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ABSTRACT

of the dissertation for the degree of Doctor of Science

SCIENTIFIC AND PRACTICAL BASIS FOR INCREASING PRODUCTIVITY IN OIL PRODUCTION AS A RESULT OF REGULATION OF ECO-PERFORMANCE INDICATORS

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GENERAL FEATURES OF WORK

The relevance of the topic and the degree of development. Ensuring reliable energy security is one of the most important issues for rapid development of the Azerbaijani economy. Therefore, in addition to the discovery and development of new fields, the use of highly efficient technical and technological work continues in order to increase the production of wells operating in old fields.

Regulation of environmental indicators of technological processes in the oil and gas industry is one of the urgent problems.Thus, since the number of repairs due to accidents caused by corrosion, erosion and deposition of salts in equipment and equipment used in oil and gas extraction processes, The period between well repairs and reduced oil production is shortening.Furthermore, accidents cause the release of harmful substances into the environment and this in turn disturbs ecological balance as a result of air, water and soil pollution. To prevent such phenomena, it is necessary to improve the oil and gas production infrastructure and use modern technologies in well operation. With the application of technological and technical (physico-chemical, and biological) methods for oil and gas extraction in accordance with modern requirements, the impact of corrosion, erosion, and salt deposition on environmental performance can be minimized. In order to ensure reliable eco-operation of oilfield equipment when operating in an environment with increased corrosive and microbiological aggressiveness, it is necessary to regularly study the corrosive aggressiveness of the product extracted from wells and develop appropriate protection measures, as well as to ensure that corrosion protection work is carried out in a planned manner.

To regulate the environmental performance of oil and gas production, it is crucial to develop and implement technologies that are environmentally sound. To achieve this goal, new multifunctional compositions were created and utilized to enhance the eco-efficiency of oil and gas extraction operations. As a result of the use of the developed new compositions of multifunctional compositions in oil and gas production, the number of repairs was reduced, the overhaul period increased, and reliable environmental protection was ensured.

Object and subject of research. The object of the study is underground and open mining equipment and facilities operating in the oil and gas industry. The subject of research is the development of new compositions for protection against corrosion, erosion and scaling. The subject of research is the creation of new multifunctional formulations to prevent corrosion, erosion, and salt deposits during technological processes, which will lead to an increase in well productivity.

Aims and objectives of the study. The purpose of the research is to develop and use new multifunctional compositions to reduce the number of repairs in production wells, increase the time between repairs and oil production, as well as to develop and utilize innovative multifunctional compositions to enhance the efficiency of the underground transport system.

Main objectives of the study:

- Study of the factors affecting the corrosive aggressiveness of the environment to ensure the reliable operation of hydraulic structures and oilfield equipment operated in offshore conditions, and carrying out planned measures to protect against corrosion;

-Study of multifunctional compositions with bactericide-inhibiting properties for protection against corrosion of underground and surface oil production equipment operating in wells;

-Development of new effective complex reagents against corrosion and salt deposition to regulate environmental and performance indicators in the process of oil and gas production;

-Complex solution for anti-corrosion protection of oilfield equipment and intensification of oil production in the reservoir pressure maintenance system;

- Study of factors affecting the environmental performance of technological processes and the development of an effective multifunctional complex to improve the efficiency of operation of infield pipelines;

- Investigation of accidents that may occur due to corrosion in the groove joints of pumping and compressor pipes and
examination of plastic compositions to protect the groove joints;

-Study of the complex influence of physical and chemical

methods on the processes of corrosion and salt deposition occurring in oil and gas extraction equipment;

- Application of an inhibitory microemulsion to increase oil production;

-The use of new developed bactericide-corrosion inhibitors in clay solutions and the study of their effect on environmental protection from environmental pollution;

Research methods. The issues presented in the dissertation are resolved on the basis of an analysis of experiments carried out in the laboratory suitable for field conditions, as well as on the basis of the results obtained in field studies using various physicochemical and electrochemical methods.

