

Proper Material Selection for Wire Rope Sleeves:

Selecting the Correct Sleeve Material for a Given Wire Rope Material in a Known Service Environment

Sleeve and/or sleeve plating material selection for a particular wire rope material within a given environment is one of the most frequently asked questions of our Engineering Department. Material compatibility between sleeve and cable material remains a critical consideration so as to minimize corrosion and potential failure once in service. The ideal material combination between any sleeve and wire rope are similar metals; however, some dissimilar metals combinations are perfectly acceptable to meet performance and/or material availability requirements.

One should understand which material combinations of wire rope and sleeves are acceptable for a given environment in an effort to minimize corrosion. The table below includes commonly accepted and utilized compatible sleeve/wire rope combinations when exposed to various environments. It references the wire rope materials as the large electrode (**red**) as compared to the sleeve materials which are smaller area electrodes (**blue**). This is important in a galvanic couple since it's always preferable to have the smaller area metal (sleeve) to be cathodic (or more noble) relative to the larger surface area wire rope which is better when it is anodic (more active). See reverse side for additional information.

Nicopress Guide to Sleeve and Wire Rope Material Combinations in Various Environments										
Sleeve Materials (small area electrode)	Wire Rope Materials (large area electrode)									
	Mildly Corrosive Environment (ex: indoors)				Moderately Corrosive Environment (ex: outdoors)				Severely Corrosive Environment (ex: chemical or ocean exposure)	
	CS	Zn CS	SS	BO SS	CS	Zn CS	SS	BO SS	Zn CS	SS
Cu	B	B	B	B	C	B	B	B	C	C
Zn Cu	C	A	C	C	NR	A	C	C	B	NR
Sn Cu	B	B	B	C	C	B	B	C	C	C
BO Cu	B	B	B	B	C	B	B	C	C	C
Al	C	C	NR	NR	NR	C	NR	NR	NR	NR
SS	B	B	A	A	C	B	A	A	B	A
BO SS	B	B	A	A	C	B	A	A	B	A

Compatibility Key

A	Excellent
B	Good
C	Fair
NR	Not Recommended

Sleeve Materials Key

Cu	Copper
Zn Cu	Zinc plated Copper
Sn Cu	Tin plated Copper
BO Cu	Black Oxide coated Copper
Al	Aluminum
SS	Stainless Steel
BO SS	Black Oxide coated Stainless Steel

Wire Rope Materials Key

Zn CS	Zinc plated Carbon Steel
SS	Stainless Steel
BO SS	Black Oxide coated Stainless Steel
CS	Carbon Steel

Note: All combinations of sleeves and wire rope in the above table represent "galvanic couples" where it is always preferable to have the "smaller area electrode," or the metal sleeve, to be cathodic (or the more noble metal) relative to the "larger surface area electrode," or wire rope, which is better when it is anodic (or a more active metal) in the couple. Refer to Technical Bulletin TB-3 for more information.

Disclaimer: The information provided herein serves as a general recommendation only. Many factors involved in service environments such as, but not limited to; temperature cycles and extremes, mechanical loading, electrical currents, radiation, chemicals, exposure methods (spray, immersion, or mists), exposure severity or frequency, and others may potentially vary or reverse an expected result.

Theory: Compressing a metal sleeve onto a wire rope or cable will form a dissimilar metals couple if the sleeve material is different from the cable material used. This dissimilar metals couple with an environment catalyst forms a galvanic cell which may generate a voltage and initiate a corrosive attack on one or both of the metals involved. To avoid possible galvanic corrosion, it is necessary to understand the materials involved and the service environment to which they will be exposed. To assist with proper coupling of dissimilar metals, the military standards committees, engineering societies, and many fastener companies have published various tables (referred to as "Galvanic Series"). These tables rank metals by their galvanic potentials (voltages) as measured against a standard. As the numbers (galvanic potential) become more positive, the metal is considered more "cathodic," "noble," or "less active"; as the potential becomes more negative, the metal is considered more "anodic" or "active".

Guidelines when using Galvanic Series Tables (example from ASM below):

- When comparing two metals in a Galvanic Series table, which ever metal is more positive is considered the cathode, and the other metal the anode.
- The material determined to be the cathode (C) should have a smaller surface area relative to the anode (A) surface area, or C/A ratio to minimize corrosion. For example, a stainless steel (SS) sleeve over Al wire is acceptable, however, the reverse is not: i.e. an Al sleeve over Stainless steel cable may severely corrode depending on the environment.
- The greater the numeric difference between the metals, the more possibility for corrosion. For this reason and if possible, select materials closer to each other in the galvanic series with differences between them less than 0.50V for room temperature environments.

Some historically acceptable combinations: a copper sleeve over 304 SS steel wire rope with a lower potential difference = 0.28v but a high C/A >>1; a Sn plated copper sleeve over 304 SS steel wire rope with a low potential difference = 0.42v but a high C/A >> 1; copper sleeve over galvanized steel wire rope with a higher potential difference = 0.67v but a low C/A << 1. Other same material sleeve and wire rope combinations with potential differences ≈ 0. 0v such as: SS sleeve on SS wire rope, and, Zn plated Cu sleeves on Galvanized steel wire rope.

Galvanic Series In Flowing Sea Water*

Steady State Electrode (Reference cell: Saturated Calomel Half-Cell, or "SCE")

Material Potentials in Volts (relative to SCE reference cell)

Graphite +0.25	Type 316 Stainless Steel (Active) -0.18	Tin -0.50
Platinum +0.15	Nickel -0.2	Type 410 Stainless Steel (Active) -0.52
Zirconium -0.04	Type 430 Stainless Steel (Passive) -0.22	Type 304 Stainless Steel (Active) -0.53
Type 316 Stainless Steel (Passive) -0.05	Copper Alloy 715 (70-30 Cupro-Nickel) -0.25	Type 430 Stainless Steel (Active) -0.57
Type 304 Stainless Steel (Passive) -0.08	Copper Alloy 706 (90-10 Cupro-Nickel) -0.28	Carbon Steel -0.61
Monel 400 -0.08	Copper Alloy 443 (Admiralty Brass) -0.29	Cast Iron -0.61
Hastelloy C -0.08	G Bronze -0.31	Aluminum 3003-H -0.79
Titanium -0.1	Copper Alloy 687 (Aluminum Brass) -0.32	Zinc -1.03
Silver -0.13	Copper -0.36	
Type 410 Stainless Steel (Passive) -0.15	Alloy 464 (Naval Rolled Brass) -0.4	

*Data from ASM Handbook, Vol. 13, Corrosion of Titanium and Titanium Alloys, p. 675.

While the sea water series is a good guide, behavior in other environments may be different, so care should be exercised when dissimilar couples are used. A smaller relative area of the corroding (less noble) metal will result in accelerated metal loss because the smaller area must provide a higher corrosion current density to protect the larger area.