Organic inhibitors to protect metals and alloys from corrosion: A review

Safa subhe Hamza[1], Haydar A.H. Al –juboori[2], Ekbal M. S. Salih[3]

[1,2,3]University of Babylon -College of Materials Engineering, Babylon, Iraq.

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ABSTRACT
Corrosion is an unavoidable fact in everyday life but always receive attention to control due to its technical, economical, and esthetical importance. Corrosion inhibitors are one of the most widely used and economically viable methods protecting metals and alloys against corrosion. Typical corrosion inhibitors are bio-toxic organic compounds, which tremendous interest in searching for an eco-friendly, and non-toxic green corrosion inhibitor. This chapter briefly discusses the importance and different methods of corrosion inhibitors with a particular emphasis given to the discussion on the different comparative view of organic inhibitors.

Keyword: corrosion inhibitors, mild steel, green inhibitors, organic, adsorption

1.INTRODUCTION

Defined as destructive and irreversible damage and deterioration, electrical and chemical destruction of tissues and all possible Environments are almost subject to corrosion to some extent, as the corroded state is the most stable state of matter. Corrosion generally occurs as a result of chemical reactions (mainly oxidation). This occurs when a chemical gas or liquid attacks an exposed surface, which is often metal. This process is accelerated by warm temperatures, acids, and salts, and is formed. Usually products of corrosion again. Some materials resist rubbing Naturally, we can protect other materials by painting, galvanizing, or galvanizing [1].

Corrosion reduces the properties and composition of materials, including strength, appearance and fluid permeability. It is a major problem in all fields and can have a serious impact on factories Major electrical power plants and chemical processing plants cause damage to vehicles Household appliances, pipelines, weapons, and bridges(2).

But nowadays awareness has increased to provide protection from corrosion due to the large losses it causes Many countries have undertaken a lot of research into corrosion control for several important main reasons motivate us for this study(4,3)

1 - The relationship of corrosion to human life, as it endangers the life and safety of people who work with the equipment. And even those who live or do business around the place.

2 - Corrosion affects the safety of the equipment and the facility, which may lead to failure and collapse.

3- Preserving the environment from corrosive residues that lead to water, air and soil pollution.

4 - The cost of corrosion and its economic impact on society. This will lead to economic losses that have direct effects And indirect.

5 - In all technical fields, metals are used and therefore they must be protected from corrosion.

6- Failure of highly sensitive operating equipment due to corrosion, which is why it requires study.

2. Methods of protection from corrosion

Metals or alloys are exposed to corrosion when they come into contact with corrosive ions. Therefore, corrosion of metals must be prevented by changing the metal, changing the environment, or isolating the metal from corrosive media. The rate of corrosion can be successfully inhibited by preventing cathodic or anodic reactions. This can be successfully achieved through the use of several corrosion control techniques such as protective coating, anodic protection, inhibitors, cathodic protection, lubrication, and electroplating Among the current methods, inhibitors are the choice best to redues of the coriossion [5,6].

3. Corrosion inhibiter

The use of inhibitors is an important way to protect metals and alloys from damage due to corrosion attack, especially in acidic environments (7).

Corrosion inhibitors may be either organic or inorganic substances, and when addedIn small concentrations to corrosive media, they effectively reduce the interaction of the metal with the medium. Inhibitors work in two ways: . (8)
(1) Changing the aggressive medium to a minimal or non-corrosive environment through its interaction with the medium
(2) Interacting with the metal surface to form a layer Protection on adsorption inhibitors, this is consistent with green corrosion inhibitors (9).

3.1.Basic properties of inhibiter
Certain conditions must be met in the inhibiter in general
-Reduce a metal's rate of corrosion while leaving its physico-chemical properties intact.
Must function well at low concentrations.-
Must be in line with non-toxicity requirements- (10,11).It must be reasonably priced-

3.2. classify inhibitors
The number of inhibitors is very large, so there are several ways to classify them according to:
-Its nature.
-According to partial interaction.
- Using it.
-Reaction mechanism.

3.2.1-Depending on the nature of the inhibitor
A- Organic inhibitors: They are compounds characterized by the presence of active centers (functional groups) that form a band on the surface of the metal as a result of their adsorption. Most studies were on nitrogenous compounds (12).

