19. THE GALVANIC (ELECTROCHEMICAL) SERIES

INTRODUCTION

All conductive elements (all metals) have different electrical potentials. These electrical potentials put each metal in a hierarchy of activity, with the most active metals at the top of the lists, and the least active at the bottom. This order of electrochemical activity is called the Galvanic Series.

A metal higher in the Galvanic Series will corrode preferentially to a metal below it in the Series. The greater the distance apart the metals are in the Galvanic Series, the higher the current that will flow between them if they are connected in the presence of an electrolyte (a conducting solution; usually water containing dissolved salts).

Some metals like aluminium and zinc develop tough oxide films. These films give them exceptionally good corrosion resistance, although they are among the most active metals.

The position of zinc on the Galvanic Series, above most other metals, means that it will corrode preferentially if it contacts any of these metals and moisture is present. This characteristic of zinc is an important part of its exceptional performance in protecting steel from corrosion.

Many steel products are galvanized using continuous galvanizing processes. These semi-fabricated steel items (columns, beams, angles etc.) are subject to further processes like slitting, cutting, drilling, punching and welding.

This leaves the steel uncoated on cut edges and other areas damaged by processing. The galvanic protection provided by the adjacent zinc coating provides these steel products with their anti-corrosion performance, otherwise rapid corrosion would occur on these exposed areas.

A counter example occurs with chrome-plated steel. Chromium is below steel in the Galvanic Series. When a chrome plating is breached to expose the steel substrate, rapid corrosion of the steel will occur as the presence of chromium will accelerate the rate of steel corrosion. In addition, copper plating is often used in the decorative chrome plating process and copper is also highly cathodic to steel.

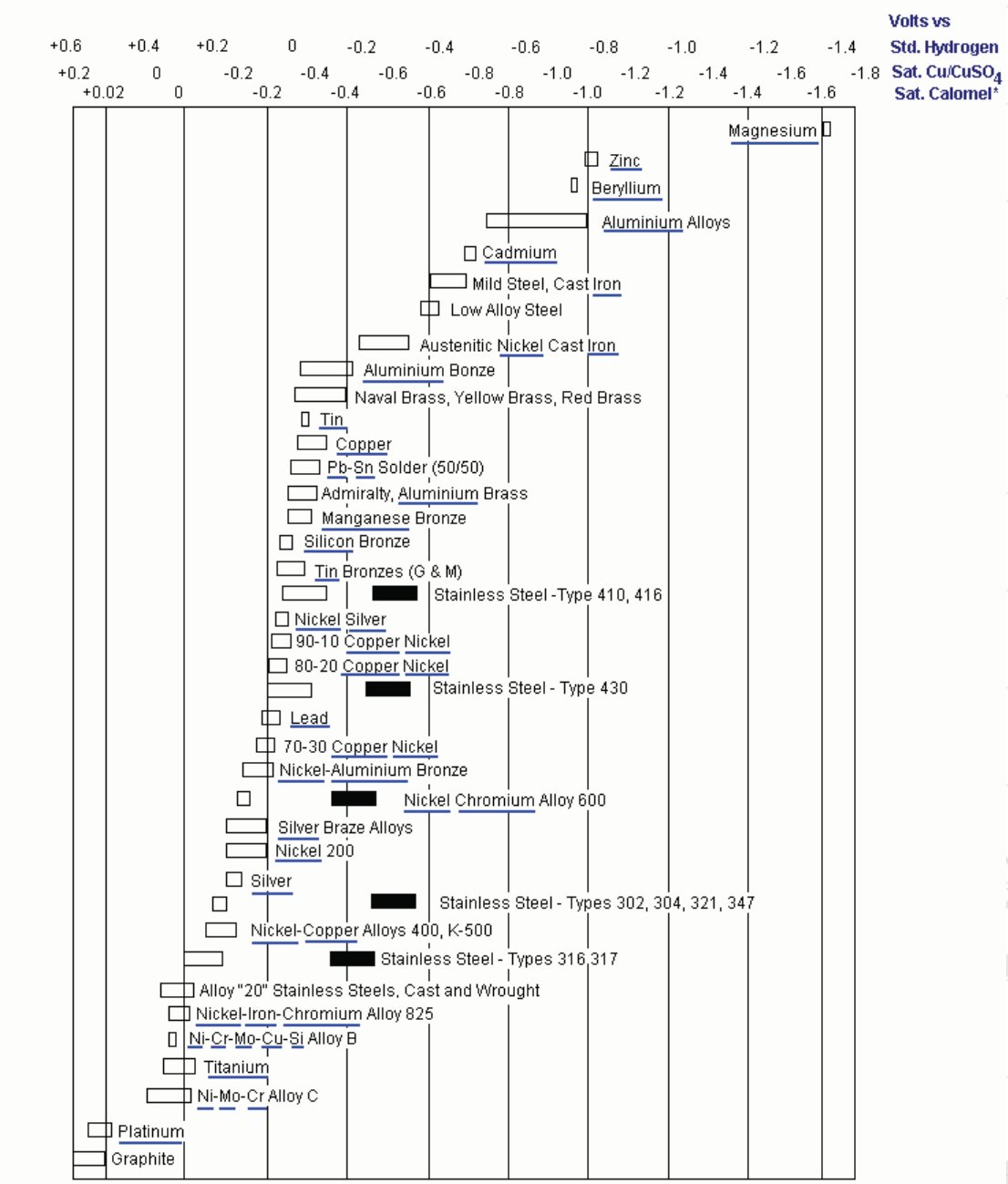
Reference to the Galvanic Series is important when selecting metals that will be in contact. Their relative positions in the Galvanic Series will determine whether corrosion occur at the point of contact. For this reason copper should never be allowed in contact with steel, zinc or aluminium, nor should run-off from copper cladding be allowed to contact these other metals, as quite serious galvanic corrosion may result.

