Corrosion Basics

Corrosion is loosely defined as the gradual deterioration of a material's surface through chemical reactions. Though not exclusively reserved for metals, the term is most often applied when talking about metallic components. The corrosive process is affected by a myriad of factors, including environment, product design, storage, cleaning, and mating surfaces. Left untreated, corrosion can be an incredibly risky and costly problem; causing pipes to burst, structures to collapse, fires to ignite, and aircraft class A mishaps.

What is Corrosion?

Corrosion is the consequence of an electrochemical reaction. To extract metals from their natural ores, the state of the metallic atoms must be changed by adding energy. As a result, these atoms tend to return to their less energetic state over time; they lose negatively charged electrons to oxygen atoms from the surrounding air, water, or other chemicals.

Losing an electron in this way is called "oxidation." Meanwhile, the atom that gains the electron is said to have undergone "reduction." However, the process typically does not end there; the two charged atoms will form an ionic bond. The overall process is known as a redox reaction, but in common parlance, the metal is just said to have been oxidized.

This oxidation is the source of corrosion and causes extensive damage to the metal surface.

Corrosion Cells

With the basic chemistry behind corrosion under our belt, let's consider the key factors that drive this process.

1. Cathode - the metal surface which gains electrons (gets reduced) and initially carries a positive potential charge (+)

2. Anode - the metal surface which donates electrons (gets oxidized) and initially carries a negative potential charge (-)

3. Electrical contact - in the case of galvanic corrosion, the metal surfaces (anode and cathode) must be in contact with one another

4. Electrolyte - the environment that contains the anode and cathode and functions as an electrical conductor

5. Potential difference - the anode and cathode have different electrical charges, resulting in a voltage gradient

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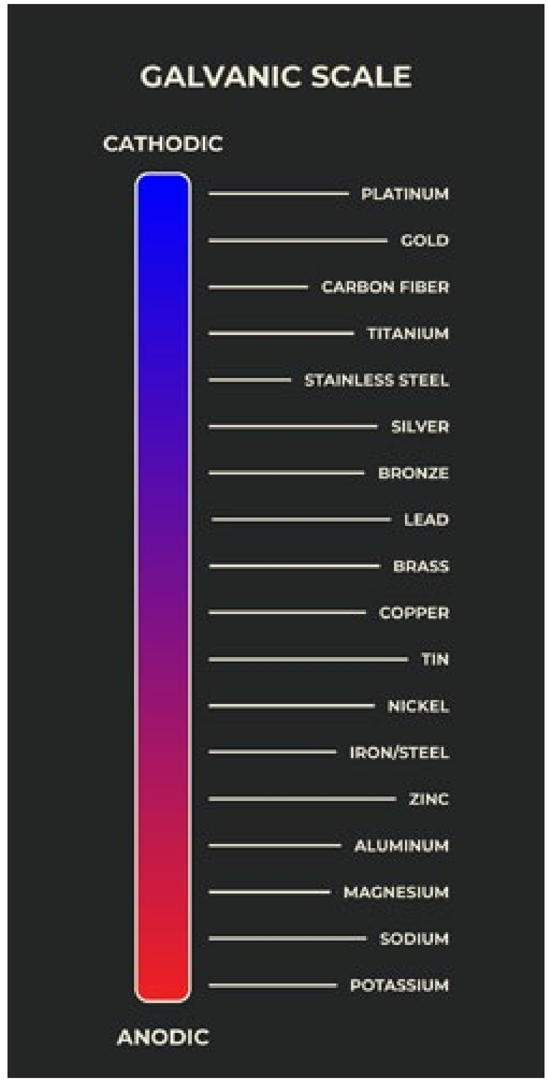
Galvanic Scale



The galvanic corrosion scale is an important chart that allows the user to mitigate corrosive damage by choosing the best material pairs. Some metal surfaces inherently want to interact with each other while others have more nominal interactions and require less preservation and maintenance. From a design perspective, it is important to note that the distance between metallic components in the galvanic scale makes a difference. Metals that are further apart on the scale are more prone to galvanic corrosion because the distance increases the potential differential. On the other hand, this greater distance increases the likelihood of oxidative corrosion within each metal surface. For example, let's look at the scale to the right. Because copper and tin are next to each other, they will be far less prone to galvanic corrosion than carbon fiber and aluminum, which are on opposite ends of the scale. Ideally, these two considerations should be optimized by weighing the contributions of each. When mounting dissimilar metals, it is always a good practice, when acceptable, to apply a sealant of some type to reduce interaction between the metals.

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