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Corrosion of Metals, Types and Measures to Prevent It

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Abstract: The article provides information on what metal corrosion is, its causes, cathode and anode processes, types of processes according to the conditions and mechanism, electrochemical and chemical corrosion, damage to the economy of metal structures corrosion, and measures to prevent it.

Keywords: corrosion of metals, cathodic process, anodic process, chemical corrosion, electrochemical corrosion, aggressive environment, inhibitor.

Introduction

It is important to synthesize competitive and highly effective inhibitors that protect metal structures from corrosion in aggressive environments. The rapid growth of the industry and the high demand for metal products are causing an increase in the demand for effective inhibitors used in aggressive environments. Special attention is paid to the development of cost-effective and environmentally friendly composite inhibitors, abandoning single-component inhibitors with high concentration. Also, analysis of inhibition properties is of great practical importance as a result of studying the mechanism of influence of the structure, quantity, temperature and nature of the aggressive environment on the protection level of the inhibitors in eliminating the corrosion process.

Today, in the world, research is being carried out on the synthesis of effective inhibitors based on water and oil-soluble organic and inorganic substances based on heteroatomic, amine-containing aromatic and aliphatic compounds containing nitrogen, phosphorus and sulfur, as well as polysilicates and complex compounds against metal corrosion. is going Based on this, instead of complex, expensive and toxic inhibitors, special attention is paid to obtaining environmentally safe, environmentally friendly inhibitors with several functional groups based on local raw materials and industrial secondary products. .

In chemistry, metal corrosion or rusting is a process that occurs as a result of the interaction of a metal plate with environmental substances (air oxygen or acids with which the metal product can react) [1].

Generally, metals to the left of hydrogen in the metal stress series, including iron, are oxidized.

The most common types of corrosion are chemical and electrochemical corrosion [2]. To understand how they differ from each other, they are compared according to several criteria in the table below.

Comparison of chemical and electrochemical corrosion of metals

Comparison marks	Chemical corrosion	Electrochemical corrosion
Description	Corrosion of metals due to interaction with non-conducting gases or solutions.	Metal corrosion in water or other electrolyte environment.
Aggressive reagents	O_2, H_2O vapors, CO_2, SO_2 , Cl_2	Electrolyte solutions
Examples	$3Fe + 2O_2 \rightarrow Fe_3O_4$	$4Fe + 3O_2 + 6H_2O = 4Fe(OH)_3$ When iron comes into contact with zinc, zinc corrodes: A (+) on zinc surface: $Zn^0 - 2e^- = Zn^{2+}$ K (–) on iron surface: $2H^+ + 2e^- = H_2$

Metals can be protected from corrosion in different ways:

covering with protective materials;

electrochemical methods;

chemical methods .

Corrosion is the spontaneous decay of elements, often metals, under the chemical or physical-chemical influence of the environment [3] . In other words, iron begins to rust due to chemical action. This is a very complex process with several steps, but the general equation of corrosion looks like this:

$4Fe + 6H_2O$ (moisture) + $3O_2$ (air) = $4Fe(OH)_3$

Corrosion is often understood as a chemical reaction between a material and its environment or its constituents, occurring at phase boundaries. This is usually the oxidation process of the metal. For example:

$3Fe + 2O_2 = Fe_3O_4$

$Fe + H_2SO_4 = FeSO_4 + H_2$

Some metals, even active ones, are covered with a dense oxide film during corrosion. This is one of their characteristic features. The oxide film prevents the penetration of oxidizing substances into a deeper layer and thus protects the metal from corrosion. Aluminum is generally resistant to air and water, even hot water. However, if the aluminum surface is coated with mercury, an amalgam will form. It destroys the oxide film, and aluminum quickly begins to turn into white flakes of aluminum metahydroxide:

$4Al + 2H_2O + 3O_2 = 4AlO(OH)$

Corrosion of metals and measures to prevent it.

Corrosion of metals (derived from the Latin word corrosion - decay) is an oxidation-reduction process, a phenomenon of spontaneous decay of metals as a result of their interaction with the environment. In this process, the corroded metal is the reducing agent, and the substance in the aggressive environment is the oxidizing agent. Often, the corrosion process proceeds spontaneously without external energy and occurs with a decrease in the Gibbs free energy of the system due to the transformation of metals into oxides, hydroxides and salts.


Metal corrosion is an unpleasant process, and in industrialized countries, 5-10% of the national income is allocated to the damage caused by metal corrosion and its elimination. If only a small fraction of these costs are irretrievably scrap metal, the main loss from corrosion, premature failure of metal structures, will increase the cost of the metals used to make them.


