

Dissimilar metals

INTRODUCTION

If two different metals are placed in electrical contact and bridged by an electrolyte, a current flows through the solution from the anodic or more active metal to the cathodic or more noble metal. As a result, the cathodic metal tends to be protected but the anodic metal may suffer significant corrosion.

Figure 1, shows a Galvanic Table which lists metals from the least active (noble) to the most active. Such tables are of significant value in drawing the attention of designers to the dangers of unintended galvanic corrosion. The table, however, must be interpreted not only on a basis of the potential difference between the metals in the table, but the area relationship between cathodic and anodic metals and the ability of some metals and alloys to form stable passive oxides. The latter phenomenon can control the overall corrosion reaction leading to a significant decrease in the rate of material loss.

A guide to the compatibility of various metals and alloys in direct electrical contact is shown in Figure 2.

One exception to the necessity for the two metals or alloys to be in direct electrical contact for metallic corrosion to occur, is when the noble metal corrodes slightly and dissolves in water which subsequently flows over a less noble material.

The corrosion product from the more noble metal may then deposit on the less noble metal forming a true galvanic contact. An example of this reaction is when copper can dissolve very slightly in some natural waters and re-deposit on zinc or zinc/aluminium coated steel. Hence galvanic corrosion may be experienced when

two dissimilar metals or alloys, not in direct contact are nevertheless connected electrically.

Obviously galvanic corrosion is more severe under immersed conditions than when exposed to normal atmospheric environments. In the case of atmospheric environments, corrosion will only occur when the galvanic couple is wet.

This is related to many factors such as the presence of moisture in crevices, speed of evaporation and specific time of wetness. Generally, under atmospheric conditions galvanic corrosion is usually localised at the point of contact. Our experience has shown that significant corrosion of the most active (anodic) component is dependent upon the time of wetness, which can be further accelerated by contamination of the surface with conductive salts.

A typical example of this reaction can be seen to be associated with stainless steel self-drilling roof screws which have been incorrectly used to fix COLORBOND® Ultra steel roof sheeting. The consequent establishment of an area of corrosion approximately 40 mm in diameter on the roof sheeting about the screw head is initiated by the deposition of detritus from the environment, which greatly extends the time of wetness. The deposit contains salts from the surrounding environment and extends to a discontinuance in the organic coating on the sheeting adjacent to the fastener.

This effectively couples the “insulated” noble fastener material to the more active steel sheet resulting in corrosion of the COLORBOND® Ultra steel sheeting about the fastener head.

This mechanism is further enhanced should the washer used to seal the fastener contain carbon

black. Carbon black is highly conductive and is capable of initiating and maintaining a significant corrosion reaction even in the absence of a noble (cathodic) fastener. Washers free of carbon black are readily available.

Figure 1: Galvanic series of metals and alloys in sea water

	NOBLE (CATHODIC)
	Gold Platinum Titanium Graphite Silver
PASSIVE	Stainless Type 316 Stainless Type 310 Stainless Type 304 Stainless Type 302 Stainless Type 430 Stainless Type 410
PASSIVE	80% Ni 15% Cr Inconel 60% Ni 15% Cr Nickel Monel
	Copper-Nickel Bronzes Copper Brasses
ACTIVE	80% Ni 20% Cr Inconel 60% Ni 15% Cr Nickel Tin Lead
ACTIVE	Stainless Type 316 Stainless Type 310 Stainless Type 304 Stainless Type 302 Stainless Type 430 Stainless Type 410 Cast Iron Carbon Steel Cadmium Aluminium Zinc Magnesium Alloys Magnesium
	ACTIVE (ANODIC)

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Figure 2: Compatibility of direct contact between metals or alloys

Material	Accessory or Fastener Material					
	Zn-coated steel & zinc	Stainless Steel (300 Series)	AM-coated steel	Aluminium	Copper, Brass, Lead & Monel	Carbon Black ^
COLORBOND® steel †	Yes*	No	Yes	Yes	No	No
COLORBOND® Stainless steel	No	Yes	No	No	No	No
AM-coated steel	Yes*	No	Yes	Yes	No	No
Zn-coated steel & zinc	Yes	No	Yes*	Yes*	No	No

* Inert catchment situation may apply. (See Technical Bulletin TB15)

† Includes all BlueScope prepainted products on an aluminium/zinc/magnesium alloy-coated steel or zinc-coated steel base

AM-coated steel = aluminium / zinc / magnesium alloy-coated steel, e.g. ZINCALUME® steel, TRUECORE® steel

Zn-coated steel = zinc-coated steel, e.g. GALVSPAN® steel

^ As found in some washers, roof penetration flashings and black "lead" pencils etc.

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