The main provisions of the defense. The main provisions defended in the dissertation are as follows:

- Development of multifunctional compositions to protect oilfield equipment from corrosion, erosion and salt deposition;
- Development of a new multifunctional composition to protect infield pipelines from corrosion, as well as to improve the fluidity of high-viscosity water-oil mixtures;
- Development of new plastic compositions for corrosion protection of threaded connections of pumping and compressor pipes;
- Development of new multifunctional compositions for maximum reduction of corrosive aggressiveness of clay solutions;
- Development of new microemulsion with inhibitory properties for treatment of the bottom bore zone of wells;
- Development compositions with bactericidal properties against corrosion caused by microorganisms in brine waters;
- Depending on operating conditions affecting corrosion, correct choice of adjustment of eco-exploitation indicators based on identification of factors;

Scientific novelty of research. For the first time, the following scientific developments on the regulation of environmental and operational indicators of oil and gas production technological processes have been obtained:

- New compositions have been developed to regulate the eco-

operation of well indicators;

- New anti-corrosion and anti-salt formulations have been developed to regulate the environmental performance of technological processes;
- Developed new compositions with multifunctional properties against the corrosiveness of clay solutions;
- New plastics have been developed to protect against corrosion and improve the tightness of threaded pipe connections;
- A new multifunctional composition has been developed for a comprehensive solution of anti-corrosion protection of equipment and to increase oil production in the reservoir pressure maintenance system;
- New bactericidal compositions against microbiological corrosion have been developed;
- A new microemulsion with inhibitory properties has been developed for bottomhole treatment.
- A new multifunctional composition has been developed to protect infield pipelines from corrosion, as well as to reduce the viscosity of oil-water mixture.
- The factors influencing the corrosive aggressiveness of the working environment to regulate environmental performance indicators in oil and gas production were studied, and the practical significance of the results obtained was assessed.

Theoretical and practical significance of the research

The corrosion aggressiveness of the working environment of underground and outdoor mining equipment used in oil and gas extraction has been studied, and on the basis of this, new multifunctional compounds have been developed to regulate the eco-exploitation performance. It has been established that these compositions are highly effective in protecting against corrosion in aggressive environments and the ability to completely stop the vital activity of SRB in optimal concentrations. The multifunctional properties of the compositions allow their use in various fields of oil and gas production.The use of the developed new multifunctional compositions has practical significance, as it creates conditions for

increasing the environmental efficiency of underground pipelines and extending the service life of oil-industrial equipment, increasing oil production, reducing the number of accidents and minimizing the costs of their elimination, as well as preventing environmental pollution.

The scientific and practical results obtained in the dissertation work can be used in the process of teaching subjects in the relevant specialties at oil and gas production, research institutes , bachelor's and master's degree programmes in higher technical education.

Author's personal contribution. The results reflected in the dissertation were confirmed by research conducted by the author. The formulation of the problem, experiments, systematization of the results were carried out with the direct participation of the author.

Approbation and application. The main provisions of the dissertation were discussed at the following conferences:

-Innovative development of the oil and gas complex. Kazakhstan, International Scientific and Practical Conference, Aktau:–2012. April 25-26,–c.108-111.

-"New techologies in oil and gas production" The second international scientific-practical conference, Abstracts, Baku, 06-07 September 2012-p.273.

-Industrial and innovative development of Kazakhstan-ecology and life safety. International Scientific and Practical Conference, Atyrau: 2012.–c. 83-85

-Ecology and oil and gas complex. International Scientific and Practical Conference of the Republic of Kazakhstan, - Atyrau: - 2013, 10-11 November,

-"Khazarneftqazyatag-2014" Scientific – practical conferenceis dedicated to the improvement of oil industry development, – Baku:– 2014. 24-25december

-"Khazarneftqazyatag-2016" Scientific – practical conferenceis dedicated to the improvement of oil industry development , – Baku: 22-23 december, –2016,

-Collection of materials of the international scientific and practical conference "Ecology and the oil and gas complex", -Atyrau, Kazakhstan - 2018. October 10,

