

Corrosion and Splices

By Waymon P. Goch

Worldwide, the annual cost of corrosion is \$2.2 trillion (US); and is currently estimated to be \$429 billion (US) annually in the United States.⁽¹⁾ Corrosion that results in failure of aircraft, pipelines, bridges and other critical structures receives a lot of publicity and attention but other failures that are primarily due to corrosion do not receive that kind of scrutiny.

Corrosion can be defined as the destruction of metals by chemical and electrochemical processes. The corrosion products are oxides, hydroxides, sulfides, sulfates, and carbonates in most cases. This represents a return to a natural state in which most common metals occur as ores. There are several types of corrosion. Atmospheric corrosion, such as rust on the surface of ferrous metals, is an example of direct chemical attack. Oxidation is a direct chemical attack that requires only oxygen. Moisture is not required for oxidation to occur. Oxides form immediately on copper and aluminum upon exposure to the air. Copper surface oxides tend to be soft and electrically conductive in contrast to the hard, almost impervious surface oxide that forms on aluminum alloys. The aluminum oxide is electrically non-conductive and the oxide thickness increases with time and temperature.

Additional accelerants present in the atmosphere are carbon dioxide, water vapor, sulfur, sodium and chlorine compounds and the severity of the attack is directly related to the amount of those compounds in the service environment.

Although splices and other connectors and hardware on overhead transmission and distribution lines are subject to direct corrosion with pitting and other outside surface changes, it usually does not result in mechanical or electrical failure, with one exception and that is the oxidation of internal aluminum splice components and conductor. That oxidation contributes to increased contact resistance, heating, and subsequent failure of splices and, to a lesser degree, dead ends and other current-carrying compression connectors.



The more significant corrosion type that affects splice life and performance is galvanic. Almost everyone is at least casually familiar with galvanic corrosion but may not be aware of some of its causes and characteristics. Galvanic corrosion is an electrochemical process that involves metal in the presence of an electrolyte. It normally requires two dissimilar metals of different electrical potential in the presence of an electrolyte.

All metals have a specific relative electrical potential as shown in the galvanic series chart of Fig 1. When metals of different electrical potential are in contact in the presence of moisture (electrolyte) a low energy electric current flows from the metal having the higher potential (anode) to the one having the lower (cathode). This galvanic action is shown graphically in Fig 2.



The actual process involves an anode reaction, the conduction of electrons through the metal from anode to cathode, and the conduction of ions through the electrolyte solution. Corrosion occurs in the anode area (less noble) while the cathode area (more noble) is protected. The corrosion deposit is analogous to ash from burning wood.

This process is intentionally employed in cathodic protection systems to prevent corrosion of underground pipelines and other structures and equipment (including hot water heaters in which the anode is normally magnesium).

Concentration cell, crevice, stress, deposit, impingement, intergranular and fatigue corrosion are all forms of galvanic corrosion.

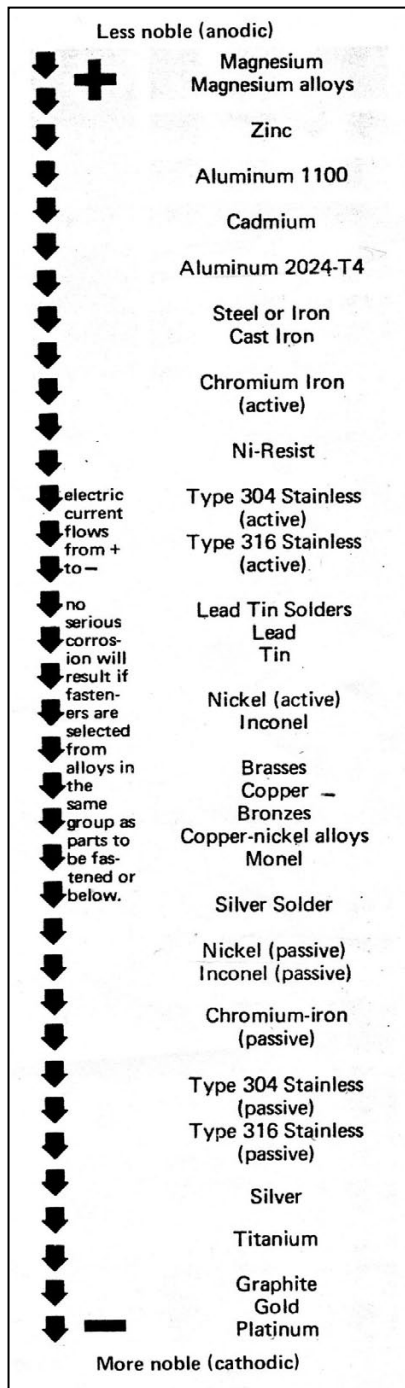


Fig 1

It was mentioned earlier that galvanic corrosion normally involves dissimilar metals but it is possible to experience galvanic corrosion in a single metal under certain conditions. If a deep crack or fissure develops and can contain stagnant moisture, it is possible to create galvanic corrosion in one metal.

It is important to recognize that the one element required for galvanic corrosion to occur in any form is moisture. If there is no moisture, there is no electrolyte and therefore no galvanic corrosion.

I'd like to call attention to an interesting characteristic in Fig 1. That is the difference in potential of active and passive types 304 and 316 stainless steel. Exposure to stagnant or poorly aerated water causes passive stainless steels to become much more active. This same characteristic can be seen in other metals in the galvanic series.

Within a line splice galvanic cells are created by the ingress of moisture, salts, and other surface and airborne contaminants. Evaporation is retarded and an electrolytic cell is created. This is the primary cause of internal corrosion, accelerated aging, and higher contact resistance resulting in shifting of the dynamic current path. This also emphasizes the importance of proper conductor cleaning and preparation to remove the non-conductive aluminum oxides immediately before splice installation and the use of the proper inhibitors to seal the contact area and conductor strand interstices.

Galvanic corrosion is not a concern with ClampStar® Connector Correctors because a galvanic cell cannot be established. There are no pockets in which stagnant moisture can accumulate and the conductor grooves and interfaces are permanently sealed with CC², a proprietary high temperature inhibitor compound that will not wash out under any service condition.

(1) U.S. Congress, Federal Highway Administration, and NACE.

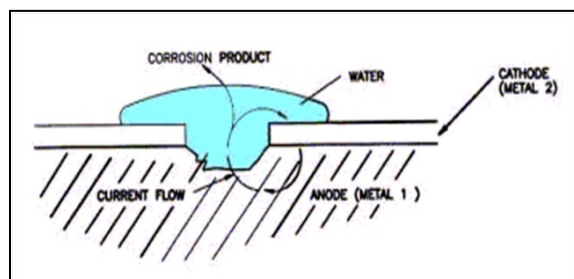


Fig 2

