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Metal Corrosion and Corrosion Protection Methods

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ABSTRACT: The article explains how to protect the equipment and tools from corrosion and protection of them during operation and maintenance. It provides information on the methods of protection against external and internal corrosion.

KEY WORDS: corrosion, corrosion environment, metal, direct corrosion, indirect corrosion, corrosion resistance, chemical corrosion, electrochemical corrosion, anode, cathode, passivation

I.INTRODUCTION

As a result of the development of a wide range of industries following the independence of the Republic, modern technological methods, equipment and tools are being used. Corrosion protection is one of the most important tasks in maintaining equipment and reliability during operation of equipment and tools. Specifically, the general pollution of the atmosphere with various corrosive substances, as well as the peculiarities of the products used in the extraction, storage and transportation of oil and gas products, require increased corrosion resistance of the equipment used in this field.

II. METHODOLOGY

Corrosion is the process of decomposition of metals as a result of chemical or electrochemical interaction of metals with corrosive environments.

Corrosive environments are aggressive atmospheric metals, acid solutions, alkalis, salts and other environments that cause corrosion processes of metals. Many metals are oxidized and degraded due to thermodynamic instability under aggressive media. As a result of corrosion processes of metals, their mass decreases, and the necessary technological properties change: mechanical strength, plasticity, and size.

Corrosion is one of the major decay factors that can lead to the failure and uselessness of parts and mechanisms.

Corrosion can be attributed to direct and indirect losses. Indirect corrosion removal costs include protection costs and complete failure of metal as a result of loss of working capacity. According to experts, the total metal defect is currently 10-15% per annum.

Indirect corrosion losses include the decline in the quality and volume of manufactured products as a result of a decrease in the productivity of the equipment and an increase in metal consumption.

Corrosion in the oil and gas industry has led to the decline in productivity and failure of many equipment. This includes pipes, taps and reservoirs.

The ability of metals to withstand corrosion is called corrosion resistance. Metal and their alloys have different corrosion resistance in different temperatures and in different environments. Anti-corrosion protection sets the task of exploring methods of protection and protection of metals and alloys, depending on the internal and external environment.

The methods of corrosion protection are subdivided into design, technological and operational activities, and their methods are developed based on experimental corrosion studies.

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Corrosion processes are classified into chemical and electrochemical corrosion by the mechanism of reactions occurring on the metal surface.

Chemical corrosion is caused by processes that interact with the metal in an aggressive environment. Chemical corrosion is caused by chemical heterogeneous reactions of liquid or gaseous environments with metal surfaces, and there is no induction of electrical current. Corrosion is observed on the metal surface under the influence of dry gases and vapors, liquid electrolytes (oil and its products, alcohols, mineral oils, organic compounds).

Electrochemical corrosion_ Heterogeneous electrochemical reactions include processes occurring in aqueous solutions, in wet gases, in salt and alkaline solutions, and by the interaction of metal with the environment. Electrochemical corrosion can be classified according to the conditions, environmental properties, and other species.

Depending on the types of aggressive environments, corrosion processes are divided into atmospheric, gas, fluid, soil, biodegradable currents, and biological corrosion.

Depending on the occurrence, there are corrosion processes in contact (different metals compounds), intermediate (space between two metals), and voltage.

Under the influence of external factors on the corrosion processes, the characteristics, kinetics and mechanisms of corrosion degradation change.

III. RESULTS

Depending on the characteristics of corrosion damage and the conditions of its formation, they are divided into general (complete), local and selective corrosion.

Due to the corrosion damage of metal objects, high losses require the development of anti-corrosion protection methods. The most common methods of corrosion protection are to obtain corrosion-resistant layers on the surface of the products. These methods include plastic, composition polymer, varnish coating, enamel coating.

The methods of coating the metal surface with other metals are widely used. metals and its alloys are covered by metals such as zinc, lead, copper, and chromium. These materials are divided into anode and cathode types in their use.

In anode coatings, the coating material is decomposed and protects the base metal from corrosion. For example: Zn coating in Fe.

In cathode coatings corrosion of the base metal occurs at the breakdown sites due to the decomposition of the coating. For example: Zn coating in Fe

The protective effect of thin layers formed on the metal surface under natural conditions, that is, the passive process, also helps to prevent the corrosion of metals.

In acidic environments, inhibitors are used to reduce the rate of corrosion of metals.

Alloying elements are used to increase the corrosion resistance of the coins. The Cr, Ni elements are used as alloyed elements. The chrome nickels with 12 ... 13% Cr and 18% Cr and 8% Ni are widely used in stainless steel. Thermal and chemical-thermal treatment methods, as well as mechanical methods for improving the surface purity are used to enhance the corrosion resistance of the steel. There are also methods of protection, such as the formation of micro-climates and protective atmospheres.

