International Journal of Management, Sciences, Innovation, and Technology IJMSIT
Review Paper
Vol.2, Issue.4, pp.17-23, July (2021) **ISSN:** 0000-0000

Corrosion, its causes and its Economic, Health and Industrial Damages

John L. Noble [1]

[1*] Associate professor at Environmental Sciences University School

[*]*Corresponding Author:* e-mail: *JohnLNoble@dayrep.com*

Available online at: https://ijmsit.com/volume-2-issue-4/

Received: 23 June 2021 Revised: 30 June, 2021 Accepted: 13 July, 2021

Abstract— Metal corrosion is one of the natural phenomena that affect all metals, and it causes damage to those metals and a change in their chemical and physical properties. The reverse process of extracting the metal from its ores, and corrosion is a failure that affects the surface of the metal resulting from chemical factors or because of chemical factors assisted by mechanical factors available in the medium in which the metal works.

Keywords— Corrosion – Metal corrosion – Effects – Damage - physical properties

I. Introduction

Corrosion is defined as the dissolution of the metal due to its interaction with the surrounding medium (chemical factors) or its corrosion as a result of friction or other (mechanical factors). There are many examples of metal corrosion, including iron rust, food cans and pipes buried in the soil, and there are other examples of corrosion of many metal parts exposed to industrial media such as acids, bases, salt water, etc. The damages caused by corrosion are numerous, and all of them have a bad economic return, and among these damages are: Dimensional change and loss of mechanical properties: Corrosion leads to weight loss due to the dissolution of the metal and consequently to a change in its dimensions. Therefore, some corrosion allowances are often given when it is present and upon design. These permits are thicker in the environments where the erosion rates are high than in the environments where the erosion rates are low. The change in the dimensions of the metal piece due to corrosion has an effect on the mechanical properties, as its ability to withstand external loads decreases, that is, its susceptibility to plastic deformation and elastic deformation increases. The use of the metal in corrosive environments leads to a decrease in the values of many mechanical properties, especially the metal's resistance to fatigue and cracks, which lead to fast fracture.

II. Impact of Corrosion

The appearance of the metal is greatly affected by corrosion, as the metal always appears bad. Therefore, metals that are resistant to atmospheric corrosion, such as aluminum or stainless steel, rather than carbon steel, should be used as virtual building materials such as window sections and materials, especially in the facades of external buildings. The good appearance of these materials is due to their resistance to atmospheric corrosion. As for the metal with weak resistance to corrosion, it is coated with different types of paint to improve its appearance by limiting its corrosion.

3. Economic damages due to preventive measures: The economic damages resulting from corrosion are many and important, as this failure often causes factories to stop working unprogrammed, and the corresponding additional unexpected economic costs. Also, the occurrence of corrosion leads to a high cost of periodic maintenance, as it requires in many cases to replace the damaged metal part with another new one. In this regard, it is sometimes possible to save some sums when choosing a metal material with higher corrosion resistance to manufacture this damaged part. There are many examples that indicate that choosing a material that is relatively expensive, but has good resistance to corrosion from an economic point of view is better than using a specific material that is cheaper and is subject to rapid damage due to corrosion, which then requires changing it periodically. In both cases, it is noted that corrosion causes damage Economical due to increased costs. Also, preventive measures to reduce corrosion are included in operating and maintenance costs.

