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WAYS TO INCREASE THE SERVICE LIFE OF OIL AND GAS PRODUCTION EQUIPMENT BY USING HETEROCOMPOSITE MATERIALS ON THE SURFACE OF STEEL STRUCTURES

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Abstract: *On the basis of analysis of the results of research in the field of polymer material science and real production-field tests the process of corrosion damage of metal structures operated at the enterprises of Uzbekistan is studied. Studies on chemical composition of bottom water, which is the main corrosive factor leading to metal loss and failure of equipment, have been carried out. Compositions of heterocomposite materials for protective coatings are proposed.*

Keywords: *Corrosion, equipment, metal structure, heterocomposite, polymer, filler, corrosive environment, kaolin, epoxy resin.*

Introduction

Today, during the period of intensive development of the oil and gas refining and chemical industries, there is a need to develop new materials based on polymers, and coatings based on them used in mechanical engineering, justified ensuring the operational reliability of process equipment along with improving its design, it is important to create new highly effective organomineral materials and coatings, technologies for their production and use.

It is known that the use of polymer materials and composites based on them is gaining great momentum in fundamental and applied research in materials science. The mechanisms of structural transformations in the interphase layers of polymer-filler, polymer-modifier, polymer-metal have been studied, depending on the intended use of composite materials, in particular in technological machines and structures operating under conditions of corrosion and wear, the application and development of technology for the production of structural materials. The obtained research results in the field of polymer materials science open up ways for their use in areas of design technology that are critical in terms of operational parameters and replacing existing ineffective materials with composite materials that ensure the performance of structures and mechanical engineering parts in various extreme conditions in order to reduce the impact of aggressive components.

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There are also known studies on the study of the mechanism of formation of the interfacial structure in the production of multifunctional heterocomposite coatings from organomineral materials, mechanical modification of mineral fillers in the development of new materials and technologies to improve the reliability of equipment for storing and transporting oil and gas products. At the same time, there are aspects of solving some issues related to their use in production under real conditions due to the lack of technology for producing and using large-gaboite structures.

It is well known that corrosion is the destruction of the surface of metals and their alloys in a specific environment. However, some metals generally exhibit higher corrosion resistance than others, and this may be due to factors such as chemical components, the nature of electrochemical reactions, and others [1].

However, the term corrosion is given a different definition in the international normative document, which states: “The physicochemical interaction between a metal and its environment, which leads to changes in the properties of the metal and which can often lead to deterioration of the function of the metal, the environment or the technical system of which it is a part. «they are» [2].

The main problem of the global economy has been and remains the protection of metals from corrosion destruction. One example can be given that the costs associated with corrosion, even in developed countries, vary from 1 to 3.5% of GDP.

It can be noted that in our country, where the oil and gas industry is one of the leading sectors of the economy in terms of contribution to GDP, scientific and technical activities related to solving problems with corrosion are becoming extremely relevant, since hundreds of fields are currently successfully operating where several thousand tanks are in operation and containers made of metal structures that urgently need protection from corrosion and wear.

The extreme importance of corrosion protection makes it a leading economic and applied problem for all countries.

In this regard, leading foreign scientists, including the USA, Germany, Belgium, Canada, Turkey, China, etc., are conducting research on the development of methods and means for protecting equipment of the oil and gas complex, studying the mechanism of corrosive decomposition of metals in various environments and obtaining various materials intended purpose [3-5].

Scientists from neighboring countries have developed methods and means to increase the operational reliability of machines and mechanisms with the targeted use of metal-polymer systems for corrosion protection [6-8].

The works of domestic scientists are also devoted to the noted aspect of the scientific and technical problem [9-12]. Research has been carried out on the rational use of local minerals in various areas of the economy.

It can be noted that selecting the right materials is a powerful tool to combat severe corrosion. Failures resulting from corrosion can be very costly, so preventing or reducing these impacts becomes very important to industries. Fatal failure caused by corrosion can be significantly reduced

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by using anti-corrosion coatings with superior chemical and mechanical properties than the original material.

Objects of research

Currently in operation is an extensive fleet of steel tanks, which are designed for storing oil, petroleum products and auxiliary reagents. As a rule, tanks with a service life of more than 10 years are made of low-carbon steels that have insufficient corrosion resistance [5-7].

The tank body is subject to intense corrosion from both the external (atmospheric corrosion) and internal (various types of corrosion, the manifestation of which is determined by the activity of the stored products) sides.

In connection with the emerging need to develop measures for corrosion protection of metal structures operated in the oil and gas industry, the operating conditions of the enterprise's technological equipment were studied in order to develop and targeted application of anti-corrosion coatings on the internal and external surfaces of tanks. The organization of experimental testing work was planned in compliance with the requirements of the comprehensive instructions developed jointly with the enterprise’s specialists.