-Modern problems of innovative technologies in oil and gas production and applied mathematics" program of the international conference dedicated to the 90th anniversary of academician Azad Khalil oglu Mirzajanzade ", Baku -2018, december 13-14,
-International scientific and practical conference "State and prospects for the operation of mature fields, - Aktau - 2019.16-17 May.
-International Scientific and Practical Conference "Kazakhstan Oil: Past, Present and Future", -2019. September 1

Field tests of the inhibitor brand "KAB" on the flooded (90%) well № 3293 of the "Bibieybatneft" Oil and Gas Production Department (OGPD)of the Azneft Production Association showed that the protective effect was 88-90%. From the industrial introduction of the bactericide-inhibitor of the brand "KAB" in "Bibieybatneft", "Siyazanneft" and OGPD named after G.Z.Tagiyev, an economic effect in the amount of 96,537 manats was obtained.

To determine the feasibility of widespread introduction of the anti-corrosion bactericide-inhibitor "KAB-2014" in production, tests were carried out at wells № 474, 743 of the "Absheronneft" OGPD and wells №107, 142 of the OGPD named after. A.D. Amirov. The protective effect of the inhibitor during field tests at the "Absheronneft" OGPD was 96%, at the A.D. Amirov OGPD - 91%.

The multifunctional inhibitor of the brand "KQÇİ-2014" was tested at the "Bibieybatneft" OGPD at well № 2888, with a water cut of 88%. In 2015, as a result of the use of the multifunctional inhibitor "KQÇİ-2014" at 12 wells, 64.3 tons of additional oil was produced at OGPD "Bibieybatneft" and an economic effect of 40,630 manats was obtained.

To conduct field tests of new plastic compositions PK-1 and PK-2, capable of providing protection for threaded joints of tubing, production wells № 3119 and 518 of OGPD "Bibieybatneft" were selected. The economic benefit from the use of the proposed PK-1 and PK-2 plastic compositions was 8879 manats.

New bactericide-inhibitors against the corrosiveness of clay solutions were tested in wells № 1191 , drilled in the Pirallahi area of the "Apsheronneft" Production Association. The protective effect of the inhibitor was 83-91%, and the degree of suppression of sulfate-

reducing bacteria was 95-99%.

Mining tests of developed microemulsion with inhibitory properties were carried out in production well No. 3305 of "Bibiheybatneft" OGPD . Oil production increased by 27% due to the dissolution of sediments consisting of heavy hydrocarbon compounds percipitated there as a result of injecting the treated microemulsion with inhibitory properties into the bottom zone of wells.

Tests of corrosion and salt deposition inhibitor brand “KDÇQ” were carried out in wells № 2877 and 2879 of OGPD "Bibiheybatneft". The protective effect against corrosion and salt deposition of the inhibitor was 90% and 70%, respectively. In 2012, “KDÇQ” inhibitors were used in 14 production wells. As a result of the implementation, an economic effect in the amount of 42,236 manats was obtained.

Corrosion and salt deposition inhibitors of the “KDİ” brand were used in conjunction with magnetic couplings with a constant magnetic field at production well №3268 of OGPD “Bibieybatneft”. The protective effect against corrosion and salt deposition on underground and surface equipment was 89% and 70%, respectively. As a result of the combined use of the “KDİ” brand inhibitor and magnetic couplings, 3,723 manats was received.

The reagent, obtained from a mixture of salts of naphthenic acid and technical phosphatide, was tested in the reservoir pressure maintenance system of OGPD “Bibieybatneft”. As a result of the impact of the reagent on the reservoir, oil production increased by an average of 11%, and the economic effect amounted to 92.8 thousand manats.

Publication of work. Published 57 scientific papers on dissertations, including 42 articles, 9 reports, 5 theses, 1 patent.

The name of the organization in which the dissertation work is being carried out. The dissertation work was carried out at SOCAR Oil and Gas Research and Design Institute.