Corrosion sometimes leads to unexpected failures in the metal parts of the factory, and here lies mainly the seriousness of the corrosion problem, as the sudden failure may lead to significant damage greater than those caused by the expected corrosion. In this regard, it is necessary to accurately determine the rates of corrosion in metal parts during the course of the manufacturing process, through continuous and periodic measurements of corrosion rates and continuous examination of metal parts to take preventive measures before the degree of corrosion reaches the point that causes the factory to stop working or affect the course of the manufacturing process. Contamination of products: The products of corrosion lead to a change in the chemical nature of the medium, i.e. its pollution, and this is often undesirable as the commercial requirements are to obtain a pure product with specific specifications and free of pollution. Examples of this are many, including contamination of canned food products due to the degree of contamination of products. Simple to corrode in the container in which that food is kept. In light of this, the life of the metal piece or the device is not the main factor in determining the failure period. For example, it is possible in some cases to use ordinary steel for a long period of time without corrosion to a large degree. However, we find that the use of higher-cost materials such as stainless steel is most commonly, this is because ordinary steel contaminates the product after using it for a relatively short period due to its corrosion during this period even to a small degree and then it is not usable.

Loss of safety: Corrosion sometimes or often leads to disasters if preventive measures are not taken to stop or reduce it, for example, dealing with dangerous materials such as toxic gases, hydrofluoric acid, concentrated acids such as sulfuric and nitric acid, flammable materials, radioactive materials and chemicals at temperatures High and at high pressure requires the use of certain metal materials that do not corrode to a large extent in such conditions. For example, stress corrosion in the metal wall separating the fuel from the oxidizers in the missile may lead to the early mixing of these two media and consequently to economic and human losses. Corrosion products sometimes turn harmless materials into explosive materials.

In this field, there are many health safety considerations, such as contamination of drinking water due to corrosion of pipes or water tanks, as well as corrosion plays an important and key role in choosing the type of metal materials from which the metal parts that are used inside the human body are made, such as hip joints, medical plates and valves. heart and so on.

Cathodic Protection: Cathodic protection is a procedure to be followed to protect steel metal structures and pipes from corrosion due to exposure of their surfaces to contact with soil or water.

III. TYPES OF CORROSION

Ferrous metal dependence

The dependence of ferrous metals - soft iron, hard iron, and steel of all kinds - leads every year to a huge economic loss in the world. This wear requires changing oil transmission pipelines and valves, railways, building materials, auto parts and mechanisms, in addition to the loss of large quantities of materials by leakage from corroded tanks and pipes, and to the loss resulting from stopping production lines in general, and chemical metal corrosion appears when the metal is exposed to the action of gases. Dry at high temperatures. Whereas, the electrochemical character of corrosion appears when the metal is exposed to an electrolytic action. In this case, the corrosive reaction of the metal is accompanied by another reaction that consumes the electrons produced by the corrosiveness. Dependence is related to the nature and composition of the environment that causes it, the nature of the mineral, the quantity and type of impurities it contains, and the overall prevailing conditions. The presence of impurities in the metal usually accelerates corrosion, and thus the exchange zinc reacts slowly in diluted acidic solutions. If this metal is touched by a platinum wire, the metal reacts violently, and it dissolves transforming into the ionic form, while the hydrogen ions on the surface of the platinum are returned to gas hydrogen. The same thing happens when impure iron metal is dipped in a hydrochloric acid solution. The two processes also accompany: the dissolution of the metal and the return of hydrogen ions; when the corrosive process is stable, the rates of the two reactions are equal.

Corrosion reaction occurs when the metal comes into contact with an aqueous solution of oxygen according to the diagram shown in the figure. The electrons liberated by oxidation of the metal are consumed here to produce hydroxyl ions, and the result is the transfer of the metal in the form of ions to the solution, or its precipitation in the form of metal hydroxide.

Non-ferrous metal dependence

Air pollution, and in particular sulfur gas, is a major source of corrosion of non-ferrous metals used in civil buildings. When the roofs are made of zinc, strong sheets of minimum thickness of 0.6 mm should be used. As for aluminum, it has a good resistance to acids due to the "film" of aluminium (aluminum oxide) that covers it, but it is more susceptible than zinc to the influence of alkaline bases, lime and Bertland cement. As for lead, it is very resistant to acid influence, and pipes made of lead are not affected by contact with plaster (acidic reaction), but on the contrary they are affected by lime or cement (alkaline reaction).

