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STRUCTURAL CLASSIFICATION AND ANALYSIS OF CORROSION OF METALS

Abstract: *This article provides information on the systematic study of corrosion of metals and alloys.*

During the storage and operation of metal structures, they interact with the surrounding substances, as a result of which they are destroyed. In particular, the structures of steel bridges, iron roofs of buildings, equipment of workshops, steel pipelines in the ground, etc. rust. This is the result of metal corrosion.

Metal corrosion wreaks havoc on virtually every industry. Corrosion of metals is like a slow process.

A number of scientists have conducted research on metal corrosion. The results of this study are reflected in published literature and scientific articles. When analyzing the data presented in the literature and scientific articles, the types, appearance and causes of corrosion can be divided into several types. However, it turned out that these data are not systematized. Therefore, we have systematized all corrosion into one system in order to simplify the study, understanding and analysis of metal corrosion.

Key words: *corrosion, phase, heterogeneous process, mechanism, damage, erosion of metals and alloys.*

Language: *English*

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Introduction

Metals and their alloys are the most important structural materials. In the process of storage and operation of metal structures, they interact with the surrounding substances, as a result of which they are destroyed. In particular, the structures of steel bridges, iron roofs of buildings, equipment of workshops, steel pipelines in the ground, etc. rust. This is the result of metal corrosion.

Spontaneous destruction of metal structures due to their chemical or electrochemical interaction with the environment is called corrosion of metals [1].

The corrosive process occurs at the boundary of two phases: metal - environment, i.e. is a heterogeneous process.

Metal corrosion wreaks havoc on virtually every industry. Losses from corrosion can be divided into two groups: direct and indirect [2].

Direct losses consist mainly of losses directly from the metal itself due to corrosion.

Indirect losses are huge and are due to the costs associated with equipment failure, downtime, the cost of repairing and replacing equipment parts, with oil and gas leaks through damage in pipelines, etc.

The metal corrosion course explores two related issues:

1) Establishing the mechanism of interaction of metals with the environment and the general laws of corrosion processes;

2) the study of methods for protecting metals from corrosion damage during their processing and

during the operation of metal structures in the atmosphere, river and sea water, soil, aqueous solutions of salts, acids, hydroxides, etc. [3,4].

II. RESEARCH METHODS

A number of scientists have conducted research on metal corrosion. The results of this study are reflected in published literature and scientific articles. When analyzing the data presented in the literature and scientific articles, the types, appearance and causes of corrosion can be divided into several types. However, it turned out that these data are not systematized.

For example, in one literature, the main reason causing the corrosive destruction of metals and alloys is written on their surface in different reactions.

Depending on the nature of these reactions and, accordingly, the mechanism of occurrence, all corrosion processes are divided into two types - chemical and electrochemical:

1) chemical corrosion refers to processes that occur during direct chemical interaction between a metal and an aggressive environment and are not accompanied by the occurrence of an electric current;

2) electrochemical corrosion refers to the processes of interaction of metals with aqueous solutions of electrolytes, accompanied by the appearance of an electric current in the system, that is, the ordered movement of electrons and ions from one part of the metal to another [5, 6].

One of the fundamental differences between these two mechanisms of metal corrosion is that during electrochemical corrosion, two processes occur simultaneously: oxidative (dissolution of the metal in one area) and reduction (discharge of cations from solution, reduction of oxygen and other oxidants in another area of the metal). For example, when zinc is dissolved in sulfuric acid, zinc ions are formed and hydrogen gas is released.

All metals, in their relation to electrochemical corrosion, can be divided into 4 groups, which are determined by the values of their standard electrode potentials:

1. Active metals (high thermodynamic instability) are all metals in the range of alkali metals - cadmium (E0 = -0.4 V). Their corrosion is possible even in neutral aqueous media, in which there are no oxygen or other oxidizing agents.

2. Metals of medium activity (thermodynamic instability) - located between cadmium and hydrogen (E0 = 0.0 V). In neutral environments, in the absence of oxygen, they do not corrode, but corrode in acidic environments.

3. Low active metals (intermediate thermodynamic stability) - are between hydrogen and rhodium (E0 = +0.8 V). They are resistant to corrosion in neutral and acidic environments in which oxygen or other oxidizing agents are absent.

4. Noble metals (high thermodynamic stability) - gold, platinum, iridium, palladium. They can corrode only in acidic media in the presence of strong oxidants [7].

Electrochemical corrosion can occur in a variety of environments. Depending on the nature of the environment, the following types of electrochemical corrosion are distinguished:

• **Corrosion in electrolyte solutions** - in solutions of acids, bases, salts, in natural water.

• **Atmospheric corrosion** - in atmospheric conditions and in any wet gas environment. This is the most common type of corrosion.

During chemical corrosion, corrosion products are formed directly on the surface areas where the metal is destroyed. However, it should be borne in mind that such a division of corrosion processes is somewhat arbitrary, since the corrosion mechanism can change. For example, electrochemical corrosion of iron in water vapor turns into chemical corrosion when the temperature rises, and in a liquid that is not an electrolyte, chemical corrosion in the presence of moisture turns into electrochemical.

