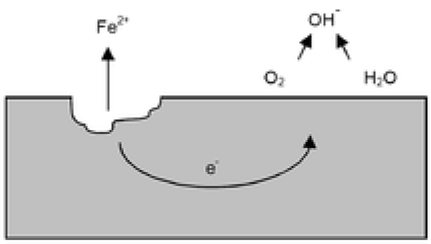
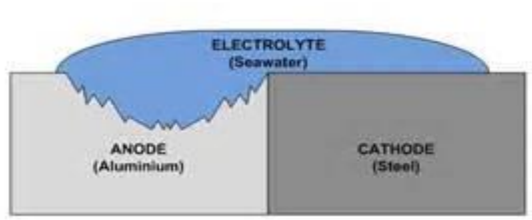
CORROSION IN BOATS

Corrosion of metals is subject to the potential reduction mechanisms that govern the movement of electrons in an electrolyte (conductive medium) and occurs when its protective coatings are destroyed.

Two forms of corrosion of immersed metals -

1. A metal in contact with an electrolyte has a natural tendency to lose its electrons and corrode: this is the phenomenon of oxidation causing electrochemical corrosion (or dissolution). Steel rusts….silver tarnishes.





2. Dissimilar metals in contact with each other when immersed in an electrolyte creates a battery. The more reactive or least noble metal (**the anode**) will lose its electrons in preference to a more noble metal(s) which is less reactive (**the cathode**).

Electrons in movement = electrical current is flowing and corrosion is happening.

Metals and liquids (especially salt water) don't date well. To protect immersed metals from corrosion – wastage, corrosion control strategies are used to limit the unavoidable and undesirable consequences of this enforced cohabitation:

1. Underwater coatings, insulating paint-like materials.
2. Electrically isolating dissimilar metals.
3. Achieving cathodic protection using protective anodes, among which are -

• Sacrificial anodes, which potential is electrically more negative than the potential of the metal to be protected. Sacrificial anodes are fitted to the majority of yachts and small craft and are made from electrically active metals or alloys of zinc, aluminum and magnesium.

• Impressed current anodes (ICCP) delivers a controlled DC protective current to immersed metals.

CATHODIC PROTECTION

All metals can be classified according to naturally occurring electrical potentials or free eroding values. This is referred to nobility on the galvanic scale of metals and can predict the opportunity for corrosion. Gold is higher on the nobility scale or nobler where zinc and aluminum is lower or less noble on the same scale.

Metallurgy Anodic Index	Index (V)
Gold, solid and plated, Gold-platinum alloy	0.00
Rhodium plated on silver-plated copper	0.05
Silver, solid or plated; monel metal. High nickel-copper alloys	0.15
Nickel, solid or plated, titanium an s alloys, Monel	0.30
Copper, solid or plated; low brasses or bronzes; silver solder; German silvery high copper-nickel alloys; nickel-chromium alloys	0.35
Brass and bronzes	0.40
High brasses and bronzes	0.45
18% chromium type corrosion-resistant steels	0.50
Chromium plated; tin plated; 12% chromium type corrosion-resistant steels	0.60
Tin-plate; tin-lead solder	0.65
Lead, solid or plated; high lead alloys	0.70
Aluminum, wrought alloys of the 2000 Series	0.75
Iron, wrought, gray or malleable, plain carbon and low alloy steels	0.85
Aluminum, wrought alloys other than 2000 Series aluminum, cast alloys of the silicon type	0.90
Aluminum, cast alloys other than silicon type, cadmium, plated and chromate	0.95
Hot-dip-zinc plate; galvanized steel	1.20
Zinc, wrought; zinc-base die-casting alloys; zinc plated	1.25
Magnesium & magnesium-base alloys, cast or wrought	1.75
Beryllium	1.85

Galvanic Corrosion Potential Copper/Brass Content

.05

.30

Copper immersed in seawater at has a potential of (-) 350 mV and aluminum is (-) 650 mV. The greater the difference in electrical potentials between these two metals or distance between each on the galvanic scale, the stronger the oxidation or wastage will be. Aluminum, with an electrical potential much lower than that of copper will oxidize or sacrifice in preference to steel.

The aluminum outdrive becomes the **anode** and therefore will sacrifice itself to the other immersed metals which are more noble or the **cathode**.

Installing a protective zinc anode [-1200 mV] will reverse this situation by repositioning the aluminum outdrive as the cathode with the zinc, less noble than aluminum, becoming the anode and will sacrifice itself or corrodes instead of the aluminum outdrive. This is referred to as **cathodic protection**.

Cathodic protection is the corollary of galvanic corrosion. Sacrificial anodes reverse the direction of the electric current and anodic material is lost in preference to the metal being protected. The potential must be shifted by no less than 200 mV to achieve protection. Dissimilar metals in marine applications should be within 100 mV DC of each other relative to the galvanic scale to reduce corrosion.

All metal parts immersed in the same electrical medium should be at the same potential (by electrical interconnection or bonding) and be within the potential limits shown below.

If there is no bonding system, immersed metals must be individually protected and be within the potential limits shown below –

PROTECTION RANGE

Nobility	Metal - Alloy	Protected Range*
Anodic – Least Noble	Marine aluminum alloys – 300 series stainless steel (active)	50 - 150 mV DC
	Iron, mild steel.	50 - 250 mV DC
Cathodic – Most Noble	Copper and copper alloys such as bronze, cupro-nickels, brasses	480 - 640 mV DC

- *Relative to a USN military spec zinc anode*