Structure and scope of research:

The dissertation work consists of an introduction, 4 chapters, conclusions, bibliography and applications. Excluding 54 tables, 4 figures, 81 graphs, 347 bibliographies and 10 appendices included in

the dissertation, its volume is 388661 (including reference 16198, chapter I 110361, chapter II 96637, chapter III 111355, chapter IV 49744 and conclusions 4366) sign.

The author expresses deep gratitude to the corresponding member of ANAS, Doctor of Technical Sciences, Professor B.A.Suleimanov for the assistance provided in the formation of a scientific direction, formulation and finding ways to solve the problem. Expresses gratitude to Shikhieva M., and employees of the Corrosion Protection Department.

GENERAL FEATURES OF WORK

The introduction describes the general characteristics of the dissertation, the relevance of the topic, the purpose of the work, the main objectives of the study, the scientific novelty of the research, the main provisions of the defense, the theoretical and practical significance of the work, and ways to solve problems.

The first chapter is devoted to the analysis and study of factors affecting the environmental and operational performance of oil and gas production processes.

It was established that the problems of corrosion, erosion and deposition of salts arising during the extraction, transportation, storage in tanks and oil and gas processing in the oil and gas industry, causes failures and failures in technological processes. This results in reduced efficiency of the oil extraction and transportation system, pollution of the atmosphere by toxic gases, soil by oil and groundwater. This is due to the use of obsolete equipment and technologies in oil production, transportation and refining.

Based on the analysis and research conducted for the purpose of regulating the operational indicators of the oil and gas extraction industry, we can come to the following conclusion:

- it is possible to reduce the number of repairs by adjusting the eco-exploitation indicators in oil and gas extraction, increase the inter-repair period and increase oil production, as well as prevent the violation of the ecological balance;

- technological and technical measures should be taken to prevent obstacles caused by corrosion, erosion and salt precipitation during operation in oil and gas extraction;

- in order to ensure the reliable operation of the equipment, the corrosion aggressiveness of the product extracted from the wells should be regularly studied and appropriate protective measures should be developed;

- considering that changes in well operating conditions change the aggressiveness of environments and the relevance of choosing a new protection method suitable for a given environment, it is necessary to develop new complex effective inhibitor

compositions to regulate the environmental performance of wells. oil and gas extraction processes;

- the application of compositions in the industry will protect oil field equipment from corrosion, reduce the number of repairs, increase the period between repairs and production.

In order to regulate the eco-exploitation indicators in oil and gas extraction, taking into account the relevance of choosing a protection method according to the aggressiveness of the environment, complex effective measures should be developed and applied. Researching the factors affecting the corrosion aggressiveness of the operating environment is one of the urgent issues for the development of complex effective measures.

Marine hydrotechnical installations are distinguished by very complex and high capital investment installations and also by a number of other specific features. So, during operation, these facilities should have high reliability and high technological characteristics, as well as high resistance to corrosion and to mechanical breakdowns. Therefore, regular study of external factors affecting the corrosion aggressiveness of hydrotechnical devices operating in sea conditions, the brand of steel materials used in the installation of hydrotechnical devices operated in an aggressive environment will enable the correct selection of optimal methods for their reliable protection.

The rate of erosion of samples of steel St-20, studied in field conditions at the Oil and Gas Production Department "Neft Dashlari", was studied with atmospheric contact and in the zone of periodic wetting. The purpose of the study is to track the change in the corrosion rate of metal samples in the atmosphere and in the zone of periodic wetting, depending on the influence of air, sea water temperature, wind speed and other factors during the year.

Based on the results obtained from the studies, it was determined that the corrosion in the zone of periodic wetting occurs faster. In the samples, the corrosion process depending on time increased by 1.5-2 times in the periodically wetting areas and 1.2 times in the atmospheric zone.The reason for this is the influence of global warming, wind speed and direction on the metal corrosion

process and changes depending on the seasons.

As can be seen, the corrosion resistance of land-based oilfield equipment and hydraulic structures operating in marine conditions depends on the influence of external factors - air and sea water temperature, humidity, wind speed and direction, height and wavelength.

