IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN:2278-487X, p-ISSN: 2319-7668. Volume 27, Issue 6. Ser. 12 (June 2025), PP 13-16
www.iosrjournals.org

Administration of protection methods to prevent galvanic corrosion

Ysmael Ramírez Jiménez[1], Véronica Solis Ramírez[2] José Del Carmen Méndez Gonzalez[3]
[1,2,3]*(Universidad Popular de la Chontalpa, Cárdenas, Tabasco, México)*

Abstract:
***Background**: (Corrosion phenomena means to the deterioration of metallic materials due to chemical and electrochemical reactions, because these materials are always trying to reach a state of lower energy potential. Corrosion has many implications in terms of economic issues, security concerns and preservation of materials, so its study and mitigation is highly important. Herein some information is provided about, (1) certain types of corrosion which can be commonly observed, (2) Some factors that influence the corrosion process and speed, and (3) certain types of methods for controlling of corrosion and protection of materials*
***Materials and Methods**: Corrosion can be minimized or avoided by selecting corrosion-resistant materials, choosing appropriate heat treatments, and respecting the constraints of their application (mass, resistance to deformation, corrosion resistance, avoiding chemical reactions with other materials, and heat). For example, when metals are formed through bending, differences in the amount of cold work and residual stresses produce local stress zones. These can be minimized by stress elimination or complete recrystallization through annealing.*
In conclusion, the composition and physical integrity of materials are altered by exposure to a corrosive environment, but by applying the appropriate corrosion protection, the useful life of products will be extended, they will have optimal performance, with good aesthetics and presentation, preventing failures and, consequently, accidents, among other benefits (depending on the method applied).These methods for preventing corrosion and their performance depend largely on the ability to choose the most appropriate method to minimize the effects of corrosion and prevent material failure.
***Results**: With this research, I complement the knowledge that my electricity teachers taught me in the classroom about the effects of the passage of an electric current through the materials that make up a metallic structure buried or submerged in an aqueous environment, causing a destruction of the metals, called corrosion.*
***Conclusion:** Cathodic protection is one of the most widely used coatings in various industrial sectors. At Petróleos Mexicanos (PEMEX), a department daily inspects, maintains, and installs this system, which reduces corrosion in its pipelines, storage tanks, and the metal structures of its equipment and buildings.*
***Key Word**: Corrosion; metallic materials; electrochemical potential; material protection.*

Date of Submission: 11-06-2025 Date of Acceptance: 24-06-2025

I. Introduction

Galvanic corrosion is an electrochemical process that causes the destruction or degradation of pure metals or alloys. When bonded to another metal and in contact with a liquid, usually running water or seawater, called an electrolyte, charges of opposite polarities are produced. Atoms with more electrons (negative charge) are called anodes, and atoms with fewer electrons (positive charge) are called cathodes. This difference is called potential difference, which establishes a flow of electron current through the electrolyte, causing the anode, which has the most negative potential, to degrade and corrode (oxidize), while the cathode remains uncorroded. Source: Wikipedia. Over time, the metal that acts as an anode loses its physical characteristics for which it was designed. For example, if it is part of a building's metal structure (industrial warehouses or real estate), the maximum design shear stresses have changed and, if left undetected, the structure will most likely collapse. Similarly, in pipes that transport fluids (liquids or gases), corrosion causes deterioration of the pipe walls, lowering the pressure limit for which the pipe was designed, and it will most likely crack and leak. If it is a non-explosive substance, there is no problem, but if it is a flammable and explosive substance, such as those transported by the oil industry, it becomes a deadly hazard.

II. Material And Methods

Preventing corrosion in metals is important to prevent this corrosive process from causing a loss of productivity and production, and consequently, an increase in costs, derived from the reduced production capacity of the machinery.
There are multiple treatments against metal corrosion, something undoubtedly essential in industrial activity. Likewise, high-strength and stainless steels can be used, which are widely used in construction because they remain unaltered by the action of moisture and other degrading processes.
Proper maintenance of industrial machinery prevents future damage and replaces it as soon as necessary. The use of brass, a metal with high corrosion resistance, helps avoid these types of problems. Thus, it is widely used in valves, gears, propellers, and other ship parts in what is known as naval brass.

• Use high-quality materials appropriate for their intended uses.

• Know what substances will be in contact with our structure and thus use the most appropriate material.

