

A Guide to Galvanic Corrosion Effects Between Aluminium and Other Metals

Metal	Galvanic Corrosion Effect When Coupled With Aluminium or an Aluminium Alloy	
Gold, Platinum, Silver	Attack accelerated in most environments	These metals, and especially those at the top of the list, are generally cathodic to aluminium and its alloys, which are therefore preferentially attacked when corrosion occurs
Copper, Copper Alloys, Silver Solder	Attack accelerated in most atmospheres and under conditions of total immersion	
Solder Coatings on steel or copper	Attack accelerated at interface in severe or moderate atmospheres and under conditions of total immersion	
Nickel and Nickel Alloys	Attack accelerated in marine or industrial atmospheres and under conditions of total immersion, but not in mild environments	
Steel, Cast Iron	Attack accelerated in marine or industrial atmospheres and under conditions of total immersion, but not in mild environments	
Lead, Tin	Attack accelerated only in severe environments such as marine and some industrial	
Tin-Zinc Plating (80-20) on steel	Attack accelerated only in severe atmospheres and under conditions of total immersion	
Pure Aluminium and Aluminium Alloys not containing substantial amounts of copper or zinc	When aluminium is alloyed with appreciable amounts of copper it becomes more noble and when it is alloyed with appreciable amounts of zinc it becomes less noble. In marine or industrial atmospheres, or when totally immersed, an aluminium alloy suffers accelerated attack when in good electrical contact with another aluminium alloy that contains substantial amounts of copper, such as the alloys in the 2000 series	
Cadmium	No acceleration of attack on cadmium except in fairly severe atmospheres in contact with an aluminium alloy containing copper and under conditions of total immersion	These metals are generally anodic to aluminium and are attacked when corrosion occurs, thereby protecting the aluminium
Zinc and Zinc Alloys	Attack on zinc is accelerated in severe environments such as marine or industrial and under conditions of total immersion	
Magnesium and Magnesium Alloys	Attack on magnesium is accelerated in severe environment such as marine or industrial and under conditions of total immersion	Attack on aluminium may also be accelerated
Titanium	Little data available, but attack on aluminium is known to be accelerated in severe marine or industrial conditions and when immersed in seawater	These metals form inert protective film that tend to reduce galvanic reaction. Where attack occurs, the aluminium base material suffers
Stainless Steel (18-8, 18-8-2 and 13% Cr)	No acceleration of attack on aluminium in moderate atmospheres, but attack may be accelerated in severe marine or industrial atmospheres and under conditions of total immersion	
Chromium Plate	No acceleration of attack on aluminium when plating is not less than 0.0025mm thick, except in severe atmospheres	

The Electro-Chemical Series

BASE METAL

Magnesium
Zinc
Aluminium
Cadmium
Mild Steel
Cast Iron
Lead
Tin
Brasses
Copper

Bronzes
Monel Metal
Silver Solders (70% Ag 30% Cu)
Nickel
Stainless Steel (Type 304)
Silver
Titanium
Graphite
Gold

NOBLE METAL

Platinum

Pitting

Pitting is the localised form of corrosion that usually occurs at random in the form of small pits or craters (of roughly hemispherical shape). Pits usually become covered with a mound of corrosion product. The rate of penetration of a pit usually diminishes with time, and frequently the pitting can be tolerated if the wall thickness is adequate. The frequency and depth of pitting vary somewhat from one alloy to another. The depth of pitting is extremely small and the process is known as "weathering". The type and level of pollution will determine general appearance.

Regular maintenance and washing down of aluminium should prevent permanent discolouration from the effects of industrial pollutants. Anodised surfaces retain their original appearance for much longer periods when regular maintenance is provided.

Poultice Action

Poultice Action is a form of corrosion that takes place under moist conditions when porous materials such as asbestos, cloth, cork, paper, etc absorb water and act as a poultice. The corrosive action is the result of differences in oxygen concentration in the water in adjacent areas of the material. It may be increased by corrosive chemicals extracted from the material.

Exposure

Aluminium and its alloys have excellent durability and corrosion resistance, but, like most materials, their behaviour can be influenced by the way in which they are used.

Aluminium's natural affinity with oxygen results in the formation of a transparent oxide film when aluminium is exposed to air. This oxide film is generally 5 to 10µ thick, extremely hard, chemically stable, corrosion resistant and adheres strongly to the parent metal surface. If damaged in anyway, it will reform if enough oxygen is available. The film is removed to facilitate anodising or welding.

In anodising, a thicker, more controlled deposit of oxide film is added. In welding, the oxide film inhibits metal fusion.

Galvanic Corrosion

Takes place when dissimilar metals are coupled together in the presence of moisture. The severity of the corrosion depends largely on the circumstances in which the electrolytic couple formed producing a current flow from the less noble metal (anode) to the more noble metal (cathode) and resulting in corrosion of the less noble metal.

Galvanic corrosion may be prevented by insulating dissimilar metals from each other with an electrically inert, non-absorbent barrier.

This type of connection is used between the aluminium superstructure and steel decking on ships.

Simple Rules to Avoid Corrosion

Since the corrosion behaviour of alloyed aluminium is influenced by the physical conditions of the environment, contact with dissimilar metals and by the presence of crevices, the design of equipment made with aluminium can have an appreciable influence on the nature and rate of corrosion.

- Never use aluminium in anaerobic (no oxygen) conditions
- Seal all joints and bolt holes
- Eliminate corners and crevices which are difficult to clean
- Butt weld where possible
- Avoid dissimilar metal contact whenever possible

Contact With Material

Wood

- Dry wood has no reaction to aluminium
- Unseasoned/damp wood should be coated with an aluminium or bituminous paint
- Treated timber may require special consideration and referral to the supplier

Insulation

- Foam, felt, fire retardant may cause corrosion of aluminium if they become wet when in contact with it
- Protect the aluminium by using an inert barrier

Concrete

- No protection under perfectly dry conditions
- As these conditions are rare, all aluminium surfaces in direct contact with concrete should be coated with bituminous paint

Chemicals

- A direct chemical attack of aluminium only occurs to any great extent in strong acid or alkaline conditions
- In some cases the temperature may significantly alter the rate of chemical reaction or be a major factor in initiating chemical attack