The intensity of corrosion in natural conditions of the operating hydraulic structures of the Oil and Gas Production Department "Neft Dashlyi" was studied.The average corrosion rate of overpass supports of structures operated for 12-20 years is 0.22 mm/year. At the same time, the corrosion rate at individual objects varies between 0.15-0.28 mm/year. The average loss of wall thickness of the supports is fixed at 32%, at individual objects 17-51%. This difference is explained by the location of the overpass structures in more severe hydrometeorological conditions.The value of the maximum average corrosion rate at the base of a stationary foundation operated without corrosion protection for 20 years was 0.43 mm/year at a height of 1.3 m above sea level. The results of the research show that it is necessary to carefully restore the supports in the zone of periodic wetting during 16-20 years of operation.

Although most of the hydraulic structures have been in operation for about 30 years, given that only half have worked out so far during the planned periods of operation of the project, the following measures should be taken to prevent the risks of accidents in the subsequent period of their operation.

-taking into account the influence of external factors when carrying out measures to protect equipment and hydraulic structures from corrosion in marine conditions;

-strengthening or replacement of elements based on the results of monitoring;

-protection of the underwater part of the supporting blocks from corrosion by electrochemical (with galvanic anodes) and periodic insulation of metal structures in the humidification zone;

-performance of works on corrosion protection of metal structures operated in open atmosphere, in accordance with the requirements of the project.

The corrosion of hydraulic structures, which are constantly exposed to aggressive sea water, corrosion and failure of oil and gas production equipment due to aggressive formation waters formed during operation allows you to choose the right methods of protection. This increases the time between workovers and production in wells, reduces the cost of production and, ultimately, provides reliable environmental protection.

Reservoir waters are mainly divided into: non-aggressive (less than 0.01 mm/year), slightly corrosive (0.01-0.1 mm/year), moderately aggressive (0.1-0.5 mm/year) due to corrosive activity, highly corrosive (0.5-2.4 mm/year) and very high (over 2.4 mm/year) groups. In the study for the corrosion aggressiveness of reservoir water, the presence of sulfate-reducing bacteria, the amount of hydrogen sulfide, as well as sulfate and chloride ions are considered as the main indicators.

In order to study the factors causing corrosion of equipment operated at the "Guneshli" field, a chemical and microbiological analysis of formation water for the presence of aggressive components was carried out.

Density of reservoir water separated from well production at "Gunashli" field is 1.010-1.047 g/cm^3, salinity 16.45-67.6 g/l, pH 6.0-8.8, amount of calcium ions (Ca^{2+}) is 40-1723 mg /l, the amount of magnesium ions (Mg^{2+}) 24-972 mg/l, the amount of sodium and potassium ions (Na^{+}+K^{+}) 5820-25226 mg/l, the amount of iron ions (Fe^{2+}) 128-2561 mg/l, the amount of chloride ions (Cl^{-}) 7799-38995 mg/l, sum of sulfate ions (SO_4^{2-}) 34-1243 mg/l, sum of hydrocarbon ions (HCO_3^{-}) 488-11956 mg/l, amount of soluble carbon dioxide (CO_2) 26.4-220 mg/l, water cut within 8-86%. The average number of sulfate-reducing bacteria in the studied associated waters is 10^2-10^7 cells/ml, and the amount of H_2S is 12-272 mg/l.

Of the 44 watered production wells operating at the "Gunashli" field, 14% of seawater is slightly aggressive, and the average corrosion rate of a metal sample in these formation waters is 0.048 mm/year, the average corrosion rate of a metal sample in wells with 25% medium aggressive formation water is 0.376 mm/ and in wells with 61% highly aggressive formation water, the average

corrosion rate of a metal sample was 0.596 mm/year.