• Apply treatments to prevent corrosion on metals, such as our product.

• Keep metal and stainless steel structures and surfaces clean.

Below, I list six methods to prevent materials from corroding. First, there is a common primary operation in corrosion protection methods known as cleaning or surface preparation (removal of contaminants, surface rust, and scale), with the goal of improving adhesion to the surface of the materials

Design First

Through proper design of products and systems for industrial, civil, and technological applications, corrosion can be minimized or even avoided. Some factors to consider are:

a) Preventing the formation of areas that generate rust. For example, in plumbing, steel pipes are often joined by brass fittings, which cause corrosion in the steel. Using intermediate plastic fasteners that electrically insulate the steel and brass can minimize this problem.

b) Making the anode area much larger than the cathode area. For example, copper rivets can be used to fasten steel sheets. Due to the small area of copper rivets, a limited cathodic reaction occurs (copper accepts few electrons), causing the anodic reaction in the steel to proceed slowly (minimal oxidation).

c) Design liquid containment components that are closed, not open, to prevent the accumulation of stagnant liquid. Partially filled tanks experience corrosion.

d) Avoid gaps or cracks between the joined or reinforced materials. Direct soldering may be a better joining technique than soldering, brazing, or mechanical fastening. Oxidized areas are oxidized in brazing or tinning, since the filler materials have a different composition than the metal being joined. Mechanical fasteners produce cracks that result in localized areas of corrosion. If the filler metal is tightly bonded to the base metal, soldering can prevent corrosion areas from forming.

Temporary coatings

Like greases or oils, they provide some protection but are easily removed. They are able to form a layer around surfaces to protect them from corrosion, reduce friction, and lubricate; the difference between greases and oils lies in their state. Oils are liquid fats at room temperature, and greases are semi-solids that are much thicker and more viscous than oils.

Non-metallic coatings

such as paint (there are different types: liquid paint, dip paint, electrostatic paint, electrophoretic paint, and sublimation paint), or ceramic coatings, such as enamel or glass, provide greater protection. However, if the coating is pitted or not continuous, a small anodic site is exposed, which causes rapid and localized corrosion.

Metallic coatings

Use a layer formed by deposition of another metal to isolate the base metal from the surrounding environment. It involves coating other materials with a metal with a higher electrochemical potential (greater resistance to corrosion), so that it is the one that deteriorates. However, when the coating shows scratches, the base metal is exposed, causing localized oxidation. The most commonly used metallic materials for coating other metals are zinc, nickel, copper, cadmium, chromium, and tin.

Chemical Conversion Coatings

They are produced by a chemical reaction with the surface. Liquids, such as zinc phosphate solutions, form a non-metallic phosphate layer on the surface of the base metal. This layer is porous and is often used to improve adhesion between the surface and the paint. Non-conductive, non-porous, adherent, and stable oxide layers form on the surfaces of aluminum, chromium, and stainless steel; these oxides prevent corrosion. On steel, a characteristic blue oxide layer forms, improving its appearance and preventing corrosion, known as bluing.

III. Result

IV. Conclusion

With this research, I complement the knowledge my electricity teachers taught me in the classroom about the effects of the passage of an electric current through the materials that make up a metallic structure buried or submerged in an aqueous environment, causing the destruction of the metals, called corrosion.

Corrosion control is essential, which is why various techniques, procedures, and products have been developed for its prevention and control. It is commonly used to protect numerous structures against corrosion, such as pipelines, tanks, vessels, vessels, pilings, docks, marine floats, underwater equipment, and a wide range of other applications—basically all buried or submerged metallic structures—allowing them to extend their useful life.

Cathodic protection is one of the most widely used coatings in various industrial sectors. Indeed, at Petróleos Mexicanos (PEMEX), there is a department that daily inspects, maintains, and installs this system, which reduces corrosion in its pipelines, storage tanks, and the metallic structures of its equipment and buildings. Cathodic protection with sacrificial or galvanic anodes is typically installed using three characteristic metals: zinc (Zn), magnesium (Mg), aluminum (Al), and their alloys. Zinc has always been the classic anode material and is the pioneer in the development of cathodic protection. Magnesium alloy anodes have also been used successfully; they are primarily used to protect structures that require rapid polarization or in aggressive, high-resistivity media, such as soils. Aluminum is an anode material of great interest due to its electrochemical characteristics. However, the development of aluminum alloys suitable for sacrificial anodes has been slower than that of the other two metals, which have seen significant development in recent years.

