



## GALVANIC CORROSION - COMPATIBLE METALS CHARTS

To minimize galvanic corrosion, select fasteners based on their material compatibility with the substrates. The closer together the material are on the chart to the right, the less galvanic action will occur. Metals listed on the top of the chart (anodic) will corrode faster than the metals on the bottom of the chart (cathodic). Contact a corrosion specialist to determine the best material for your application.

Material	Anodic Index (Volts)
Graphite	+0.25
Type 316 Stainless Steel (Passive)	0.05
Type 304 Stainless Steel (Passive)	0.08
Monel 400	0.08
Silver	0.13
Type 410 Stainless Steel (Passive)	0.15
Type 316 Stainless Steel (Active)	0.18
Nickel	0.20
Type 430 Stainless Steel (Passive)	0.22
Copper Alloy 443 (Admiralty Brass)	0.29
G Bronze	0.31
Copper Alloy 687 (Aluminum Brass)	0.32
Copper	0.36
Type 410 Stainless Steel (Active)	0.52
Type 304 Stainless Steel (Active)	0.53
Carbon Steel	0.61
Cast Iron	0.61
Aluminum 3003-H	0.79
Zinc	1.03

### Galvanic Compatibility

When design requires that dissimilar metals come in contact, galvanic compatibility can be managed by finishes and plating which protects the base materials from corrosion.

The chart to the left is Galvanic Series In Flowing Sea Water.

- Harsh environments, such as outdoors, high humidity, and salt environments. Typically there should be not more than 0.15 V difference in the "Anodic Index". For example; silver - nickel would have a difference of 0.17V being acceptable.
- Normal environments like non-temperature and humidity controlled environments. Typically there should not be more than 0.25 V difference in the "Anodic Index".
- Controlled environments, such that are temperature and humidity controlled, 0.50 V can be tolerated. Caution should be maintained when deciding for this application as humidity and temperature do vary from regions.

Active (Anodic) Most Likely To Corrode
Magnesium
Magnesium alloys
Zinc (hot-dip, die cast, or plated)
Aluminium 1100, 3003, 3004, 5052, 6053
Tin (plated)
Lead
Steel 1010
Iron (cast)
Stainless steel 410 (active)
Copper (plated, cast, or wrought)
Nickel (plated)
Chromium (Plated)
Stainless steel 301,304,310 (active)
Stainless steel 430 (active)
Tungsten
Brass
Nickel-silver (18% Ni)
Stainless steel 316L (active)
Bronze 220
Copper 110
Red Brass
Stainless steel 347 (active)
Copper-nickel 715
Admiralty brass
Stainless steel 202 (active)
Bronze, Phosphor
Monel 400
Stainless steel 201 (active)
Stainless steel 321 (active)
Stainless steel 316 (active)
Stainless steel 309 (active)
Stainless steel 17-7PH (passive)
Silicone Bronze 655
Stainless steel 301,304,321 (passive)
Stainless steel 201,286 (passive)
Stainless steel 316L (passive)
Stainless steel 202 (passive)
Titanium
Nobel (Cathodic) Least Likely To Corrode

## Fastener Material Selection Based on the Galvanic Series of Metals

Table developed using information supplied by AISI Committee of Stainless Steel Producers.

### Key

- A. The corrosion of the base metal is not increased by the fastener.
- B. The corrosion of the base metal is slightly increased by the fastener.
- C. The corrosion of the base metal may be considerably increased by the fastener material.
- D. The plating on the fastener is rapidly consumed.
- E. The corrosion of the fastener is increased by the base metal.

		FASTENER MATERIAL			
		STEEL Zinc Plated	STAINLESS STEEL Type 410	STAINLESS STEEL Type 302, 304, 316	ALUMINUM
BASE METAL	Zinc   Galvanized   ZN/Al Coated Steel	A	C	C	B
	Aluminum	A	Not Recommended	B	A
	Steel / Cast Iron	A,D	C	B	A
	Brass, Copper, Bronze	A,D,E	A	B	A,E
	Stainless Steel 300 Series	A,D,E	A	A	A,E

### Footnotes

1. Because aluminum can expand a large distance, the high hardness of 410 SS case harden screws may lead to screw to failure due to lack of ductility or stress corrosion cracking.

NOTE: Organic coating to the screw will improve the corrosion resistance. Environments can affect the rate of corrosion and change the activity of the metals.

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### Special Note: Preservative-Treated Lumber Applications

ACQ, Penta, CA or CBA preservative-treated lumber can be incompatible with certain types of fasteners. In those cases where any type of metal roof or wall cladding materials are being attached to preservative treated lumber, the following fasteners are not compatible: zinc plated screws, zinc-alloy headed screws, stainless capped screws, aluminum, copper and copper alloy. When attaching metal panels to those types of preservative-treated lumber, a moisture barrier should be used between the lumber and the panel material. Metal panel fasteners that are compatible with preservative-treated lumber are stainless steel fasteners, or hot dip galvanized nails manufactured to ASTM A153 class D or heavier. Other types of fasteners coated with proprietary anti-corrosive technologies are also available for use with preservative-treated lumber. In addition, zinc-plated screws can be used in CCA and MCQ pressure-treated lumber.

All information is non-binding and without guarantee. Before using the products, all specifications and calculations must be checked by a suitably qualified person and local regulations must be observed. This document is subject to revision. We reserve the right to make technical changes. (0321-1)