Texas Journal of Multidisciplinary Studies
https://zienjournals.com

ISSN NO: 2770-0003
Date of Publication: 28-06-2022

# Anticorrosion agents in different forms- A review

**Hussein Idrees Ismael[1], Rawaa Z.Jafat[2] , Shaker Salih Bahar[3] , Hayfaa A.mubarak[4]**
[1] chemical department \ college of science , University of Babylon, Iraq
[2]Medical Physics Department , Hilla University College ,Babylon ,Iraq
[3,4]Chemical Engineering Department, College of Engineering, University of Babylon, Iraq
sci.hussein.edrees@uobabylon.edu.iq , rawaaza@hilla-unc.edu.iq
eng.shakir.salih@uobabylon.edu.iq , Haifaadnan_81@uobabylon.edu.iq

**Abstract**
An enormous amount of annual research has been conducted on corrosion inhibitos, including their synthesis or extraction, as well as the mechanisms of classification and inhibition. For a long period of time, the corrosion and damage caused by it in the majority of industrial operations resulted in significant losses and expensive expenses.

The ability of such compounds to adsorb on the metal/solution interface isoften attributed to their capacity to stop corrosion. The mechanism of electrochemical corrosion and the surface area accessible for the process are both altered as a result of an inhibitor's contact with a metal surface.

**Keywords**: corrosion inhibitors, corrosion mechanism, inhibitor types

## 1.Introduction

Corrosion happens in the workplace as a result of chemical or electrochemical attack on materials. Corrosion is a term used to describe the deterioration of plastics and other nonmetallic materials, such as rubber, produced mostly by physiological processes such as swelling and crazing, cracking, and softening. Corrosion is defined as the loss of material characteristics caused by the interaction of engineering materials (metals) with their environment [3][ 4]. Wet and dry corrosion processes are classified according to the corrosive environment [4] [5].Metal deterioration occurs in several forms, including general corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, environmental fracture, dealloying, and erosion-corrosive corrosion [6] [7]. Formalized formalized formalized formalized formalized formalized Metals can be protected against corrosion through coatings, alloying, cathodic protection, anodic protection, and laser surface treatment. Metal surface treatment with a laser is another approach for increasing metal qualities such as roughness, hardness, and corrosion resistance. [8][9].Corrosion inhibitors can be used in a range of practical applications, such as reducing metallic waste during production and lowering the risk of material failure, which can result in the abrupt stoppage of industrial processes, resulting in additional expenditures. Mineral dissolution and acid consumption can be reduced by using corrosion inhibitors [10][11]. There are two types of corrosion processes, which change depending on the nature of the corrosive environment: wet corrosion and dry corrosion[12].Intergranular corrosion,pitting corrosion,crevice corrosion, environmental induced fracture, de-alloying, galvanic, and erosion corrosion are all types of corrosion that can be classified based on metal damage morphology [13][14] [15].

## 2.Corrosion process and mechanism

### 2.1Chemistry of Corrosion:

Oxide coatings cover the surfaces of all metals (with the exception of gold) that are exposed to air.When metal is submerged in water, the oxide layers on the surface of the metal tend to disintegrate. There is no corrosion that is not caused by electrochemical reactions. The rate of corrosion is determined by the two conjugate reactions that occur at the metal surface:

#### 2.1.1Anodic reaction:

$$M \rightarrow Mn^{+} + ne^{-} \qquad (1)$$

It is the anode that is responsible for metal corrosion.Metal ions, which have a positive charge, are dissolved in the solution. The electrons proceed to the cathode, where they are converted into electrical current [16].

### 2.1.2 Cathodic Reaction:

$2H^{+} + 2e^{-} \rightarrow H2$ (2)

At the cathode, electrons react with a reducible electrolyte component, releasing them from the metal to which they are attached. According to Faraday's Law, anodic reactions must occur at the same rate as cathodic reactions.

This is determined by the "corrosion current," Icorr is the whole of the electron flow from the anode to the cathode. Corrosion currents must undergo ionic conduction in order to move through the electrolyte, which has

a A "mixed electrode" is a corroding metal that is subjected to both anodic and cathodic processes at the sam e time.

The mixed electrode can function as a full electrochemical cell on a single metal surface[16][17][18].

For example, the electrochemical reactions that occur during the corrosion of iron include the following:

Anodic reaction (corrosion)

$Fe \rightarrow Fe^{2+} + 2e^{-}$ (3)

Cathodic reaction

$2H^{+} + 2e \rightarrow H2$ (4)

Or

$H2O + \frac{1}{2}O2 + 2e^{-} \rightarrow 2OH^{-}$ (5)

Cathodic reactions are sparked when acidic solutions are present (4). When the pH is between 6.5 and 8.5, oxygen reduction is the primary process. (Case 5). In this later instance of corrosion, anodic and cathodic products react to generate solid corrosion debris.

