

Dezincification-resistant (DZR) brass is the name used to identify a group of copper alloys containing more than 15% zinc where elements like arsenic (As) and antimony (Sb) are added in controlled quantity in order to inhibit the selective dissolution of zinc caused by contact with various types of water including sea water. Hot-formed articles made with DZR brass require a controlled heat treatment to provide an effective resistance to dezincification, whose measurement criteria are set by international standards such as ISO6509 and AS2345, and can be verified with specific tests.

Properly manufactured DZR brass articles are suitable for applications in contact with sea water.

Typical Applications for Brasses

Type of Brass	Applications
Aluminium brass	Seawater tube and pipe
Naval brass	Tubesheet
Aluminium-nickel-silicon brass	Hydraulic, pneumatic and instrument lines
Dezincification-resistant brass (DZR)	Through hull fittings
Manganese bronze (cast and wrought)	Propellers, shafts, deck fittings, yacht winches
UR 30TM (proprietary alloy)	Aquaculture

Table I: typical applications for brasses

Source: *Copper Alloys for Marine Environments*, Copper Development Association.

However, if DZR brass components are fitted in contact with parts made from different alloys or metals, an electrolytic cell might be formed, with the resulting risk of galvanic corrosion. The anti-dezincificant properties of DZR brass give no effective protection against galvanic corrosion.

The conditions that trigger galvanic corrosion are:

1. An electrolyte bridging the two metals, which may not necessarily be aggressive to the individual metals when they are not coupled;
2. Electrical connection (direct contact) between the metals;
3. A significant difference in potential between the two metals to provide a significant galvanic current;
4. A sustained cathodic reaction on the more noble of the two metals, in most practical situations the consumption of dissolved oxygen in the electrolyte.

Sea water is a very effective electrolyte and undoubtedly the most widely studied. Many experimental studies have led to the definition of the galvanic series of metals in sea water, where metals and alloys are classified according to their potential. The general recommendation is that a coupling of two metals with very different potentials bridged by sea water should be avoided because the more electronegative metal acts as an anode and is quickly corroded; the obvious exception is the purposeful use of zinc or aluminium sacrificial anodes.

Electro Positive	Graphite	
	Platinum	
Gold		
High Alloy Stainless Steels	{Super Austenitic}	
	{Super Duplex}	
	Titanium	
	Nickel Chrome	{625; C-276}
	Molybdenum Alloys	
	Low alloy stainless steels (eg 316)	(PASSIVE)
	Alloy 400/Alloy K-500	
	Silver	
	Nickel Aluminium Bronze	
	Copper nickel (70/30; 90/10)	
	Gunmetals/Tin Bronzes	
	Brasses	
	Tin	
	Lead	
	Austenitic Cast Iron	
	Low alloy stainless steels (eg 316)	(ACTIVE)
	Cast Iron	
	Carbon Steel	
	Aluminium alloys	
	Zinc	
	Magnesium	
Electro Negative		

Table II: galvanic series in sea water

Source: *Bimetallic Corrosion*, National Physical Laboratory

Although the potential difference between materials is the prime driving force of the corrosion current, it cannot be considered a reliable guide to the rate and form of corrosion suffered at any particular contact. In particular, statements claiming that specific differences of potential are safe or unsafe, are unreliable. The severity of bimetallic corrosion is dependent on the conductivity of the electrolyte solution, bimetallic corrosion is more severe under immersed conditions than in the atmosphere. The risk of corrosion under immersed conditions is greatest if the area of the cathodic metal is large compared to the area of the anodic metal.

Based on the existing scientific literature, we can formulate the following suggestions for dealing successfully with galvanic corrosion:

1. Avoid whenever possible to join together parts made with different metals, in contact with (or immersed in) a highly conductive electrolyte (i.e. sea water).
2. If different metals are put in contact, it is advisable that the surface wetted by the electrolyte of the more electronegative (anodic) metal should be much larger than the wetted surface of the more electropositive (cathodic) metal. For instance, in a brass-bronze electrolytic cell (brass being the anode and bronze the cathode) a large brass object in contact with small bronze accessories is unlikely to undergo significant corrosion.
3. The bimetallic corrosion rate of copper-based alloys in sea water depends upon the flow rate of the water as well as on the area ratio, with copper alloys tending to become less noble (and to corrode more) with increasing flow rate.
4. When an electrolytic cell is formed with an unfavourable surface ratio (the anode being smaller than the cathode) and/or a significant flow rate of the electrolyte, a suitable cathodic protection of the anodic metal is highly recommended; this may be the case with a large bronze item in contact with a smaller brass part, with a zinc sacrificial anode electrically connected to the latter.