Corrosion of mortar and cement concrete

Corrosion here occurs as a result of two main reasons, first: the disintegration of building materials by expansion which is attributed to the formation of a comminuted salt called candlot (highly hydrated tri-calcium sulfoalamine) from the action of calcium sulfate-containing water in calcium aluminate-rich Portland cement, and second: decalcification With the dissolution of lime, and by the hydrolysis of lime salts (silicates and aluminates), this occurs by the action of acidic water and saline water, especially water rich in carbon gas, and swamp water (which contains humic acids). Portland cement is also affected by some effective grnaulates such as chalcedony and some silex. A cracked expansion reaction occurs between the active granular silica and the cement alkali, and the concrete granules are affected by the presence of moist air and carbon gas, turning into laterite, that is, into a red solid soil. Coal slag from incineration destroys mortar and concrete, and blast furnace slag does the same.

Dependence of grilled clay and plaster

The accumulation of salts in the pores of the bricks and bricks, along with moisture, leads to effective corrosion and deterioration in them, and the grains of live lime present in the bricks cause cracking when exposed to rainwater that seeps into the pores, causing the bricks to swell and crack. Anhydrous plaster, which has been transformed into a watery plaster, becomes very sensitive to moisture due to its solubility and porosity.

Rubber wear and tear

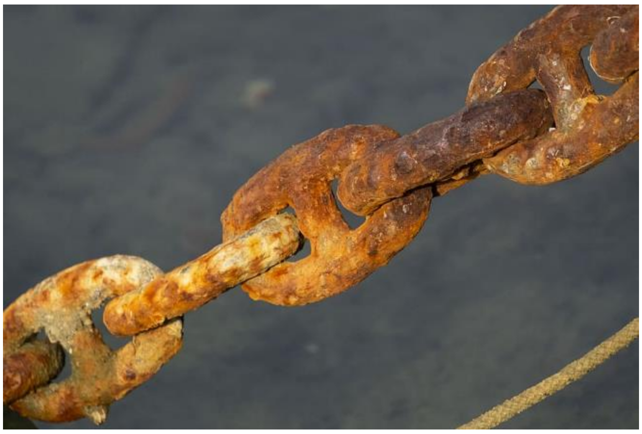
Rubber is very sensitive to oxygen, so the use of anti-oxygen agents is effective in protecting rubber. One of these substances is heavy phenols. The effect of rubber is activated by the mediation of some metals such as copper and manganese and their salts. Gasoline, oils, and chlorine solvents affect natural rubber, but perbunan (a nitrile synthetic rubber) is resistant to mineral oil, and chlorine solvents affect it only very slowly. Some oxidants, such as potassium permanganate, destroy rubber, turning it into a resinous, celluloid-like product.

Tekkal paints

Paints made of linseed oil, lime, and cement concrete wear out over time. Because the lime saponifies the oil, forming oleate or calcium stearate. Paints may be damaged by some materials, such as resinous wood or poor-dry wood, wrinkled and cracked. The paints used for coating the treated plaster may swell as a result of the back setting salts, and the paints will also be damaged if the metal surfaces are not polished well before coating.

Dependence of elastic materials

Plastics, especially polychlorinated vinyl (PVC) and polyethylene, are resistant to abrasion, yet are susceptible to weak acids (organic acids). Melamine formalin, nylon, methyl methacrylate (plexiglass) and urea-formol resins are affected little or no. Substances degrade casein-formol resins, vulcanized fibres, phenol-formol resins, and fermol-ball resins. Organic solvents destroy cellulosic resins and methyl methacrylate. It is polychlorinated with vinyl, but does not destroy ethyl cellulose and chlorinated rubber. The ultraviolet light slowly affects the plastic materials, breaking the bonds in them, leading to their gradual dissolution. Although glycero phthalate resins are flammable and flammable, they resist all diluting acids and weak alkalis, but on the other hand are affected by strong acids or concentrated (highly concentrated) bases.



