The current state of the issue of corrosion protection of oil and gas facilities

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Abstract. In this paper, modern methods of protecting oil and gas equipment from corrosion are considered. The types of corrosion and their characteristics are listed. The features of the operating conditions of oilfield equipment are described. The damage caused by corrosion is shown. The methods of protection of equipment from corrosion, their features, advantages and disadvantages are given. used to minimize, control and monitor corrosion. The article presents an algorithm of actions to combat corrosion. Possible ways to solve the problem of corrosion by using online corrosion monitoring using interactive ultrasonic thickness sensors are presented.

1 Introduction

Today, the destruction of oil and gas equipment due to corrosion causes serious environmental damage and significant economic losses. Corrosion is the process of destruction of a material under the influence of many different factors, including external influences, mechanical damage and electrochemical processes. Oil and gas industry facilities are directly exposed to a corrosive environment, namely under the continuous influence of moisture, aggressive chemicals, high temperatures and pressures. Oil and natural gas by themselves do not cause corrosion. However, the presence of even a small amount of water (1-5%) in the transported petroleum products can lead to the beginning of the corrosion process. The presence of salts and, above all, ions of chlorine, carbon dioxide, oxygen and hydrogen sulfide in the water accompanying the oil only increases its corrosive activity. The rate of progression of corrosion depends on specific conditions and can range from 0.5 to 12 mm per year. Crude natural gas containing active corrosive elements has the highest degree of corrosion activity. Its corrosion activity depends on the presence of carbon dioxide, hydrogen sulfide, operating and partial pressures, temperature and other factors. Corrosion affects not only the properties of building materials, but also environmental changes. As a result, there is a need to actively search for technologically effective methods and means to counteract corrosion [1-4].

The most common type of corrosion is electrochemical, which occurs when metal interacts with the environment under the influence of an electric current. This process is

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especially active in the presence of moisture or solutions that act as electrolytes. Electrochemical corrosion leads to the formation of oxide films on the metal surface, which can lead to its destruction. The second type of corrosion is chemical. It occurs when equipment materials interact with chemicals contained in oil and gas, such as acids, alkalis, salts and other chemically active compounds. Chemical corrosion can lead to the formation of corrosive deposits and deterioration of the strength of the material. The third type of corrosion is intercrystalline corrosion, which occurs due to changes in the structure of the material under the influence of an aggressive environment, which can lead to a decrease in the strength and durability of the material. This type of corrosion is especially dangerous for building and metal structures. In addition, there are several other forms of corrosion, such as fretting corrosion, stress corrosion, cavitation corrosion and others. Each of these types of corrosion has its own characteristics and conditions of occurrence [5-9].

Corrosion protection processes used in production require mandatory standardization and regulation. The most optimal way to solve this problem is to use a set of measures to protect metals from corrosion. To date, several methods of protecting oil and gas facilities from corrosion are available[10-11].

2 Methods and Materials

The choice of material for the manufacture of oil and gas equipment plays an important role in corrosion resistance. The selection of the material should be based on the operating conditions and requirements for reliability and wear resistance. Many metals are highly resistant to corrosion. Stainless steel used in the manufacture of pipes, tanks and fittings has high corrosion resistance due to the content of chromium and nickel, which form a protective film on the metal surface. Another common material for the manufacture of pipelines, apparatuses and assemblies is titanium. It is characterized by high strength, resistance to high temperatures and chemicals. Inconel is another common metal for the oil and gas industry. This alloy has high temperature resistance, chemical inertness and corrosion resistance. Inconel is widely used in high temperature and aggressive environments, which makes it an ideal material for the oil and gas industry [12-16].

Cathodic protection is one of the most effective methods of protection, which is based on the creation of special conditions under which the metal structure becomes the cathode and the aggressive medium becomes the anode. In this method, the object of electrochemical protection is connected to a direct current source to form a protective electric field that stimulates anodic processes on the surface of the object precisely in the areas of corrosion occurrence. The use of this method leads to a decrease in the rate of corrosion processes. This method entails a decrease in the rate of corrosion and an increase in the service life of the object, which prevents further destruction of the material. Anodic protection, to a greater extent, involves the creation of conditions for anodic oxidation to prevent corrosion of the metal structure of the object. This method is used when cathodic protection is not effective enough or when objects have characteristics that make it difficult to apply cathodic protection.

The most common method is the use of special anticorrosive coatings that protect the surface from direct contact with aggressive media. This coating creates a protective layer on the material and prevents the penetration of moisture, oxygen and chemicals that cause corrosion. Protective coatings and films are also used for greater protection. These materials are applied to the metal surface of the object and prevent contact with an aggressive environment. Protective coatings can be of various natures, including paints, polymeric materials and special formulations. Modern anticorrosive coatings have high strength and durability, which makes it possible to increase the service life of oil and gas equipment. The use of special additives in corrosive environments is also used. Such

additives form protective films on the surface of the object and prevent the penetration of corrosive substances. This method of protection is especially in demand in cases where the application of coatings is impossible or difficult.

3 Results and Discussion

Based on the analysis of the literature data, the diagram (Figure 1) shows the damage caused by corrosion.

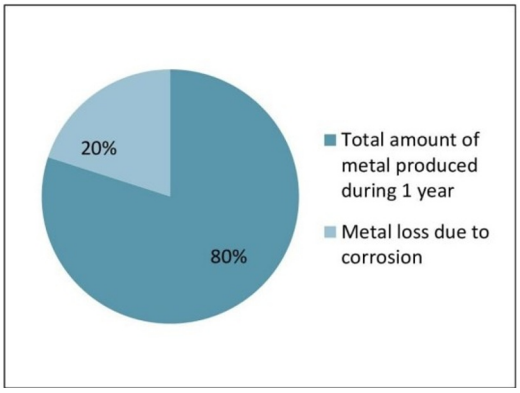

Fig. 1. The damage caused by corrosion.