Based on the analysis of the above information, for the practical implementation of the research results, we have planned the development and use of organomineral heterocomposite materials (OHCM) based on epoxy resin (ED-20 and ED-16), which make it possible to obtain casting compounds and coatings from them in production conditions.

Applied research was carried out on problematic production equipment and tanks for the collection and storage of oil and gas condensate of oil and gas production enterprises of the Republic of Uzbekistan (Fig. 1).

a b

c

a- Reservoir RVS400 for collection and storage of gas condensate; b- corrosive areas of the upper surface of the equipment; c- metal corrosion in component parts technological process for draining produced water

Fig. 1. Corrosive destruction of equipment operating in the oil and gas industry

For protective coatings, epoxy binders ED-20 and ED-16 were used as a binder, which are the most practical from a technological point of view, components of heterocomposite materials and coatings made from them for use in technological equipment. The hardener used is polyethylene polyamine (PEPA), plasticizer – dibutyl phthalate (DBP), as well as a structure former – chemical modifier from local industrial waste and products of Angren Kaolin LLC, grades AKF-78, AKS-30, AKT-10.

Analysis of research results

Based on the above analysis of theoretical research, we identified the need to conduct applied research to analyze the composition of produced water, and studying the process of corrosion of equipment for storing oil and petroleum products in the "Loading and Loading of Products" workshop of the Shurtan Oil and Gas Production Directorate to study the properties of coatings based on organomineral heterocomposite materials in various environments.

A sample of water taken from the Shakarbulok field, transparent, colorless, without sediment, with the smell of petroleum products.

The analyzed water is a weak brine of the calcium chloride type with a density of 1.081 g/cm3, with a total mineralization of 113.8 g/l, metamorphism (rNa/rCl) of 0.91, sulfate coefficient (rSO4/rCl) of 0.007 and chlorine -bromine coefficient (Cl/Br) – 353. The reaction of the medium (pH-7.53) is slightly alkaline.

The ionic-salt composition of water is dominated by chlorine ions - (68.7 g/l) and alkali metals (Na) - (40.6 g/l), calcium ions - (2.96 g/l) 5.3 times more than magnesium ions (5.35 g/l), sulfate - and bicarbonate - ions are 0.67 g/l and 0.89 g/l, respectively.

In the microcomponent composition of water, the background value of iodine is higher - 14.8 mg/l, bromine - 194.67 mg/l, boron oxide - 111.64 mg/l.

The collected water sample from the Northern Guzar field is transparent, colorless with the smell of hydrogen sulfide and a brown colloidal sediment.

The analyzed water is a very weak brine with a density of 1.023 g/cm3, with a total mineralization

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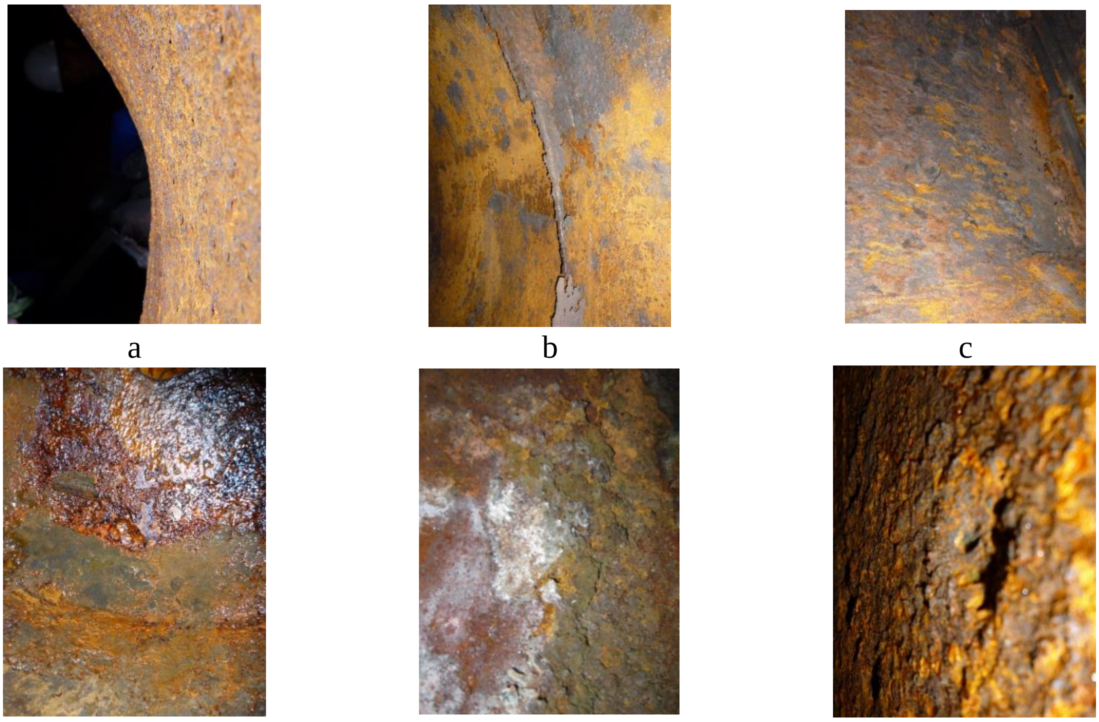
of 35.7 g/l, metamorphization (rNa/rCl) of 0.93, sulfate coefficient (rSO4/rCl) of 0.01 and chlorine bromine coefficient (Cl/Br) – 202. The reaction of the medium (pH-7.85) is slightly alkaline.