$Fe^{+2} + 2OH^{-} \rightarrow Fe\,(OH)_2$ (6)

The pure iron (Π) hydroxide is white, but the material formed by corrosion is usually greenish in color because of partial oxidation in the atmosphere.

$2Fe\,(OH)_2 + H2O + \frac{1}{2}O2 \rightarrow Fe\,(OH)_3$ iron (Ш) hydroxide (7)

Further hydration and oxidation events can result in the formation of the reddish rust. Rust is porous and absorbent, and as a result of the secondary reaction that precipitated it, it has a tendency to behave as a deadly poultice in the environment.Different forms of anodic and cathodic reactions can occur when different metals or conditions are used. If anodic oxidation results in the development of solid corrosion products on the surface, these materials may act as a highly protective coating, inhibiting further corrosion. After that, the surface is set to "passive." A case in point would be the process of coating iron with oxides in water at extreme temperatures and under oxidizing conditions:

$2Fe + 3H2O \rightarrow Fe2O3 + 6H^{+} + 6e^{-}$ (8)

### 3.Corrosion inhibitors

By introducing a little amount of corrosion inhibitor into an atmosphere, the rate at which a metal corrodes is reduced. Corrosion inhibitors slow down the rate of corrosion in the following ways:

1-Degradation of anodic or cathodic reactions.

2-Ion mobility on metallic surfaces is being increased.

3-Increase the electrical resistance of the metallic surface by a factor of two. Numerous chemical substances have been found in scientific and technical literature as corrosion inhibitors. Only a few inhibitors were utilized in practice, depending on the desired qualities of an inhibitor for metal protection.When making a decision, the cost, toxicity, availability, and environmental friendliness of an inhibitor must all be considered.Corrosion inhibitors are particularly advantageous since they can be applied during the process without interfering with it. Inhibitors have a plethora of applications.

Environments that are aqueous, partially aqueous, or gaseous can all be altered. Nature water, cooling water systems, oil and gas production and refining, and acid pickling are all examples of aqueous solutions with pH values close to or equal to zero. Corrosion inhibitors are used in the oil and gas explor ation and production sector, petroleum refining industry, chemical industry, heavy industrial manufacturing, water treatment facilities, and product additive industries[19].

### 3.1 Types of Inhibitors:

Today, a wide variety of inhibitors are available, including the following:

### 3.1.1Inhibitors of Volatile Organic Compounds:

Vapor phase inhibitors are another name for this sort of inhibitor. The inhibitor molecules in the vapor adhere to the metal surface when they come into touch with it. Hydrolysis may then be used to liberate protective ions.The usage of amines and nitrite can be used to limit corrosion of ferrous metals.By utilizing amines in volatile situations,atmospheric corrosion can be avoided. Amines are cationic inhibitors. Polyhydric alcohols are frequently utilized in situations with a high concentration of HCL at a concentration of 0.2 percent (glycol). Wells are made using long chain aliphatic diamines.When a ferrous metal system is involved, neutralizing amines prevent rust by adjusting the pH of the electrolyte [16][18][20]. Nitrates, in their volatile state, can be employed for a variety of applications. Localized chloride and sulfate-induced attacks on sodium Nitrite may occur in open recirculating systems.The inhibitory effect of nitrite is removed when the pH dips below 5.5-6.0.

### 3.1.2 Inhibitors that passivate (or anodic) current:

Anodic inhibitors, on the other hand, are also referred to as passivating agents or substances. They can passivate the metal's surface. It is possible to divide passivating inhibitors into two groups: oxidizing anions and non-oxidizing anions.Chromate, nitrite, and nitrate are examples of anions that can passivate metals in the absence of oxygen. A localized attack could occur if chloride and sulphate concentrations rise above the threshold for chromate to have any effect on the system. Phosphate, tungstate, and moly date are all non-oxidizing inhibitors that need oxygen to passivate metal surfaces. This sort of inhibitor is extensively used and is more effective than other types[16].

### 3.1.3Inhibitors of precipitation:

Silicates and phosphates are both common film forming inhibitors. They are capable of blocking both anodic and catholic sites efficiently. They precipitate a layer of protection on the metal's surface.Hard water contains high concentrations of magnesium and calcium.When these salts precipitate, they produce a layer of protection on the metal surface. The pH of the water, the makeup of the water, and the temperature all have an effect on the way inhibitors that form films act [16].

### 3.1.4 Cathodic Inhibitors:

Cathodic inhibitors can be used to retard the reduction of oxygen in near
neutral situations and the evolution of hydrogen in acidic solutions.These inhibitor
species accumulate on cathodic sites, raising the surface impedance and lowering the
diffusion rate.