Corrosion process consists of various manifestations depending on the conditions of their occurrence. The corrosion process differs according to the nature of corrosion damage and the reaction mechanism. Therefore, there are several ways to divide them into classes.

Corrosion is divided into the following types according to the driving conditions:

1. Atmospheric corrosion - corrosion of metals in natural atmospheric conditions (about 80% of metal structures are operated in atmospheric air).
2. Corrosion in electrolytes (salt, acid and alkali solutions) – corrosion of metals in mediums carrying electric current.
3. Soil corrosion - corrosion of metals in soil and soil.
4. Contact corrosion - electrochemical corrosion, as a result of contact of metals with different electrode potentials in a corrosive medium.
5. Frictional corrosion (fretting corrosion) - as a result of simultaneous action of frictional force with a corrosive environment.
6. Cavitation corrosion is a forceful effect of a corrosive environment.
7. Electrocorrosion - impact corrosion of an external current source.
8. Crevice corrosion is corrosion that occurs in narrow spaces between two metals or in areas of loose contact between a metal and a non-metallic inert corrosive material.
9. Structural corrosion is corrosion associated with structurally heterogeneous metals.
10. Radiochemical corrosion is caused by radioactive radiation.
11. Biocorrosion is a process under the influence of the product of life activity of microorganisms.
12. Gas corrosion - chemical corrosion of metals with gases at high temperatures.
13. Corrosion in non-electrolytes (gasoline, kerosene, oil and other organic liquids).

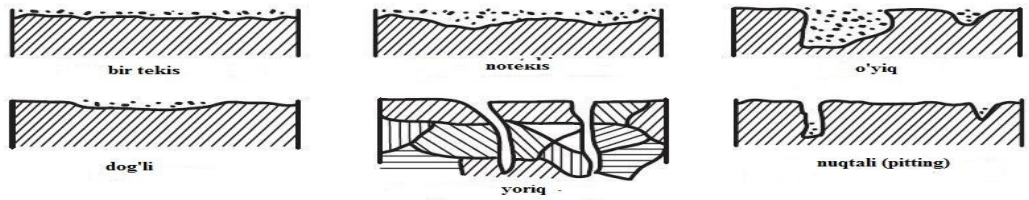
Corrosion disorders are divided into the following types according to their nature:

1. Total or general corrosion, in which the metal corrodes over its entire surface. General corrosion is divided into several types:

a) uniform corrosion - general corrosion that occurs at a uniform speed over the entire surface of the metal;

b) uneven corrosion - general corrosion that occurs at different speeds in different parts of the metal surface;

c) selective (selective) corrosion is a process in which the structure of one component of the alloy is destroyed.



2. Local (local) corrosion is a corrosion process occurring in individual sections of the metal surface. Local corrosion is also divided into several types:

a) spot corrosion - local corrosion formed in the form of a separate spot;

b) pitting corrosion - occurs with the formation of pits of large or small depth in metal;

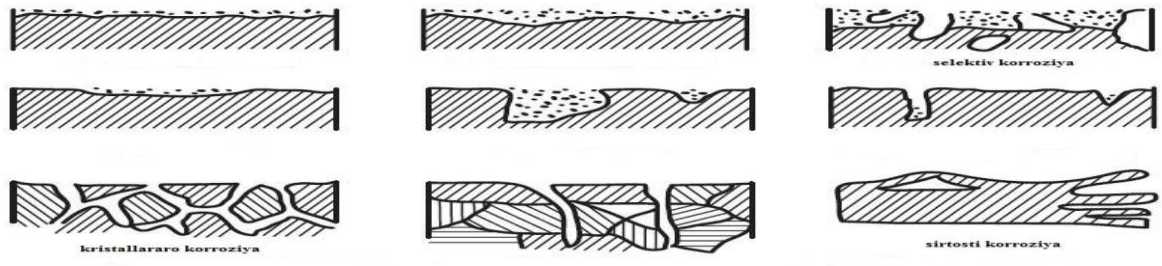
c) point (pitting) corrosion - a form of local corrosion with a breakdown of the metal surface in the form of separate points;

d) surface corrosion - the process of corrosion under the metal surface;

e) intercrystalline corrosion - corrosion process between metal crystal lattices;

f) transcrystalline corrosion - a process of corrosion that goes through all the crystals of a metal;

g) crevice corrosion is a corrosion process that occurs as a result of the simultaneous effect of mechanical stress with a corrosive environment.