Other factors that promote corrosion are the characteristics of the soil, which substantially affect the type and rate of corrosion of a structure in contact with it. For example, dissolved salts influence the current-carrying capacity of soil electrolytes and help determine reaction rates on the anodic and cathodic surfaces. Moisture content, pH, oxygen concentration, and other factors interact in complex ways, influencing corrosion.

Here, as a summary, I mention five possible solutions to protect steel products from the effects of corrosion. I think it's a quick guide to taking action and preventing structures from the corrosive effects.

- Use stainless steel instead of regular steel. Stainless steel is iron and regular carbon mixed with other metals such as nickel and chromium. However, the cost of stainless steel makes it impractical for everyday use, except for small fasteners such as bolts and nuts.
- Coat regular steel with zinc. Coating steel with zinc, another metal, is a process commonly known as galvanizing and is the most common way to protect small manufactured objects such as mooring rings, bollards made of pipes, bolts, clamps, chains, shackles, water pipes, etc. The materials to be coated are typically dipped in a bath of molten zinc in specialized workshops. Once an object has been dipped in hot-dip zinc, no welding, cutting, or drilling should be performed, as this would destroy the integrity of the protective coating.
- Coat ordinary steel with special plastics. Coating steel with special wear-resistant plastics is another form of corrosion protection; however, the high cost involved in the coating process (in specialized workshops) makes this method impractical for everyday use.
- Paint ordinary steel with special paints. Painting steel using special paints is the most common method of protecting large steel structures. Surfaces to be painted should be thoroughly cleaned with a wire brush (or preferably sandblasted). The bottom coat should be a zinc-based primer. The second and third coats should be a pitch-based epoxy paint.

When painting steel, the following points should be kept in mind:

- Standard household paints are not suitable for the marine environment because, like some plastics, they age very quickly when exposed to sunlight.
- Diesel, kerosene, and gasoline are not chemically compatible with marine paints; the appropriate paint thinner should be used.
- Gloves should always be worn when handling marine paints.

References

[1]. NOM-008-SECRE-1999- Control de la corrosión externa en tuberías de Acero enterradas y/o sumergidas.
[2]. 49 CFR 192.112 - Requisitos de control de la corrosión - Transporte de gas natural por gasoducto y otros: normas mínimas de seguridad federales
[3]. ASTM G-8, G 42 - Evaluación de la resistencia catódica desprendimiento de los revestimientos
[4]. DNV-RP-B401 - Diseño de protección catódica – Det Norske Veritas
[5]. UNE-EN12068:1999 - La protección catódica. Exteriores recubrimientos orgánicos para la protección contra la corrosión de tuberías enterradas o sumergidas de acero utilizadas en relación con la protección catódica. Las cintas y los materiales retráctiles
[6]. UNE-EN 12473:2000 - Principios generales de la protección catódica en agua de mar
[7]. UNE-EN 12474:2001 - La protección catódica de tuberías submarinas
[8]. UNE-EN 12495:2000 - La protección catódica para estructuras marinas fijas de acero
[9]. UNE-EN 12499:2003 - Interior de protección catódica de estructuras metálicas
[10]. UNE-EN 12696:2000 - La protección catódica del acero en el hormigón
[11]. UNE-EN 12954:2001 - La protección catódica de enterrados o inmersos estructuras metálicas. Principios generales y aplicación para las tuberías
[12]. UNE-EN 13173:2001 - La protección catódica para estructuras de acero flotando en alta mar
[13]. UNE-EN 13174:2001 - La protección catódica para estructuras de leche flotando en el cielo
[14]. UNE-EN 13175:2001 - La protección catódica de las instalaciones portuarias
[15]. UNE-EN 13509:2003 - técnicas de protección catódica de medida
[16]. UNE-EN 13636:2004 - La protección catódica de tanques metálicos enterrados y relacionados con las tuberías
[17]. UNE-EN 14505:2005 - La protección catódica de estructuras complejas
[18]. UNE-EN 15112:2006 - Exteriores de protección catódica de revestimiento del pozo
[19]. UNE-EN 50162:2004 - Protección contra la corrosión por corrientes parásitas de sistemas de corriente