The study of corrosion protection methods is mainly carried out in the following areas:

а) impact on metal;

б) environmental impact;

в) development of combined and complex methods of protection.

The use of cathode protection, protectors and other types of electrochemical corrosion protection is widespread in the industry.

Pipes and reservoirs used in oil and gas fields are subject to internal corrosion and external corrosion due to environmental, atmospheric, soil and erosion currents, depending on the properties of the oil and gas system.

It is exposed to the environment for protection against internal corrosion, while the metal is exposed to the surface to protect it from external corrosion. In this case, bilateral corrosion protection is performed at the same time in separate ways.

The presence of mechanical additives and inorganic substances in the oil and gas-water system increases corrosion activity of the environment and at the same time causes chemical and electrochemical corrosion processes. Therefore, it is important to include stabilizers or inhibitors in the environment.

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As a result of the formation of oxide layers the thermodynamic instability of the metal surface is changed, that is, the potential of the metal electrode goes from negative to positive. The resulting thin oxide layer protects the metal against corrosion and gives the surface a good appearance.

Oxidizers are the main passive medium. Metals such as Cr, Si, Ti, Al, Mo are freely passive due to the formation of oxide layers in an oxygen-free environment. Passive metals in highly oxidized solutions are Fe, Ni are weakly passive metals, and oxidizing solutions are passivators.

During chemical corrosion, the chemical reactions that may occur on the surface of the metal and its alloys with the external environment are studied, and the reaction of the surface energy before and after the reaction takes place. The greater the change in the free energy of the surface reaction product (surface layer) resulting from the chemical reaction (Δ G), the higher the probability of the reaction going on and vice versa Δ G.

A chemical reaction is likely to occur

$Mg + H_2O + 1/2O_2 \rightarrow Mg(OH)_2$

$Mg(OH)_2$ for ΔG=- 142600 corrosion occurs because of the cororality.

The rate of corrosion is studied depending on the composition of the metal and its alloys and the effects of aggressive environments.

If the corrosion process is considered from the point of view of the electrochemical mechanism to the maximum reaction (decrease in free energy) of the reaction, then the probability of corrosion is as follows.

$$-\Delta G = -n F \cdot E$$

here; n is the number of electrons (which is the metal's valence) when the metal ion becomes metal;

F - Faraday number (96500 pendants);

E - corrosion element E.Yu.K.

The potential differences between metals and solutions (Nernst equation):

$E = RT / nF \ln(C/ Co)$

where: R-gas constant (8.31 j / grad.mol)

T - absolute temperature, t ^oK

C - concentration of the solution

Co- the size of the metal which depends on the nature of the metal

In the galvanic element $nA + mB \Leftrightarrow pC + q D$

If a reaction occurs, the free energy change is as follows:

$$-\Delta G = RT \ln K_c^{p\ q\ n\ m} - RT \ln C_c \cdot C_d / C_A \cdot C_B$$

$-\Delta G = -n F \cdot E$ and return the element's equilibrium to the standard (or normal) E.Yu.

$E_o = RT / nF \ln K_c$ respectively. It is a galvanic elements E.Yu.K.

$$\text{will be } E = E_o^{p\ q\ n\ m} - RT / nF \ln C_c \cdot C_d / C_A \cdot C_B$$

This equation helps to identify the problems of electrochemistry and the possibility of corrosion processes.

Since the electrons in the galvanic element are passed from the anode to the cathode, the rate of corrosion is equal to the number of charged currents and the dissolved ions.

$$K = \Delta g / S\tau;$$

According to Faraday's law

$\Delta g = Q \cdot A / nF,\ g$

corrosion rate can be expressed as follows:.

$K = 3600\ JA / nF \cdot S\ ,\quad r / m^2 \cdot hours;$

In the industry, their alloys are mainly used for pure metals. The elements in the alliance interact with each other. Depending on the atomic-crystal structure of the alloys, it is assumed to be divided into two types: solid solutions and intermediate phases.

IV. CONCLUSION

The velocity of the ocean movement results in changes in the oxygen, ions and protective layers on the surface. In most cases, an increase in the rate of aggressive environment accelerates corrosion processes and in some cases corrosion erosion and cavitation events.

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Details of the equipment and tools used in the oil and gas fields, storage, gathering and processing of oil and gas products are subject to both internal and external corrosion at the same time.

Internal corrosion includes the corrosion properties of metal and its corrosion resistance, the formation of protective layers, as well as the corrosion properties of the oil and gas - water environment and various additives in them.

The external corrosion of the equipment used in this area is the composition of the soil, the presence of various salts and solutions, the effects of the lost currents and the effects of microorganisms.

In fact, many additives that are part of the oil and gas-water system cause the environment's hydrogen potential to change pH, which means the environment can be transformed from acidic to acidic or from acidic to alkaline.

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