Wood dependency

Wood is destroyed by microorganisms capable of hydrolyzing cellulose, so it is protected with disinfectants. Sometimes it may be exposed to some diseases due to fungi and algae, which rot or blacken, and may be infected with insects that live in wood. The wood is preserved by removing its sap and drying it with hot air, then blotting (injecting) copper sulfate, mercury dichloride, creosote oil, and others.

IV. WHY DOES EROSION OCCUR?

The iron surfaces of metal structures, pipes and iron equipment generally corrode when their surfaces come into contact with soil or water as a result of chemical reactions accompanied by the flow of electrons (i.e., the flow of electric current). Or water, or even exposed to humid weather, where a galvanic cell is formed.

V. ANTI-CORROSION METHODS

All methods of anti-corrosion are based on preventing the leakage of electric current from the installations to the surrounding soil or water, and the following are the methods used to achieve this: Using good packaging, including dye, which is an electrical insulator that separates the metal from the environment around it. To be available in good packaging is to be continuous and of high resistance and good adhesion to metal and is not affected by heat and that its permeability reaches the degree that does not allow moisture to pass through it. It may be in the form of factory-worn or PVC adhesive tapes, which are highly effective.

The use of a chemical reaction inhibitor (Inhibitor), a chemical substance added to liquids, prevents corrosion on the wall of the container containing it because it prevents chemical reactions from occurring at the anode or cathode or both and thus stops the effect of corrosion cells and leaves a light insulating layer on the vessel wall. The chemical reaction inhibitor is added to liquids at a certain concentration periodically. This method can be used in drilling wells, boilers and water systems. Using corrosion-resistant materials This means choosing the material that resists corrosion in a specific environment, provided that it is suitable for the operational conditions. The materials used for this purpose are chromium, nickel, lead, tin, plastic, rubber, ceramics, concrete and glass fibers. Environment treatment: This means making changes in the composition of the surroundings surrounding the metals that prevent or reduce corrosion on them. The distinction between the reaction inhibitor and the ocean treatment is not clear. The presence of calcium bicarbonate in the water is deposited on the wall of the vessel containing a layer of calcium carbonate separating the vessel and the water, protecting it from corrosion, but calcium bicarbonate is not classified as corrosion inhibitor. One of the means used in ocean treatment is to get rid of oxygen, moisture and dissolved salts and control the degree of hydrogen ion concentration.

Adopting a good design, which avoids or reduces the possibility of corrosion cells and facilitates the application of anti-corrosion means on installations or detection. One of the things that must be taken care of is to avoid direct contact between two different metals and the absence of traps for the accumulation of water, gases or air, and to minimize the presence of compressed parts as much as possible.

The use of cathodic protection, as corrosion in metals is located in the anodic region as a result of the discharge of electric current from it to the environment around it, while the cathodic region remains intact and free of corrosion. It is clear, then, that the corrosion process stops if all parts of the metal become cathodic. This can be achieved by using an electric current from an external source that flows in a direction opposite to the current of the corrosion cells, with sufficient intensity to make the entire surface of the metal a cathode, and the electric current resigns from the environment around it instead of emptying it to it. Hence came the term cathodic protection.

VI. CONCLUSION

The flow of electrons is from the cathodic area to the anodic area through the soil or water surrounding the metal structure. The direction of the electric current is from the anodic region to the cathodic region through the soil or the hydrosphere (solution). Electrons are generated as a result of iron atoms losing electrons and converting them to the positive iron ion. Iron ions combine with OH ions to produce Ferric Hydroxide Fe(OH)3, which is the usual rust. Electrons arriving through the metal to the cathode combine with hydrogen ions, which are liberated at the cathode. It is noted that iron is lost from the surface of the anode, as it constantly turns into rust, while this does not happen on the surface of the cathode. Corrosion has devastating effects and must be stopped

Authors Profile

[1] Associate professor at Environmental Sciences University School.