To determine the chemical properties of formation water at the OGPD "Neft Dashlari", samples were taken from 177 watered production wells.According to the results of chemical analysis, the formation water density was 1,005-1,077 g/cm^3, mineralization 0,371-105,567 g/l, pH 5,0-9,0, the amount of calcium ions (Ca^{2+}) 0,030-2,725 g/l, the sum of magnesium ions (Mg^{2+}) 0024-2,042 g/l, sum of sodium and potassium ions ($Na^{+}+K^{+}$) 2,485- 39,755 g/l, sum of iron ions (Fe^{2+}) 0.10-3,194 g/l, amount of chloride ions (Cl^{-}) 2.481-60.974 g/l, the amount of sulfate ions (SO_4^{2-}) 0.004-2,459 g/l, the amount of hydrocarbonate ions (HCO_3^{-}) 0.388- 8,540 g/l, the amount of soluble carbon dioxide (CO_2) 30,8-352 mg/l, water cut within 14-95%.

In the reservoir waters of 177 flooded wells, the average corrosion rate of a sample of steel St 20 varied within 0.0128-3.8749 mm/year, the amount of SRB was 10^1-10^8cells/ml, and sulfate-reducing bacteria were not found in 11 wells. The total amount of chloride and sulfate ions ranges from 2532 to 60314 g/l, and the amount of hydrogen sulfide is from 1.2 to 119.0 mg/l, and in 60 wells it was more than 50 mg/l, 14 wells sulfide was found.

According to the degree of aggressiveness of the studied reservoir water, the water of 2 wells was slightly aggressive, the water of 7 wells was medium aggressive, the water of 154 wells was highly aggressive, and the water of 14 wells was very aggressive. The average corrosion rate of a metal sample in slightly corroded formation waters was 0.02 mm/year. The average corrosion rate was 0.46 mm/yrar in moderately corrosive reservoir waters, and the average corrosion rate was 1.38 mm/yr in highly corrosive reservoir waters. The average corrosion rate of a metal sample in very strongly corroded formation waters was 2.99 mm/year.

The study of the chemical composition of formation waters taken from the wells operated in "Neft Daslari", "Palçığ Pilpilesi" and "Guneshli" fields shows that the main reason for the increase in the corrosion rate is the increase in the dilution of the well product, as well as the infection of the formation waters with various groups of corrosion-causing microorganisms. In addition, the study of the

corrosion aggressiveness of the layer water made it possible to draw up aggressiveness maps for the "Guneshli", "Palchiq Pilpilesi" and "Neft Daslari" fields.

Based on the results of the research, the following technological and complex effective technical measures (physicochemical and biological methods) were developed to develop appropriate protective measures to ensure the reliable operation of oilfield equipment when operating in a highly corrosive reservoir water environment. As well as for the planned performance of works on corrosion protection, it is recommended to use:

-adjustment of technological regimes (prevention of oxygen supply, creation of stable thermodynamic conditions for gas-liquid mixture, rapid movement, etc.) aimed at reducing corrosiveness in wells with low formation water corrosivity;

-improvement of environmental and performance indicators with the adjustment of technological regimes and the joint use of inhibitors of complex action in wells with formation water of medium corrosive activity;

-in the wells with high and very high corrosion activity of formation water, regulation of eco-operation indicators and prevention of environmental balance violation by the joint application of technological and special methods (physical, chemical, biological);

-new method of protection according to the aggressive characteristics of the environment and the application of technical measures will reduce the number of accidents at production wells, increase the interval between repairs and oil production and, as a result, provide reliable protection of the environment;

The development of new methods for increasing the maintenance interval and oil production, reducing the cost of the product, and ensuring reliable protection of the environment in wells with high, very high corrosion activity of reservoir water remains relevant.

The second chapter is devoted to the development of multifunctional compositions to improve the environmental and operational efficiency of oil production processes.

One of the main causes of complications arising during the operation of wells is the corrosion of underground and surface equipment, which leads to economic losses due to a decrease in production and environmental pollution.

Changing operating conditions change the corrosive aggressiveness of the environment. Therefore, it is necessary to select inhibitors corresponding to the corrosive aggressiveness of the environment. In addition, the use of new technological measures against each of the complications in the operation of oil wells ultimately leads to an increase in the cost of oil. Considering the urgency of the problem, the development and application of complex multifunctional compositions is a solution to a key problem.