B- Inorganic (mineral) inhibitors
They are mineral compounds that are either oxidizing compounds, such as Cro4, if it is widely used, especially in basic media. Perhaps the most widely used of these compounds in the acid field is the iodine ion. As for moderate media, both lithium and magnesium ion have been studied, based on aluminum, or non-oxidizing, which are weak acids and bases, such as Sodium phosphate and polysodium phosphate (12).

3.2.2-Classificationaccording to partial reaction:
A-Anodic inhibitors
Anodic inhibitors prevent the corrosion process by controlling the anodic reaction. This usually forms. This type of inhibitor provides a durable protective layer on the active anodic sites on the surface of the alloy, resulting in Shift the voltage value towards the anodic side (positive direction). This moves the metal surface to the noble region (passive zone). Anodic inhibitors are widely used to protect materials from corrosion due to their efficiencyHigh protection compared to other types of inhibitors (13,14).

B- Cathiodic inhibiter
The cathodic corrosion inhibitor stop the occurrence of the metal cathodic reaction during the corrosion process . these inhibitors have metal ions able to make a cathodic reaction due to alkalinity ,thus generate an insoluble compound which precipitate selectively on the cathodic site .deposit over the metal an adherent and compact film ,restricting the species which reduced the diffusion in these areas . thus ,in creasing the diffusion restriction nof the reducible species and the impedance of the surface , that is ,the electrons conductiety and oxygen diffusion in these areas (15,16).

C-Mixed inhibitors
Mixed inhibitors work by reducing the interactions of the anodic and cathodic sites and affecting both voltagesCathodic and anodic. The voltage shift in this process is small compared to cathodic and anodic dampers.These inhibitors have advantages over other inhibitors due to their effect on both cathodic processes and(17,18)and anodic. It usually forms a protective layer on metal surfaces to prevent corrosion.

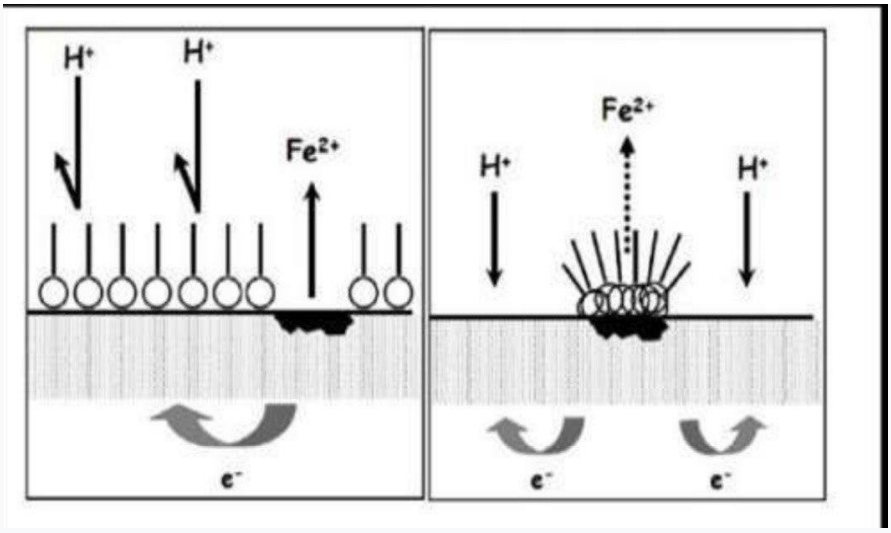


Figure (1-1) Formation of cathodic and anodic barrier layers from electrochemical reactions in acidic media .

3.2.3According to its use

1-In an ionic medium:(19)

A- In a neutral ionic medium

It concerns monitoring and protecting water circuits for cooling.

B- In an acidic ionic medium: It is used in these media to prevent chemical attack on steel during the process of wiping or cleaning from rust, as for petroleum industrial media, where it is added to the liquid.

C-Organic medium:

A large amount of inhibitors is used in motor oils and at gas stations. These fluids often contain water molecules and ionic compounds that incite corrosion.

3.2.4.Inhibition according to the reaction mechanism

A- Passivation inhibitors:

The inhibitor plays the role of an oxidizer for the metal, so a thin layer of oxides is formed on its surface (an inert layer), which leads to the displacement of corrosion to the inert area. The extent of the compactness of the protective inert layer can be determined by measuring the residual curren(20).