The ionic-salt composition of water is dominated by chlorine ions - (20.8 g/l) and alkali metals (Na) - (12.6 g/l), calcium ions - (0.92 g/l), magnesium ions (0 .14 g/l), sulfate and bicarbonate ions are 0.31 g/l and 0.89 g/l, respectively. The microcomponent composition of the water contains iodine - 4.8 mg/l, bromine - 102.68 mg/l, boron oxide - 62.78 mg/l.

Analysis of the results of a study of corrosion destruction of the surface of tanks showed that not only that part of the equipment that comes into contact with oil and petroleum products (Fig. 2 b) and produced water (Fig. 2 c, d), but also the upper part (Fig. 2 a) is subject to the corrosion process.), which is explained by the fact that vapors of SO2, CO2 and mineralized produced water collect on the surface of the tank, leading to corrosion of the structural steel from which tanks and containers for storing and collecting oil and petroleum products are made. At the same time, in the process of electrochemical corrosion, uneven corrosion occurs with prevailing ulcerative corrosion destruction (Figure 2 e, f) which leads to a decrease in the wall thickness of the equipment leading to production losses.



a b c d e f

a) upper part (5-6 zones), b) middle part (3-4 zones), c) lower part (1.2 zones), d) bottom of the tank, e) uneven corrosion of the tank surface, f) destruction of the tank surface in the process corrosion

Fig.2. Photographs of the surfaces of tanks for the collection and storage of oil and oil and gas products damaged in the process of corrosive destruction.

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The results obtained showed that the relative water-jet wear resistance of epoxy compositions filled with kaolin of the AKF-78, AKS-30, AKT-10 grades in water-abrasive media is always higher compared to the abrasive wear resistance in dry friction. The highest water-jet wear resistance in both dry and liquid friction is observed in samples kept in an aqueous environment, and the lowest - in samples kept in an H_2SO_4 environment (Table 1).

Table 1. Relative waterjet wear resistance of coatings in various environments

Coatings	Exposure time, (in days)				
	5	10	15	20	25
	In the aquatic environment				
No filler	0,366	0,365	0,364	0,364	0,364
KPM+AKT–10	0,389	0,388	0,388	0,387	0,387
KPM+AKS–30	0,238	0,236	0,233	0,232	0,232
KPM+AKF–78	0,114	0,114	0,113	0,112	0,111
	In NaCl medium (5%)				
No filler	0,266	0,267	0,266	0,265	0,264
KPM+AKT–10	0,271	0,272	0,272	0,271	0,271
KPM+AKS–30	0,182	0,178	0,172	0,168	0,167
KPM+AKF–78	0,105	0,104	0,103	0,102	0,102
	In H_2SO_4 environment (5%)				
No filler	9,254	0,255	0,254	0,253	0,252
KPM+AKT–10	0,261	0,262	0,263	0,261	0,261
KPM+AKS–30	0,152	0,151	0,150	0,149	0,149
KPM+AKF–78	0,093	0,093	0,092	0,091	0,091

The main performance property of coatings is microhardness, which characterizes mechanical resistance to external influences.

Based on the fact that the surfaces of technological containers are exposed to thermal and radiation effects of the environment, it is advisable to use coatings containing electrically conductive fillers, such as graphite, soot, etc. in small quantities. This is due to the fact that the outer surfaces of the containers are exposed to thermal and radiation effects of the environment. Fillers-graphite, carbon black, and other ingredients—increase the light stability and radiation resistance of coatings [13].

Conclusions

Based on theoretical and applied research on the influence of the quantitative and qualitative composition of ions in electrolyte solutions on the corrosion process, studies have been carried out to study the ionic composition of produced water and corrosion damage to oil and petroleum product storage tanks operated at the production facility of JSC "Shurtan Oil and Gas Production Directorate" "UZBEKNEFTGAZ"). The prevailing influence of the ulcerative type of corrosion destruction with uneven corrosion under the influence of the ionic composition of produced water leading to corrosion of structural steel has been revealed. Based on the conducted research, optimal compositions of corrosion-abrasive-resistant materials for heterocomposite coatings for metal structures used in the production and preparation of oil and gas for transportation have been proposed.

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