

Different Types of Corrosion

- Recognition, Mechanisms & Prevention

Galvanic Corrosion, Bimetallic Corrosion or Dissimilar Metal Corrosion: Causes and Prevention

Galvanic Corrosion Recognition

What is galvanic corrosion? Galvanic corrosion or "Bimetallic Corrosion" or "Dissimilar Metal Corrosion", as sometimes called, is defined as the accelerated corrosion of a metal because of an electrical contact (including physical contact) with a more noble metal or nonmetallic conductor (the cathode) in a corrosive electrolyte.

The less corrosion resistant or the "active" member of the couple experiences accelerated corrosion while the more corrosion resistant or the "noble" member of the couple experiences reduced corrosion due to the "cathodic protection" effect.

The most severe attack occurs at the joint between the two dissimilar metals. Further away from the bi-metallic joint, the degree of accelerated attack is reduced.

In this photo, a 5-mm thick aluminum alloy plate is physically (and hence, electrically) connected to a 10-mm thick mild steel structural support. Galvanic corrosion occurred on the aluminium plate along the joint with the mild steel. Perforation of aluminium plate occurred within 2 years due to the huge acceleration factor in galvanic corrosion.



Galvanic Corrosion Mechanisms

What causes galvanic corrosion? Different metals and alloys have different electrochemical potentials (or corrosion potentials) in the same electrolyte. When the corrosion potentials of various metals and alloys are measured in a common electrolyte (e.g. natural seawater) and are listed in an orderly manner (descending or ascending) in a tabular form, a Galvanic Series is created. It should be emphasized that the corrosion potentials must be measured for all metals and alloys in the same electrolyte under the same environmental conditions (temperature, pH, flow rate etc.), otherwise, the potentials are not comparable.

The potential difference (i.e., the voltage) between two dissimilar metals is the driving force for the destructive attack on the active metal (anode). Current flows through the electrolyte to the more noble metal (cathode) and the less noble (anode) metal will corrode. The conductivity of electrolyte will also affect the degree of attack. The cathode to anode area ratio is directly proportional to the acceleration factor.

Galvanic Corrosion Prevention

How to prevent galvanic corrosion? Galvanic corrosion can be prevented through a number of methods:

- Select metals/alloys as close together as possible in the galvanic series.
- Avoid unfavorable area effect of a small anode and large cathode.
- Insulate dissimilar metals wherever practical
- Apply coatings with caution. Paint the cathode (or both) and keep the coatings in good repair on the anode.
- Avoid threaded joints for materials far apart in the galvanic series.

Galvanic Corrosion Modeling, Prediction and Evaluation

GC-Compass®: A Software Tool for Galvanic Corrosion Prediction and Materials Galvanic Compatibility Assessment

GC-Compass is the only device and OS independent software tool on the market for the prediction of galvanic corrosion and assessment of materials galvanic compatibility. Designers, engineers, architects, consultants, maintenance and inspection personnel can quickly assess and quantify the impact of galvanic coupling of dissimilar metals on the remaining life of their components or systems anytime, anywhere, on any device running any OS without the need to install or download anything. More detailed information on GC-Compass is available [here](#).

The screenshot displays the GC-Compass software interface. At the top, there are two tabs: "Metals & Alloys" (selected) and "Intermetallics". Below the tabs is a header area with the text "GC-Compass: Galvanic Corrosion Prediction & Galvanic Compatibility Assessment" and "Metals & Alloys". The main interface contains several input fields and a dropdown menu:

- Select the Anode-Cathode Couple:** A dropdown menu is open, showing a list of material pairs. The currently selected pair is "AA6061 - SS304L". Other visible options include "AA6061 - PH13-8Mo", "AA6061 - Sn", "AA6061 - SS301", "AA6061 - SS304L", "AA6061 - SS316" (highlighted in blue), "AA6061 - SS347", "AA6061 - Ti-6Al-4V", "AA6061 - Ag", "AA7050 - Carbon Steel", "AA7050 - Carbon Fibre Composite", "AA7050 Anodized - Carbon Fibre Composite", "AA7050 - Ti-6Al-4V", "AA7050 Anodized - Ti-6Al-4V", "AA7050 - Ti-3Al-2.5V", "AA7050 Anodized - Ti-3Al-2.5V", "AA7075 - 4130", "AA7075 - A286", "AA7075 - Carbon Steel", and "AA7075 - Ag".
- Select the Environment:** A text input field.
- Enter the Temperature (°C):** A text input field.
- Enter the Effective Cathode to Anode Area Ratio:** A text input field.
- Enter the Effective Thickness of Anode (mm):** A text input field.
- Predicted Anode Corrosion Rate (mm/y):** A text input field.
- Remaining Life (years):** A text input field.
- Galvanic Compatibility Class:** A text input field.

At the bottom left of the interface, there is a "Reset" button with a circular arrow icon. Below the input fields, there is a footer line that reads "GC-Compass Version 9.18 © 1995 ~ 2018 WebCorr Corros".

Over 200 galvanic couples are included in GC-Compass, the computer software for galvanic corrosion modeling, prediction and materials compatibility assessment.

GC-Compass: Galvanic Corrosion Prediction & Galvanic Compatibility Assessment
Metals & Alloys

Select the Anode-Cathode Couple:	AA6061 - Carbon Steel
Select the Environment:	Sea Water
Enter the Temperature (°C):	25.00
Enter the Effective Cathode to Anode Area Ratio:	11.040
Enter the Effective Thickness of Anode (mm):	5.000
Predicted Anode Corrosion Rate (mm/y):	2.462
Remaining Life (years):	2.031
Galvanic Compatibility Class:	Class III: Not Compatible

GC-Compass Version 9.18 © 1995 ~ 2018 WebCorr Corrosion Consulting Services, Singapore

Outputs from the software include the predicted galvanic corrosion rate of the anode member of the galvanic couple, the remaining life of the anode, and the galvanic compatibility class.

For more details on Galvanic Corrosion - Causes and Its Prevention

More details on Galvanic Corrosion or Bimetallic Corrosion are included in the following corrosion courses which you can take as in-house training courses, course-on-demand, online courses or distance learning courses worldwide:

A Basic Course in Corrosion Control and Its Prevention (5 days)

Corrosion Inspection, Corrosion Testing and Corrosion Monitoring: Techniques and Applications (5 days)

Corrosion, Metallurgy, Failure Analysis and Prevention (5 days)

Marine Corrosion, Causes and Prevention (2 days)

Materials Selection and Corrosion (5 days)

Stainless Steels and Alloys: Why They Resist Corrosion and How They Fail (2 days)

If you require corrosion expert witness or corrosion consulting service on galvanic corrosion, our NACE certified Corrosion Specialist is able to help. Contact us for a quote.