B. Adsorption inhibitors

The principle of action of corrosion inhibitors depends on the direct or indirect adsorption of inhibitor molecules on the metal surface, which reduces the contact of the metal surface with the aggressive medium. The majority of metal materials are naturally unstable so that they tend to react chemically, electrochemically with aggressive agents of the environment such as C) resulting from the application Corrosion inhibitors in corrosive media are adsorbed onto the active sitesHigh energy areas of the metal surface after the formation of a protective film. This layer isolates the metal surface fromaggressive environment thus preventing it from corrosion(21).

Adsorption is a phenomenon that occurs on a general surface because every surface is made up of atoms that have no bonds Chemically sufficient, this surface has the ability to compensate for this deficiency by attracting the atoms and molecules next to it. We can distinguish two types of adsorption(22).

Physical adsorption:-1

It is also called physical adsorption, and it preserves the identity of the adsorbed particles, and we distinguish types of forces for it:

Diffusion forces are always present.-

Polar forces are the result of the presence of an electric field . -

Hydrogen bonds resulting from the hydroxyl or amine group.-

2-Chemical adsorption

In contrast to physical adsorption, chemical adsorption occurs by sharing electrons between the polar part and the metal surface, where very stable chemical bonds are created based on the bond energies.The majority of electrons come from pairs that do not appear in the inhibitory molecules, these atomsIt is

characterized by its higher electronegativity than other atoms, and chemisorption is characterized by a reversible mechanism.

C - Inhibition by sedimentation

A difficult-to-dissolve compound is formed between the metal ion and the inhibitor ions, which reduces the speedCorrosion as an example, we mention the use of silicium-bonded steel (alloy), which encourages the formation of silicatesIron on the surface of the metal, and the presence of the latter in the passive layer strengthens the inhibitory effect against Corrosion (20).

4.Green inhibiter

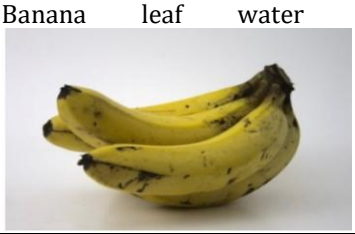
The search for natural compounds that may be useful as metal corrosion inhibitors has been prompted by the toxicity issues associated with synthetic inhibitors.Because herbal compounds are readily available, eco-friendly, and biodegradable, there has been a lot of interest in their use. Green inhibitors are various plant-derived chemicals, like flavonoids and tannins [25], that are bound to the metal surface by means of functional groups containing N, O, S, P, or heteroatoms. Phytochemical components are the active groups of the organic green corrosion inhibitor Many researchers have investigated the inhibitory efficacy of natural extracts derived from various plant components (seeds, leaves, and stems) in various corrosive mediaThe importance of green inhibitors is also explained in the following literature over the past ten years (26,27).

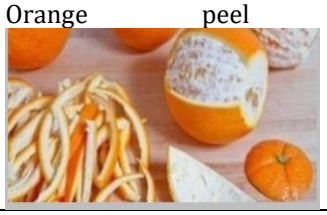
FIGURE 1.1 Various types of green corrosion inhibitors.

Table 1

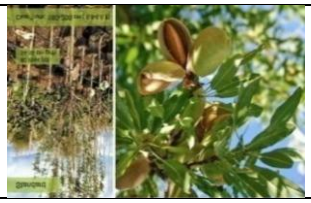
Refrenc				Meadem	Tayp	Materal	yaers
28	Chemical	92.3%IN H2SO4 93.8 IN HCL	Steel Q235	HCL H2SO4	Mixed	Brassica oleracea aqueous extract 	2021
29	Chemical	93.2%	Mild steel	Hcl	Mixed	Phenolic extract of the local palm tree plant	