III.THEORETICAL ANALYSIS

On the following and the literature is written on the conditions of corrosion, there are several types of corrosion:

1) gas - corrosion in gases at high temperatures;

2) atmospheric - corrosion in an atmosphere of air or wet gas;

3) liquid - corrosion in a liquid medium (in solutions of non-electrolytes and electrolytes);

4) underground - corrosion in soils and grounds;

5) biocorrosion - corrosion under the influence of the vital activity of microorganisms;

6) structural - corrosion associated with the structural heterogeneity of the metal;

7) corrosion by stray currents;

8) contact - electrochemical corrosion caused by the contact of metals with different electrode potentials in a given electrolyte;

9) crevice - corrosion in cracks and gaps between metals;

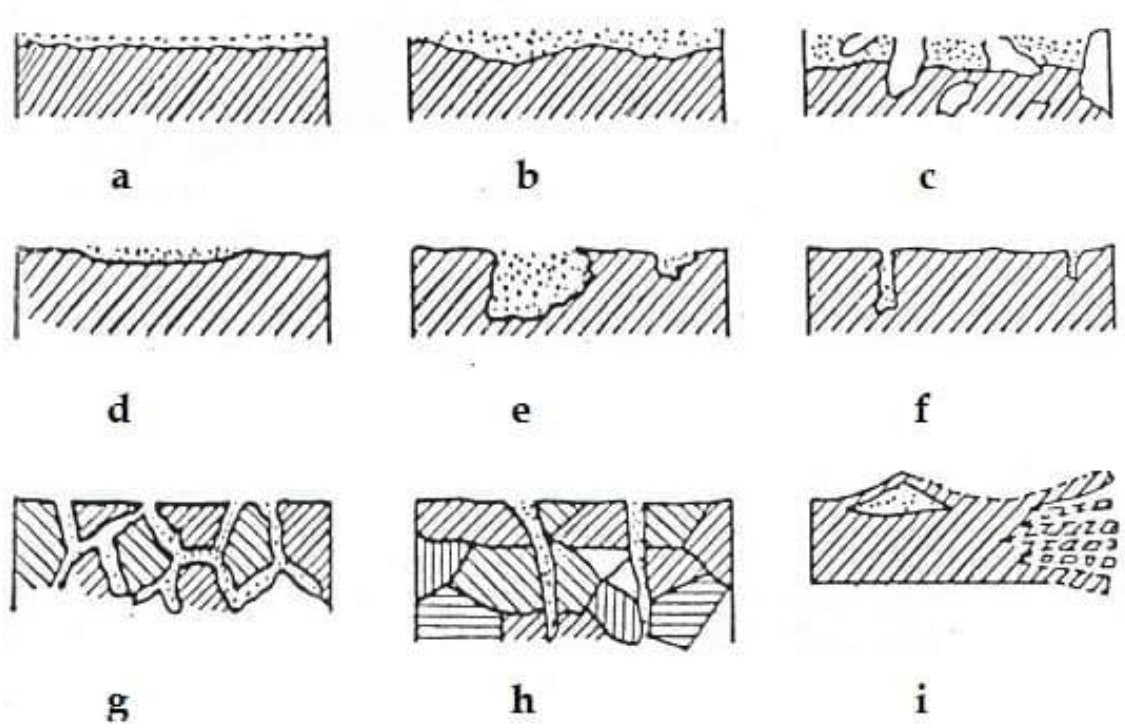
10) stress corrosion - corrosion with the simultaneous effect of a corrosive environment and mechanical stress;

11) corrosive cavitation - the destruction of the metal caused by the simultaneous corrosion and shock effects of the external environment [8].

And in other literature it is written that the most common types of metal corrosion are:

1. Uniform - covers the entire surface evenly
2. Uneven
3. Electoral
4. Local spots - corrode certain areas of the surface
5. Ulcerative (or pitting)

6. Spot
7. Intergranular - spreads along the boundaries of the metal crystal
8. Cracking
9. Subsurface



Picture 1.

Corrosion of metals is an electrochemical reaction that involves changes in both the metal and the environment in contact with the metal. While the mechanisms of corrosion are the same on a microscopic level, various microstructure, composition, and mechanical design issues will lead to different manifestations of corrosion.

There are seven common types of metal corrosion

- Uniform
- Galvanic
- Crevice
- Pitting
- Intergranular
- Stress corrosion cracking (SCC)
- Dealloying

Resistance of steels and alloys against electrochemical, chemical corrosion (atmospheric, soil, alkaline, acid, salt), intergranular corrosion, stress corrosion, etc. is determined primarily by their composition [10, 11].

Below is a diagram of the operation of a galvanic pair underlies the electrochemical corrosion of metals and alloys. Different phase components present in the structure of the alloy, being in the electrolyte, acquire electrode potentials of different magnitude and sign.

The greater the difference in the electrode potentials of the individual phase components, the more active the corrosion process and corrosion destruction of the alloy will proceed. The electrochemical heterogeneity of the metal surface is the cause of corrosion. Alloys with a homogeneous solid solution structure are more corrosion-resistant.

