Galvanic Reaction Between Metals

Galvanic Corrosion

Galvanic corrosion occurs when two dissimilar metals come into electrical contact with a conductive electrolyte, usually rainwater or groundwater. In this process, a metal atom is oxidized, during which it leaves its bulk metal after losing one or more electrons and is then transferred to another site. The site where the metal atoms lose electrons is called the anode, while the site where the electrons are transferred is called the cathode.

It is especially important to consider the potential of galvanic corrosion when choosing metal paneling, trim, joist hangers and fasteners.

Minimizing Galvanic Corrosion

Use metals that are not dissimilar. Metals close together in the Galvanic Series list as metals close together generally do not have a strong effect on one another. The farther apart any two metals are on the list, the stronger the corroding effect on the more active metal. Prevent dissimilar metals from becoming electrically connected by water. Keep small anodes from contacting large cathodes. The rate of corrosion depends on the surface area of the anode with respect to the cathode. The smaller the surface area of the anode relative to the surface area of the cathode, the more concentrated the flow of electrons at the anode and the faster the rate of corrosion. The larger the anode's surface area in relation to the cathode, the more spread out of the flow of electrons and the slower the rate of the anode's corrosion.

The application of a protective metallic coating, known as a sacrificial coating, can provide galvanic protection to the base metal when the coating is measurably more anodic than the base metal. Galvanic corrosion will take place with the anodic material when the base material is exposed. The extent to which a sacrificial coating can continue to protect the base metal is directly related to the thickness of the coating. Metallic coatings that are not sacrificial, as well as paint coatings, plastic, or other non-metallic barriers can also significantly reduce galvanic corrosion. However, when using a paint coating, it is important to realize that if the base metal becomes exposed through a small scratch in the paint, the base metal could rapidly corrode if it becomes the anode in a reaction with a nearby dissimilar metal with a large surface area.

Preventing Corrosion in Fasteners

Galvanic corrosion is obviously a concern in the use of metal fasteners such as bolts, screws, and welds. Because fasteners have a much smaller surface area than the materials they fasten, fasteners that take on the role of the anode will be at risk of rapid corrosion and thus should be avoided. To minimize the risk of galvanic corrosion of fasteners, match the surface metal on the fastener with that on the metal it will fasten. The most desired combination of large anode with small cathode; in other words, fasteners such as bolts and screws should be made of the metal less likely to corrode, or the more cathodic.

The following chart can be used to guide the selection of fasteners based on galvanic action:

Base Metal	Fastener Metal					
	Zinc & Galvanized Steel	Aluminum & Aluminum Alloys	Steel & Cast Iron	Brasses, Copper, Bronzes, Monel	Martensitic Stainless (Type 410)	Austenitic Stainless Steel (Type 302/304, 303, 305)
Zinc & Galvanized Steel	A	B	B	C	C	C
Aluminum & Aluminum Alloys	A	A	B	C	Not Recommended	B
Steel & Cast Iron	AD	A	A	C	C	B
Terne (Lead Tin) Plated Steel Sheets	ADE	AE	AE	C	C	B
Brasses, Copper, Bronzes, Monel	ADE	AE	AE	A	A	B
Ferritic Stainless Steel (Type 430)	ADE	AE	AE	A	A	A
Austenitic Stainless Steel (Type 302/304)	ADE	AE	AE	AE	A	A

Key:
A: Corrosion of the base metal is not increased by the fastener.
B: Corrosion of the base metal is marginally increased by the fastener.
C: Corrosion of the base metal may be markedly increased by the fastener material.
D: Plating on the fasteners is rapidly consumed, leaving the bare fastener metal.
E: Corrosion of the fastener is increased by the base metal.

Corrosion of Panels and Trim in Contact with Treated Wood

Do not allow aluminum, aluminum-coated, and galvalume-coated components come into direct contact with wood preservatives containing copper, mercury, or fluorides. Avoid direct contact between bare metal panels and treated lumber where condensation will frequently form on the metal surface in contact with the lumber, and where the wood treatment is more, noble than the metal surface. Use an appropriate barrier to separate metal components and treated lumber.

Citations: . "Corrosion of Metals," . David R. Bonhoff, "Metal Panel and Trim Installation Tolerances," July 2005. "Galvanic Corrosion Chart," http://www.metal-mart.com/Guides/Galvanic.htm. "Galvanic Corrosion Chart," "Galvanic Chart," http://www.mcnallyinstitute.com/CDweb/g-html/g001.htm. Bonholf citing The Specialty Steel Industry of North America.