Figure 2 reflects the causes of defects in the pipeline. The loss of metal in the pipeline due to corrosion usually leads to the formation of localized defects of various depths and irregular shapes on its outer and inner surfaces.

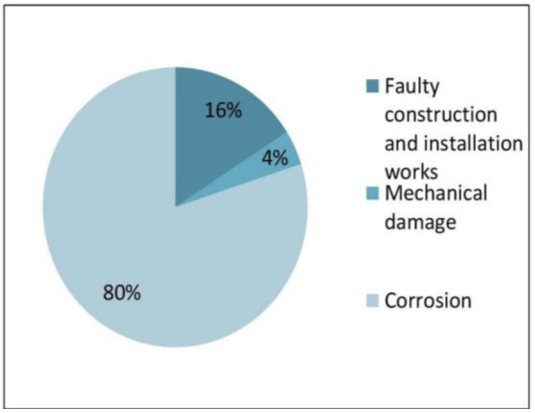

Fig. 2. Classification of pipeline defects.

Many different methods have been developed to combat corrosion (Figure 3).

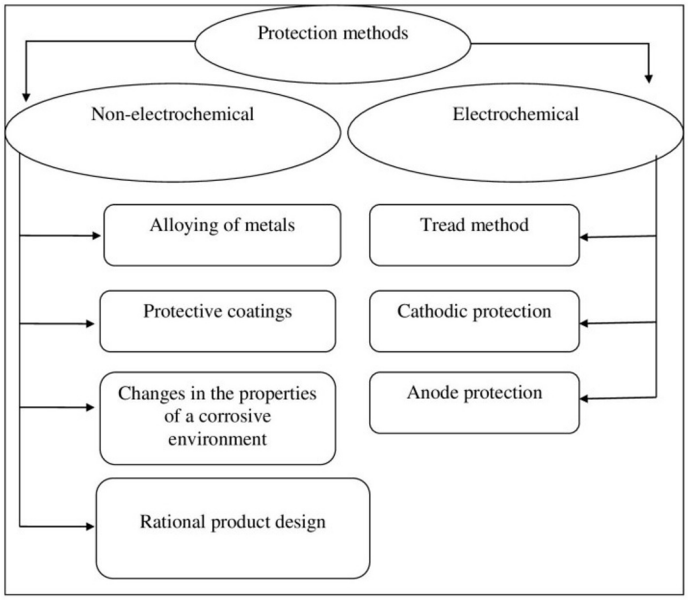

Fig. 3. Methods of corrosion protection.

With the development of technology, corrosion protection methods are becoming more and more effective. For example, the use of nanomaterials makes it possible to create stronger and more durable anticorrosive coatings.

In order to minimize the impact of corrosion, it is important to carry out timely monitoring. The figure (Figure 4) shows the algorithm of actions to combat corrosion. Recently, online monitoring has shown its effectiveness, in which corrosion control is carried out using interactive ultrasonic thickness sensors in various industries, including oil and gas.

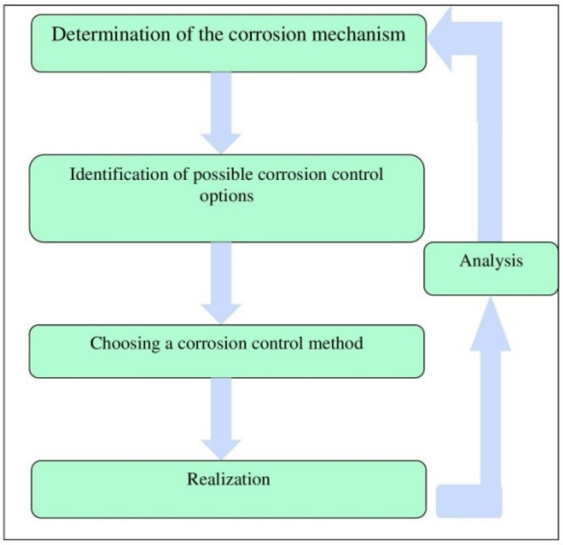

Fig. 4. The algorithm of actions to combat corrosion.

4 Conclusion

Data analysis shows a significant impact of corrosion on the integrity of metal products. Corrosion is a serious problem for the oil and gas industry. Corrosion protection of oil and gas facilities is a key task that requires continuous attention and innovation. One of the promising methods of corrosion control is online monitoring. The sensors used in this method can provide accurate and reliable measurement of the thickness of metal structures without requiring physical access to the equipment and without disrupting its operation. Regardless of the chosen method of corrosion protection, it should be noted that a systematic approach and regular maintenance of equipment are necessary. It includes monitoring the condition of protective coatings, monitoring electrical parameters when using cathodic or anodic protection, as well as regular inspections and tests.

The most common cause of destruction of oil and gas equipment is corrosion. The modern approach to corrosion protection of oil and gas industry facilities includes the use of integrated techniques and advanced technologies, as well as system maintenance and monitoring of the condition of these facilities. Modern approaches to protection can reduce the risks of corrosion and ensure the safe operation of oil and gas industry facilities. More and more effective methods of monitoring the condition of metal structures are being actively developed, which will identify problems at an early stage and prevent the development of corrosion.

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