Table 1. EXAMPLES OF CORROSIVE PAIRS

Group corrosive steam	Corrosive pair	Anode	Cathode
Corrosive vapors from two different materials	Fe—Zn	Zn	Fe
	Fe—Sn	Fe	Sn
	Perlite	Ferrite	Cementite
	Cu—Al	Al	Cu

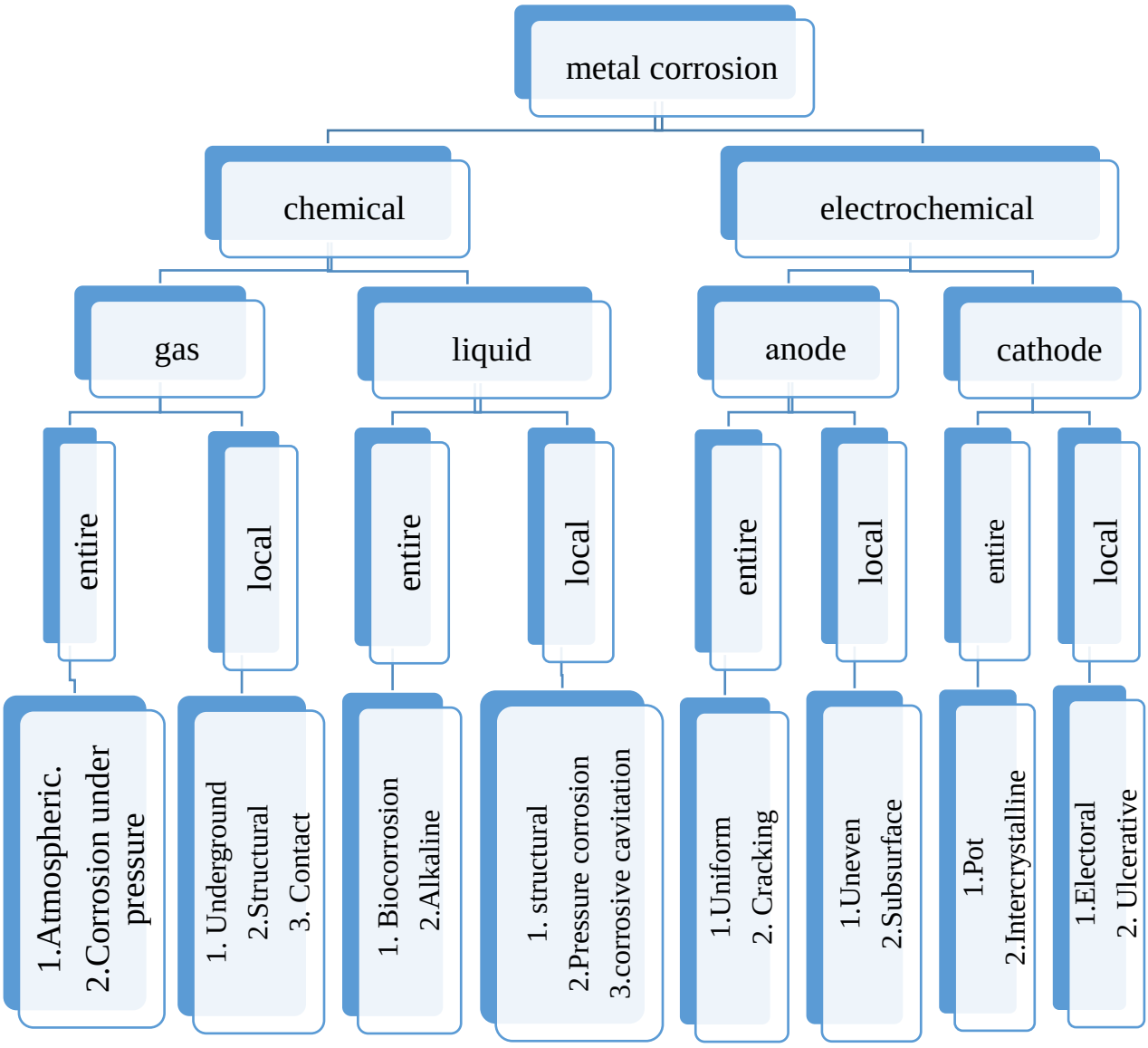
More recently, scientists have studied the types of corrosion, its causes, and the damage it causes to the economy. In order to reduce the damage caused by corrosion of metals and alloys to the economy, research has been carried out on corrosion-resistant metals and alloys and corrosion-resistant coatings.

That is, metal corrosion is caused by many factors. When analyzing research carried out by scientists, the chemical composition, structure, place of use, environment, etc. are determined. Metals and alloys. are corrosive.

IV. CONCLUSIONS

Corrosion of metals is like a slow process. However, in most cases, when crystalline or intergranular corrosion of metals and alloys occurs, they cause erosion of the metal and alloys from the inside, without being visible from the outside. Therefore, it is very effective to systematically study the corrosion of metals.

Having studied the above, we have systematized all corrosion into one system to make it easier to study, understand and analyze metal corrosion.



Picture 2.

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