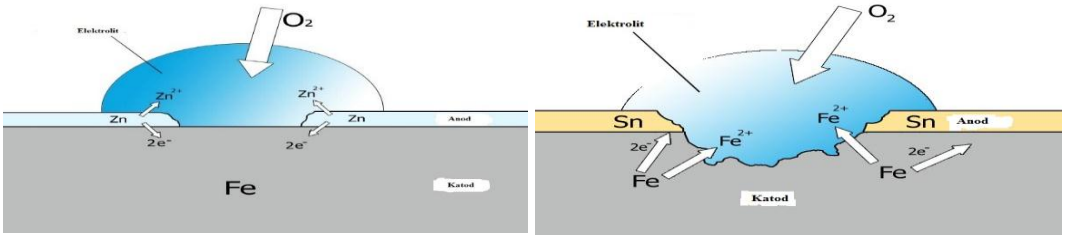
Metals of corrosion to go to the mechanism according to corrosion process two type divided into: Chemical and electrochemical.

Chemical corrosion is of metals corrosion environment with secret as a result of process in this metal oxidized, corrosion of the environment oxidizer component will be returned. Such to become mysterious as a result oxidizing, metal valent electrons take one of time in himself she is with chemical compound harvest does [4].

Chemical of corrosion wide spread out and practical in terms of important have was type gas corrosion is considered she is high temperature dry gases under the influence (gas of pipes in the shoulder blades, internal burning in engines, jet of engines in the nozzles) goes. Metals gas of

corrosion the reason is theirs that's it in the environment thermodynamic in terms of instability and high in temperature corrosion of the environment aggressive components (oxygen, hydrogen sulfide, halogens and another with oxidizers). to the reaction get in the ability be is considered Also chemical _ corrosion without water in the environment liquid non-electrolytes (gasoline, kerosene, hydrocarbons and others) with participation too goes [5].

Electrochemical corrosion - of metals from himself vine who wears medium (electrolytes solution and liquefaction) with participation decay process. In this process, the metal is oxidized (changes to the ionic state), and the oxidizing component of the corrosive medium is returned. Oxidation-reduction processes take place in various stages, and their speed depends on the potential of the electrodes. This division of oxidation-reduction processes is related to the fact that the metal surface is electrochemically different (heterogeneous) [6].



Reasons for electrochemical heterogeneity:

1. Contact of two or more metals of different potential;
2. Contact of metals with various environments;
3. The presence of an oxide film on the metal surface;
4. Variety of metal structures;
5. Variation of internal stresses in metal;
6. Due to the temperature difference in different sections of metals.

All this means that in one section of the corroding metal surface, the oxidation process (anode process) takes place, and in another section, the reduction process of the oxidizer (cathode process) takes place.

The interaction of two or more different metals (contact corrosion or galvanocorrosion) associated with the formation of such corrosion pairs is often observed.

When does metal oxidation (corrosion) occur? When the potential of the metal is less than the potential of the oxidizer in this corrosive environment:

$E_{Me^{n+}/Me} < E_{Ox/Red}$

In the literature on corrosion, the concept of oxidant is called a special term - depolarizer. The most common depolarizers in metal corrosion are dissolved oxygen and hydrogen ions. These are divided into hydrogen and oxygen depolarization processes, respectively [7].

Today, various methods are used to prevent metal corrosion, and these methods differ from each other in terms of their effectiveness and economic efficiency.

To divide these methods into several groups depending on the practical use of measures to protect metals from corrosion [8] can:

1. Increasing the corrosion stability of metals and alloys by alloying;
2. By reducing the aggressiveness of the corrosive environment (inhibition);
3. Protection by means of electric current (electrochemical protection);
4. Covering with protective coatings (varnish, paint, enamel, primer);

5. Protection using combinations of protection methods.


Current in the day of states development chemistry, oil - gas and energy without industry imagination reach difficult. This industry in enterprises metal constructions from corrosion protection fall in order to corrosion environment aggressiveness reducing chemical using substances (inhibitors) is coming. Inhibitors (corrosion stopping) aggressive to the environment very less amount will be added and the metal to protect efficiency high become an enterprise to the economy another expensive was to methods relatively much benefit brings.

Corrosion inhibitors as character chemical to content have was organic and inorganic substances is used [9].

Summary

The article provides information on what metal corrosion is, its causes, cathode and anode processes, types according to the conditions and mechanisms of the process, electrochemical and chemical corrosion, damage to the economy of the metal structures corrosion, and measures to prevent it.

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