There are three different mechanisms of action for cathodic inhibitors [16][18].

**•Cathodic poisons**

When the hydrogen recombination process is inhibited, the cathodic reduction is retarded. Arsenic and antimony are two of the most prevalent cathodic poisons, and they are also highly hazardous.

**• Cathodic precipitates**

A layer of oxides, such as calcium and magnesium, can provide corrosion protection for metal surfaces

**• Oxygen scavenger**

Corrosion is minimized through the removal of oxygen from the system. Oxygen scavenger compounds react in the system with oxygen.

ISSN NO: 2770-0003
Date of Publication: 28-06-2022

### 3.1.5Inhibitors of Organic Chemistry:

A coating of organic inhibitors has been applied to the damaged surface. They overlay a hydrophobic coating on top of the metal to prevent it from disintegrating. The inhibitor's efficiency is influenced by its molecular structure, chemical makeup, and metal affinity. As a result, they are commonly used in situations involving environmental issues. The high level of protection afforded by the organic inhibitor is attributed to A polar group including N, O, S, P...etc. atoms and serving as an active center for adsorption on the metallic surface is required [16].

### 3.1.6 Inhibitors of Inorganic Compounds:

Inorganic inhibitors such as sodium chromate and molybdate are frequently utilized as crystalline salts. Inorganic inhibitors have modest protective properties and are capable of forming spring-soluble compounds on metal surfaces [18].

### 3.1.7 Toxic Inhibitors:

To preserve both ferrous and non-ferrous metals, sodium tungstate (Na2WO4), vandates (NaVO3), nitrites (NaNO2), silicates (Na2Si2O5), and chromates (NaCrO4) were utilized. Due of their toxicity, nitrites and chromates are being phased out. When corrosion inhibitors for open recirculating cooling water systems were required for environmental protection, molybdate salt or rare earth metals were employed instead of chromates, but these compounds are prohibitively expensive [21][22]. Phosphate salts were frequently employed as an inorganic inhibitor in conjunction with zinc salt (zinc 2 mg/L). [1] [23][24].

### 3.1.8Friendly Inhibitors:

Inhibitors are increasingly being utilized in conjunction with environmentally friendly substances.Researchers are concentrating their efforts on the role of organic components found in natural goods such as fruit shells and leaves, which include a varies array of compounds that are organic (e.g., amino acids, alkaloids, and pigments)that impede metal dissolution and so aid in the prevention of environmental pollution[25].According to Qurishi et al. [26], aqueous extracts of certain naturally occurring compounds can be employed as corrosion inhibitors for metal dissolving at a reasonable cost and without toxicity. According to El-Hosary et al. [27], corrosion inhibitors for Fe, Cu, Al, Zn, and other metals have been discovered in aqueous extracts of leaves, fruit peels, and seeds.

## Conclusions

This page provides an overview of the numerous corrosion inhibitors that are used to protect metal surfaces from corrosion. Organic, inorganic, or hybrid (organic/inorganic) corrosion inhibitors are all possible. Furthermore, they are classified as cathodic, anodic, or mixed-type inhibitors based on the active inhibitor molecules that obstruct the corrosion process. Silicates, nitrites, molybdates, phosphates, zinc salt, and cerium salt are often used inorganic inhibitors. As inhibitors, a wide range of natural compounds have been widely used. Physisorption, chemisorption, barrier formation, thin-film production, and electrochemical processes can all be used to guard against corrosion.

## References:

[1]Fontana, M. G., Corrosion engineering, McGraw-Hill (1986).

[2]Green, D. W. and Perry, R. H., Perry's chemical engineers' handbook, eighth edition, McGraw-Hill Education (2007).

[3]Shreir, L. L., Burstein, G. T. and Jarman, R. A., Corrosion, Butterworth-Heinemann (1998).

[4]G.V. Redkina, A.S. Sergienko and Yu.I. Kuznetsov, Hydrophobic and anticorrosion properties of thin phosphonate–siloxane films formed on a laser textured zinc surface, Int. J. Corros. Scale Inhib., 2020, 9, no. 4, 1550–1563. doi: 10.17675/2305-6894-2020-9-4-23

[5] A.I. Biryukov, O.A. Kozaderov, R.G. Galin, D.A. Zakharyevich and V.E. Zhivulin, Details of the mechanism of dissolution of iron–zinc coatings based on the δ-phase in acidic media, Int. J. Corros. Scale Inhib., 2020, 9, no. 4, 1477–1489. doi: 10.17675/2305-6894-2020-9-4-18.

