MW Components

MATERIAL COMPATIBILITY SELECTION DATA

Galvanic Corrosion

Similar metals are compatible; dissimilar metals are not. When dissimilar metals contact in the presence of an electrolyte, a galvanic action occurs which causes one of the metals to corrode at a much faster than normal rate, while the other corrodes more slowly, if at all. The rate, location, and the extent of the corrosion depend on three factors:

- The difference in electrical potentials
- The conductivity strength of the corroding medium, and
- The relative sizes of the contacting areas.

All metals have electrical potentials. Through research, the potentials of different base metals and their alloys, when exposed to seawater, were measured and then ranked into a series.

Galvanic Series

Table 1 presents the Galvanic Series of Metals and Alloys. The various metals are grouped. Those within the same group are reasonably compatible when used together; those from different groups cause a corrosion problem. Some metals basically those with significant contents of nickel and chromium are included in the Series both in their active and passive conditions. Passivation (surface cleaning and sealing) lowers the metal electrical potential and improves its corrosion behavior.

In an electrical couple, the metal of higher electrical potential is the cathode (-), that of the lower the anode (+). Current flows from the cathode to the anode, from the anode through the electrolyte (corroding medium) and back to the cathode. Corrosion occurs at the point the current leaves the anode to enter the electrolyte. When dissimilar metals contact, the anode corrodes, the cathode survives.

Study of the Galvanic Series suggests that steel and aluminum are reasonably compatible; but, if titanium and aluminum contact, the aluminum, as the anode, will corrode. Fig. 1 illustrates an example. The bolt, where it contacts the aluminum, will not corrode because it is now the cathode. The aluminum plate in contact with the bolt may corrode, but only slightly because of the minor difference in their electropotentials and the large anode-to-cathode area ratio. The aluminum plate will corrode where its exposed exterior surfaces contact the copper plate. The aluminum plate may also corrode on its interior surface, but not to the same degree because the corroding medium and oxygen supply are largely sealed out due to the bolt clamping action.

Table 1:

Galvanic Series of Metals & Alloys

*Materials in the same group are compatible, used with other materials may cause corrosion.

+ Corroded End (anodic, or least noble)
• Magnesium • Magnesium alloys • Zinc
• Aluminum 1100 • Cadmium • Aluminum 2024-T4 • Steel or Iron • Cast Iron • Chromium-Iron (active) • Ni-Resist cast iron
• Type 304 Stainless (active) • Type 316 Stainless (active)
• Lead tin solders • Lead • Tin
• Nickel (active) • Inconel nickel-chromium alloy (active) • Hastelloy Alloy C (active)
• Brass • Copper • Bronzes • Copper-nickel alloys • Monel nickel-copper alloy
• Silver solder • Nickel (passive) • Inconel nickel-chromium alloy (passive)
• Chromium-Iron (passive) • Type 304 Stainless (passive) • Type 316 Stainless (passive) • Hastelloy Alloy C (passive)
• Silver • Titanium • Graphite • Gold • Platinum
–Protect End (cathodic, or most noble)

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