Similar care must be taken with stainless steel in contact with either mild steel or galvanized or Zinclume™ coated steel.

An often-overlooked material in the Galvanic Series is graphite – the only non-metal listed. It is lowest in the series, and thus can cause serious electrochemical corrosion problems with a range of other metals. Some rubber sealing products have high graphite content and can cause electrochemical corrosion problems.

Earlier versions of self drilling roofing screw washers were made from this material and resulted in the premature failure of the coated steel roofing and cladding on which they were used. The effect of graphite can also be observed on galvanized or Zincalume™ roofs near wood or oil fire chimney outlets. The carbon (graphite) deposits falling on the roof will accelerate the corrosion of the roofing.

The Galvanic Series diagram shows the differences in electrical potential between materials. The further apart they are in the Series, the greater the potential and the greater the corrosion current that can operate between them.


Volts vs
Std. Hydrogen
Sat. Cu/CuSO4
Sat. Calomel*
+0.6 +0.4 +0.2 0 -0.2 -0.4 -0.6 -0.8 -1.0 -1.2 -1.4
+0.2 0 -0.2 -0.4 -0.6 -0.8 -1.0 -1.2 -1.4 -1.6 -1.8
+0.02 0 -0.2 -0.4 -0.6 -0.8 -1.0 -1.2 -1.4 -1.6
Magnesium
Zinc
Beryllium
Aluminium Alloys
Cadmium
Mild Steel, Cast Iron
Low Alloy Steel
Austenitic Nickel Cast Iron
Aluminium Bonze
Naval Brass, Yellow Brass, Red Brass
Tin
Copper
Pb-Sn Solder (50/50)
Admiralty, Aluminium Brass
Manganese Bronze
Silicon Bronze
Tin Bronzes (G & M)
Stainless Steel -Type 410, 416
Nickel Silver
90-10 Copper Nickel
80-20 Copper Nickel
Stainless Steel - Type 430
Lead
70-30 Copper Nickel
Nickel-Aluminium Bronze
Nickel Chromium Alloy 600
Silver Braze Alloys
Nickel 200
Silver
Stainless Steel - Types 302, 304, 321, 347
Nickel-Copper Alloys 400, K-500
Stainless Steel - Types 316,317
Alloy "20" Stainless Steels, Cast and Wrought
Nickel-Iron-Chromium Alloy 825
Ni-Cr-Mo-Cu-Si Alloy B
Titanium
Ni-Mo-Cr Alloy C
Platinum
Graphite


INDUSTRIAL GALVANIZERS
INDUSTRIAL GALVANIZERS
INGAL
SPECIFIERS MANUAL

01 - SPECIFIERS MANUAL — THIRD EDITION

Industrial Galvanizers Australian Galvanizing Division (IGAG) operates nine galvanizing plants around Australia, ranging in size from large structural galvanizing facilities to specialised small plants designed to process small parts.

The Australian Galvanizing Division has galvanized in excess of 2 million tonnes of steel products in Australia since its first plant was commissioned in 1965 and is recognized for its ability to handle complex and difficult projects, as well as routine contracts.

This experience has been collated in the Specifiers Design Manual, to assist those involved in the design of steel products and projects to better understanding the galvanizing process and allow the most durable and cost-effective solutions to be delivered to these products and projects. All sections of this Third Edition have been completely updated and additional sections have been included to provide additional technical information related to the use of hot dip galvanized steel.

In addition to its Australian Galvanizing operations, Industrial Galvanizers Corporation has a network of manufacturing operations in Australia, as well as galvanizing and manufacturing businesses throughout Asia and in the USA.

The company's staff in all these locations will be pleased to assist with advice on design and performance of hot dip galvanized coatings and products. Contact details for each of these locations are located elsewhere in this manual.

This edition of the Industrial Galvanizers Specifiers Manual has been produced in both html and .pdf formats for ease of access and distribution and all documents in the Manual are in .pdf format and can be printed if paper documents are required.

The Specifiers Manual is also accessible in its entirety on the company's web site at www.ingal.com.au.

Additional copies of the Specifiers Manual are available on CD on request.

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