[6]Yu.I. Kuznetsov, Triazoles as a class of multifunctional corrosion inhibitors. Review. Part II. 1,2,3-Benzotriazole and its derivatives. Iron and steels, Int. J. Corros. Scale Inhib., 2020, 9, no. 3, 780–811. doi: 10.17675/2305-6894-2020-9-3-1

ISSN NO: 2770-0003
Date of Publication: 28-06-2022

[7] A. Kadihum, Improvement the fatigue resistance and increase its life of specimens of naval brass alloy using laser shock wave processing, J. Nanosci. Technol., 2016, 2, no. 1, 69–726.
[8] A. Kadhim, R.S. Jawad, N.H. Numan and R.J. Al-Azawi, Determination the wear rate by using XRF technique for Kovar alloy under lubricated condition, Int. J. Comput. Appl. Sci. (IJOCAAS), 2017, 2, no. 1, 1–5.
[9] M. Hanoon, D.S. Zinad, A.M. Resen and A.A. Al-Amiery, Gravimetrical and surface morphology studies of corrosion inhibition effects of a 4-aminoantipyrine derivative on mild steel in a corrosive solution, Int. J. Corros. Scale Inhib., 2020, 9, no. 3, 953–966. doi: 10.17675/2305-6894-2020-9-3-10.
[10]A.A. Al-Amiery, A.A.H. Kadhum, A.B. Mohamad, A.Y. Musa and C.J. Li, Electrochemical study on newly synthesized chlorocurcumin as an inhibitor for mild steel corrosion in hydrochloric acid, Materials, 2013, 6, no. 12, 5466–5477. doi: 10.3390/ma6125466
[11] A.A. Al-Amiery, A.A.H. Kadhum, A.B. Mohamad and S. Junaedi, A novel hydrazinecarbothioamide as a potential corrosion inhibitor for mild steel in HCl, Materials, 2013, 6, no. 4, 1420–1431. doi: 10.3390/ma6041420
[12]H. Herbert, H. Uhlig and R. Revie, Corrosion and Corrosion Control: An Introduction to Corrosion Science And Engineering, 4th edition, John Wiley & Sons, 2008.
[13]A. Kadihum and S.J. Raid, Spectral study of some pharmaceuticals and cosmetics, Eng. Techol. J., 2015, 33, no. 2, 172–177.
[14] M. Hashim, A. Kadhim and R.J. Al Azawi, Effect of laser Peening on the Microhardness and Roughness of Al-7277 alloy, Eng. Techol. J., 2019, 37, no. 10A, 404–407.
[15] M. Hashim, R. Al-Azawi and A. Kadhim, The Q-switched Nd:YAG laser shock processing effects on mechanical properties of C86400 Cu-Zn alloy, Iraqi J. Phys. (IJP), 2019, 17, no. 42, 136–140.
[16]Roberge, P., Handbook of corrosion engineering, Mcgraw-hill (1999).

[17]Abdel Hamid, Z., Ghanem, W. A. and Abo El Enin, S. A., "Process aspects of electroless deposition for nickel–zinc–phosphorous alloys", Surface and Interface Analysis 37, 792 (2005).
[18]Revie, R. W., Uhlig's corrosion handbook, Wiley (2011).
[19] 1S. A. Abo El-Enin, 2Ashraf Amin.Review of Corrosion Inhibitors for Industrial
[20]Sharma, S. K. and Eddy, N. O., Green corrosion chemistry and engineering: Opportunities and challenges, Wiley (2011).
[21]Bofardi, B. P., "Cooling water treatment for highly supersaturated caco3 environment", 8th European Symposium on Corrosion Inhibitors, Università di Ferrara, Italy (1995).
[22]Vukasovich, M. S. and Van Riper, G. G., "Molybdate: A low toxicity corrosion inhibitor", 7th European Symposium on Corrosion Inhibitors, Università di Ferrara, Italy (1990).
[23]Gonzales, Y., Lafont, M. C., Pebere, N. and Moran, F., "Corrosion inhibition study of a carbon steel in chloride solution by electrochemical techniques and surface analysis", 8th European Symposium on Corrosion Inhibitors, Università di Ferrara, Italy (1995).
[24]Manahan, S. E., Environmental chemistry, seventh edition, Taylor & Francis (1999).
[25]Favre, M. and Landolt, D., "The influence of gallic acid on the reduction of rust on painted steel surfaces", Corrosion Science 34, 1481 (1993).
[26]Qurishi, M. A., Farooqi, I. H. and Saini, P. A., "Corrosion protection of aluminum by natural product", Corrosion (1999).
[27]El-Hosary, A. A., Saleh, R. M. and El-Dahan, H. A., "Corrosion inhibitor", 7 th European Symposium on Corrosion Inhibitors--Proceedings., Università di Ferrara, Italy (1990).