Although each of the chemical compounds with inhibitory properties, consisting of several components, has a certain effect on the course of corrosion, the composition of their mixture already has a synergistic effect.

$$\frac{E_k}{E_r} > 1 \text{ and } \frac{E_k}{E_r} \leq 1 \qquad (1)$$

E_k - efficiency of the new composition,

E_r - efficiency of the reagent.

If the new composition satisfies the condition Ek/Er>1, then a synergistic effect is observed, and if $E_k/E_r \leq 1$, the synergistic effect in the composition is not achieved.

From the mixtures of the studied reagents, three compositions were selected that satisfy the condition $E_k/E_r>1$. All three compositions have a simple preparation technology, low cost due to the use of available local raw materials, and high inhibitory properties. It was found that the compositions can vary in color from dark brown to black, have a specific oily odor, are poorly soluble in water (emulsion) and well in hydrocarbons.

The compositions obtained as a result of laboratory research were named corrosion inhibitors under the brands “KAB", "KAB-2014" and “KQÇİ-2014".These corrosion inhibitors mainly contain phospholipids, technical lecithin, fatty acids, glycerin, phosphoric acid, nitrogenous compounds, gossypol and its derivatives. The complex composition of inhibitors gives them versatility and allows

them to be used in various aggressive conditions.

The component composition of compositions with a high protective effect as a corrosion inhibitor is given below.

-composition based on filtered oil residue, nitroalcohol, asidol, polyethylenepolyamine, heavy gas oil fraction to protect the environment from environmental pollution during well operation.

-composition for effective protection against corrosion based on soapstock, naphthenic acids, dimethylethanolamine, nitroalcohol, lightgas oil fraction

-multifunctional composition consisting of mixtures of technical lycitine, technical isopropyl alcohol, nitroalcohol and asidol.

Compared to other inhibitors, the compositions have low cost and high inhibitory properties due to the use of simple, available local raw materials. Taking into account the areas of application of the processed compositions, dissolution media were studied. It has been established that these compositions are highly soluble in hydrocarbons and poorly soluble in water (emulsion form).

In order to study the corrosion protection effectiveness of the new complex effective compositions, laboratory studies were conducted in a U-shaped device for 6 hours and at a temperature of 25 ^{0}C in reservoir waters brought from aggressive wells.

Corrosion rate of metal based on mass loss is calculated by the following formula.

$$K = \frac{m_1 - m_2}{S \cdot \tau} \qquad (2)$$

Where K - corrosion rate, g/m^2·hour;

m_1 - mass of the test specimen before the test, g;

m_2 - mass of the test specimen after the test, g;

S - the surface area of the witness specimen, m^2;

t - test time, hour.

The effectiveness of the protective action of the inhibitor was characterized by the degree of protection Z, %.

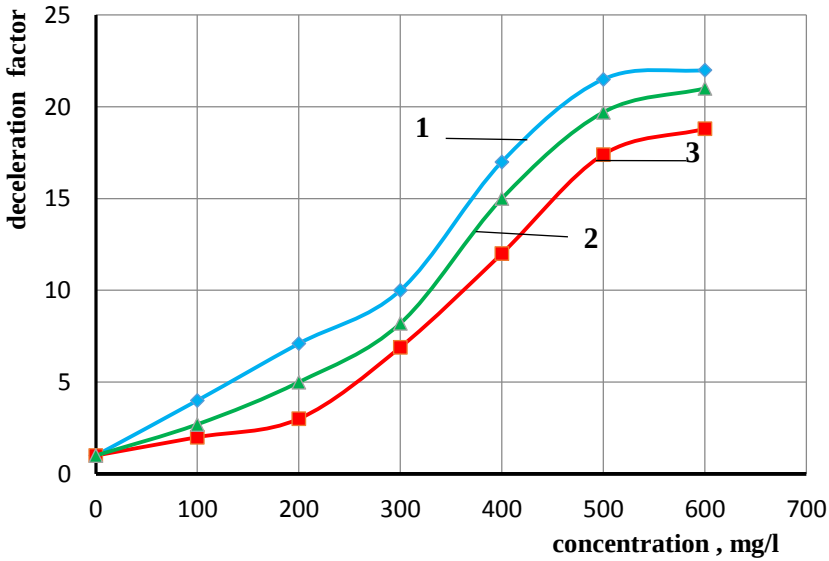
$$Z = \frac{K_0 - K_i}{K_0} \cdot 100\% \qquad (3)$$

