

ENVIRONMENTAL POLLUTION AND ITS NEGATIVE EFFECT ON THE CORROSION OF METALS

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There are many types and causes of corrosion and depending on a particular scientist's or corrosion engineer's tendencies to look upon the subject more broadly or narrowly there is no clear and exact total for the number of corrosion types. Most corrosion experts however can agree on the basic varieties of corrosion listed below.

ATMOSPHERIC: Atmospheric corrosion and its severity is essentially determined by four variables: air pollution (both man made and natural such as volcanic gases), airborne salt spray or droplets, temperature, moisture.

The presence of industrial pollutants in the polar ice caps demonstrates that even the most remote corners of the Earth are not immune to its effects. Nitrogen and sulfur compounds can form acids when discharged or acidic material may be released to the atmosphere directly by some industries accelerating the corrosion process on metal these substances encounter. Of course urban areas and those areas in close proximity to or downwind from "smokestack type" industries and power plants are subject to the most corrosive effects of airborne pollution.

Salt spray and airborne saltwater droplets introduce chloride ions to metal surfaces with a corresponding deleterious effect on the metal. But one does not have to live on the beach to experience these corrosive effects as it is estimated that airborne sea spray saltwater micro droplets can carry as much as 7 miles inland from the coast. The presence of moisture is an absolute necessity for most corrosion processes and when combined with elevated temperatures and salt or pollutants further enhances the atmospheric corrosion process. Atmospheric corrosion is ubiquitous and is responsible for more metal damage (both on a cost accounting basis and an actual quantitative basis) than any other form of environmental corrosion. After all, everything on the Earth's surface is exposed to the atmosphere be it vehicles, buildings, bridges, etc [1].

GALVANIC: When dissimilar metals are connected in the presence of an electrolyte a galvanic corrosion reaction occurs. Both the presence of an electrolyte solution and a bi-metallic coupling is required for this type of corrosion to occur. Electrolytes are electrically conductive solutions such as sea water or road salt spray which contain chloride or rain, mist or dew containing sulfur or nitrogen compounds. The most common sources of chloride contamination are marine and coastal environments as well as winter road salting spray. Sulfur and nitrogen compounds are more ubiquitous being the product of air pollution and industrial fallout.

When two dissimilar metals are connected electrically through an electrolyte or salt bridge one metal will become anodic with reference to the other and the potential difference will create a corrosion current causing the more anodic metal to corrode.

UNIFORM/GENERAL: When corrosion occurs uniformly over a wide area of the metal surface producing a general thinning of the metal leading to eventual failure. The rate of general corrosion is usually relatively predictable.

PITTING: Pitting corrosion is quite often evident on metal surfaces where no uniform corrosion is present and is usually highly localized. Pitting usually proceeds fairly rapidly and is accelerated by the presence of chlorides and is particularly common at the base of breaks in coatings. Pitting corrosion takes advantage of the different metallurgical phases present on the surface of most common modern alloys. Generally it is considered to be the product of localized anodic dissolution where the anodic portion of the corrosion cell is dwarfed by the larger cathodic portion [2].

STRESS CORROSION CRACKING : Stress corrosion is the product of tensile stress (including residual stress remaining after fabrication) and localized corrosion which combine to produce a brittle cracking of metal under certain conditions. Examples of environments which enhance stress corrosion are high pH amine solutions for most common steels and chloride bearing solutions for most stainless steels as well as certain aluminum alloys.

CREVICE CORROSION: Crevice corrosion occurs in sheltered, localized areas such as crevices, joints, bolted and threaded parts and under existing corrosion deposits. It is the result of concentration of salts, acids and moisture which results in the formation of an occluded corrosion cell in such sheltered areas. A small anode is created in the crevice with the remainder of the body acting as a large cathode so corrosion at the crevice is highly accelerated as well as concentrated.

HIGH TEMPERATURE: Under very high temperature metals need only the presence of oxygen or other oxidizing gases to corrode. This type of corrosion is referred to as high temperature oxidation, scaling or tarnishing and requires neither moisture nor dissolved electrolytes (salts, acids) to proceed.

References

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