mean the bonding system is incomplete, or the anode metal chosen is inappropriate. Remember: only magnesium for fresh water, and aluminum is your best friend for use in both salt and fresh — or brackish waters.
- Always clean mounting studs, using emery paper or a wire brush. Bronze wool is preferred over steel wool as steel wool can leave particles behind which will rust.
- Maritime slimes make the current flow, and resulting corrosion much worse — cleanliness of anode contacts is imperative. Power-wash and scrub contacts.
- Anodes completely consumed within a year indicate too little anode material. It can take some experimenting to get the correct amount, particularly on prop shafts.
- Anodes can be changed underwater, but most shipwrights recommend a haul-out so that anode mounting is fully secured and cleanliness can be assured.
- Follow manufacturer’s recommendations with outboards and I/O drives — lack of anode protection here can be fatal — serious failures from corrosion are all too common.
- A bronze prop turning pink is a mark of a failing bonding system and/or under protection by anodes — recheck the system and consider adding more anode material nearby.
- For maximum effectiveness anodes should be close to or mounted on the metal at risk — or follow a direct “line-of-sight” rule.

- Bonding systems are a must to ensure that ALL metal parts are protected. Heavier rather than lighter gauge wires are needed as the current flow is small.

SIDEBAR: **Why we need anodes.**

Some history

Scientists have known about dissimilar metals causing corrosion since the mid-1700s after the published works of Luigi Galvani (1737–1798) and Alessandro Volta (1745–1827), both considered the fathers of early electro-chemical research.

Around the same time, Samuel Pepys, Secretary of the British Navy, reported mysterious corrosion of iron and soft steel when found in the presence of copper and bronze. His experts did not know what caused the premature failures, but it was a major expense to replace war ships prematurely because the fasteners had disintegrated.

Scientists eventually learned that different metals had different electrical properties and would interact and cause an electrical current when in close contact and within any substance that would conduct electricity. Different metals that actually touch each other corrode quickly by generating electron flow. This discovery then led directly to battery development as widely different metals could be found that created up to 1.5 volts — and these could be added in series to create powerful batteries. Nickel-cadmium (NiCd) is a good example still widely used today, but they are corrosive if the contents leak — landfills don't want old batteries for this reason. Other battery examples include Lithium-Ion, Nickel-Metal-Hydride, Gallium-Arsenide etc. All feature two different metals. Lead/acid batteries work on a slightly different principle.

The Galvanic or Noble Scale

While creating an electrical current, one metal, the "softer" or "less noble" one was gradually destroyed. The "more noble" (noble was the term created to describe the different electrical properties of metals — its proper scientific term is the Galvanic Scale) was not harmed. While this worked well for batteries, even they eventually lose their power and need to be replaced following the consumption of one of the metals. Even the re-chargeable ones wear out eventually.

In boating, any current flow from dissimilar metals is not helpful. Different metals are needed for shafts, for example, in stainless steel, while thru-hulls and props are often made from bronze. Outboards have stainless props but aluminum housings. Left unprotected one of these metals will corrode and need premature replacement. Salt water makes an ideal electrolyte for current flow, but even fresh water has enough impurities that it too will conduct small amounts of electricity. Corrosion of metal parts we don't need. Corrosion of motor or drive parts can quickly lead to expensive failures.

A Galvanic Scale was developed that measured this different electrical activity for different metals. Magnesium, zinc and aluminum are all at the "active" end, while, stainless steel, titanium and graphite are at the less active or "more noble" end of the scale. Electrical flow between these extreme ends will be highest, but will also occur between ***any two*** different metals, even if they are close together on the scale.

Boaters have adopted a system that added a sacrificial metal to all underwater metal parts and hulls so that the new metal would be consumed instead of the needed marine parts that come with a hefty price tag. Zinc was the first metal found to be effective, as it was low on the activity scale, was relatively inexpensive, and readily available. No one minded when the zinc was sacrificed.

Recent research shows aluminum is now the better choice for marine anodes as it has performance advantages, costs no more and has no poisonous content.

OPTION: Include a Noble, or Galvanic Scale in chart form.