							
30	Mixed with physics	95-92.3%	Mild steel	H3po4	Mixed	Pomelo peel extract Ppe 	
31	Chemical	97%	Copper	H2so4	Mixed	Fesratrum root extract Ver 	
32	physical	73.5%	Mild steel	Nacl	cathodic	Ethanol extract of cardamom 	
33	Physical	96%	Mild steel	Hcl	Mixed	Mish Aush leaves extract 	
34	Physical AND Chemical	98.7%	Mild steel	Hcl	Mixed	Artichoke extract 	
35	Physical	97.418%	C38 steel	Hcl	Mixed	Hydroalcoholic extract of coffee 	
36	Physical AND Chemical	81.96%	Mild steel	H2so4	Mixed	Magnolia Coeus DC Extract 	

37	Physical	94.88%	Mild steel	Hcl	Mixed	Ethanol extract of Calendula officina flower fragrance is not 	
38	Physical	92%	Mild steel	Hcl	Mixed	Pistachio nut hard shell extract 	
39	-	94%	Mild steel	Hcl	Mixed	Aqueous extract of Webesa citrudora leaves 	
40	Chemical And physical	90%	Tin	Hcl	Mixed	Banana leaf water extract 	2021
41	-	73.9%	Steel	Nacl Acetic acid	Cathidic	Pectin isolated from tomato peel waste 	
42	-	98.3%	Solid steel	Hcl	Mixed	Huttonia cordana leaf extract	
43	Chemical	92%	Mild steel	Hcl	Mixed	Lavender extract 	
44	-	90%	Mild steel	Hcl	Mixed	Banana peels 	

45	Chemical And physical	85%	Solid steelq235	Hcl	Mixed	Magnolia grandiflora leaf extract 	
46	Physical	87.89%	Mild steel	Hcl	Mixed	Sponge gourd extract 	
47	-	85.7%	Magnesium alloy	nacl	Mixed	Orange peel extract 	
48	-	93%	Mild steel	H2so4	Mixed	Tephrosia Purpurea 	2019
49	-	95.8%	Solid carbon steel	Hcl	Mixed	Teacoa leaf extract	
50	Physical	88%	Steel ss	H3po4	Mixed	Essential oil extract	
51	Chemical	80%	Mild steel	H2so4	Mixed	Sage and jojoba oil extract 	
52		93.7%	Mild steel	Hcl	Mixed	Gentian oleifera extract 	
53	Mixed	91%	Mild steel	Hcl	Mixed	Watermelon fruit extract	

							
54	Mixed	88%	Mild steel	Hcl	Mixed	Green eucalyptus leaf extract 	
55	Chemical	92%	Mild steel	HCL	Mixed	Aqueous extract of Chinese gooseberry fruit peels 	
56	Chemical	91%	Mild steel	HCL	Mixed	Borage flower aqueous extract 	
57	-	97.6%	LOW CARBON STEEL	HCL	Mixed	Pineapple stem extract bromelain 	
58	-	92.67%	Mild steel	HCL	Mixed	Parsley leaf extract 	
59	-	66.31%	Double phase steel	NACL	Anodic	Curry papaya peel extract 	
60	Mixed	93%	Mild steel	Hcl	Mixed	Almond peels	

							
61	-	88%	Mild steel	Hcl	Mixed	Licorice extract 	
62	Physical	98%	Mild steel	Hcl	Mixed	Sunflower seed extract 	
63	Mixed	95.47 %	Mild steel	H2so4	Mixed	Cuscata reflex fruit extract 	
64	-	91%	Mild steel	Hcl	Mixed	Green pea peel extract 	
65	-	80-84%		Nacl	anodeic	Brassica campestrips extract 	
66	Physical	91.73%	Mild steel	Hcl	Mixed	Griffonia similiavalia seed extract 	2017
67	-	93%	Mild steel	Hcl	Mixed	Extract of leaves from agarwood trees	

CONCLUSION

Corrosion affects the most varied sectors and directly impacts the economy of a country, especially industrialized and large oil and gas explorers. The need for means to reduce these impacts is evident and for this, science and technology are fundamental. The scientific and patent survey carried out in the present study recovered several documents about the use of derivatives of plant extracts as green corrosion inhibitors and allowed drawing an overview.

Most extracts are prepared from leaves, but the use of fruit peels, seeds, flowers and roots are also reported. Acid medium is the most tested in corrosive environments and protection of carbon steel is the most researched. Excellent inhibition efficiencies were obtained at room temperature, with percentages above 80% for the corrosion rate. Results are associated with synergistic effect due to the presence of phytochemicals, known as nontoxic substances.

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