CORROSION TECHNICAL BULLETIN 12

MAY 2017 | Revision 5

This issue supersedes all previous issues

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 to the cathodic or more noble metal. As a result, the cathodic metal tends to be protected but the anodic materials may suffer great corrosion.

Figure 1, shows a Galvanic Table which lists metals from the least active (noble) to the most active metals. Such tables are of significant value in drawing the attention of designers to the dangers of bi-metallic corrosion. The tables, 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 materials 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.

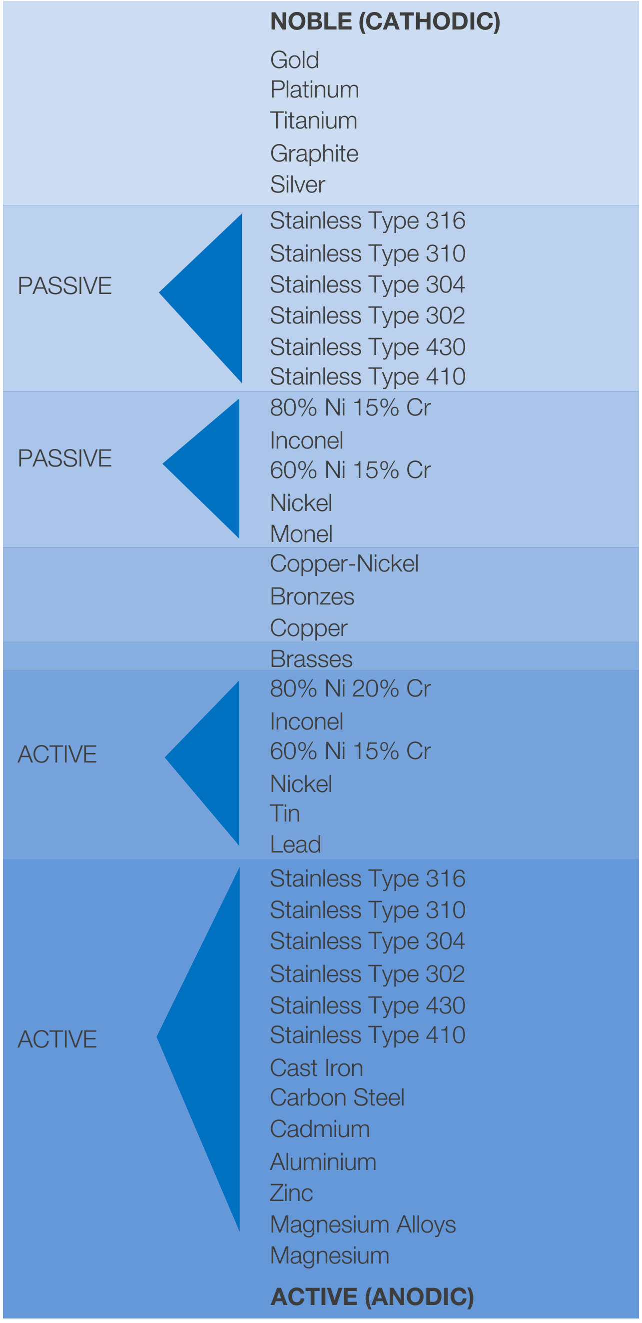
A guide to the compatibility of various metals and alloys in contact is shown in *Figure 2*.

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 bi-metallic 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 bi-metallic corrosion may be experienced when two dissimilar metals or alloys, not in direct contact are nevertheless connected electrically.

Obviously bi-metallic 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 bi-metallic couple is wet.

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)

Figure 2: Compatibility of Direct Contact between Metals or Alloys

Cladding Material	Accessory/Fastener Material							
	Stainless Steel (300 series)	Zinc-coated steel & Zinc	Zinc/ aluminium coated steel	Aluminium	Copper & Brass	Lead	Monel	Carbon Black[2]
Zinc-coated steel & zinc	No	Yes	Yes[1]	Yes[1]	No	Yes	No	No
ZINCALUME® steel	No	Yes[1]	Yes	Yes	No	No	No	No
COLORBOND® steel[3]	No	Yes[1]	Yes	Yes	No	No	No	No
COLORBOND® Stainless steel	Yes	No	No	No	No	No	No	No

Key: [1] Inert catchment situation may apply. (See Technical Bulletin TB15)

[2] As found in some washers, roof penetration flashings and black “lead” pencils etc.

[3] Includes all BlueScope prepainted products on a ZINCALUME® steel or galvanised base e.g. COLROBOND® Ultra steel

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 bi-metallic corrosion is usually localised at the point of contact. Our experience has shown that significant corrosion of the less noble or the more 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 anodic 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 or cathodic fastener. Washers free of carbon black are readily available.

One unusual example of such galvanic activity is related to the corrosion induced by the use of common black marking pencils on bare galvanized and ZINCALUME® steel products. Black “lead” pencils contain graphite/carbon rather than lead. This reacts with the metallic coating resulting in indelible marking or fine corrosion of the sheet surface and, in aggressive environments, severe knife like corrosion of the metallic coating.

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