Deceleration coefficient formula determined by the following.

$$\gamma = \frac{K_0}{K_i} \qquad (4)$$

K_0 və K_i –is the corrosion rate of steel without inhibitor and after application of inhibitor.

In order to determine the durability and optimal use of the compositions as a corrosion inhibitor in various aggressive conditions, the corrosion rate of Ct-20 brand steel samples made from pump-compressor pipes in neutral, alkaline and acidic type formation waters was studied. The indicators of the deceleration coefficient of the corrosion rate depending on the amount of inhibitors are given in graph 1.



Graph 1. Dependence of the retardation coefficient of the corrosion rate on the amount of inhibitors (1-"KAB", 2-"KAB-2014", 3-"KQÇİ-2014")

As can be seen from the graph, the corrosion rates of samples made of unreacted Ст-20 steel in neutral, alkaline and acidic environments are, respectively 0.8743, 0.9839 and 1.1539g/m^2·hour. When the optimal amount of "KAB", "KAB-2014" and "KQÇİ-2014" brand inhibitors are added to these environments, the corrosion rate decreases to 0.0406; 0.0499 and 0.0641 g/m^2·hour. That is, the retardation coefficient of corrosion of samples made of Ст-20 steel in an aggressive environment with added inhibitors is

21.5, respectively; It was 19.7 and 18. It is reasonable to take 500 mg/l of the optimal consumption of the applied inhibitors in neutral, alkaline and acidic environments. In this case, the corrosion protection effect of the compositions as an inhibitor was 94-96%. Studies have shown that a further increase in the concentration of reagents does not have a significant effect on the rate of corrosion of samples. Considering that steel corrosion in reservoir waters is electrochemical in nature, the mechanism of action of the compositions as an inhibitor was studied by the electrochemical method.

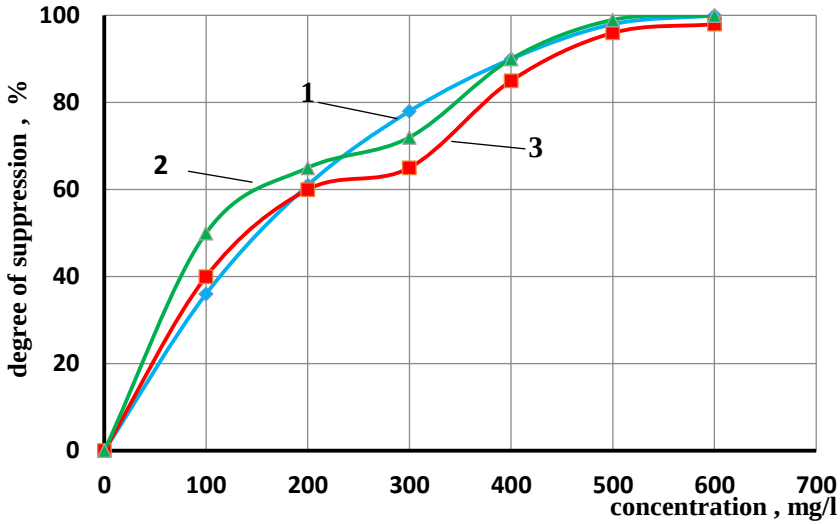
According to the results of electrochemical studies, the optimal amount of inhibitors added to the medium leads to the fact that active centers on the surface of the steel become passive due to changes in the electrode potential of the metal, anodic and cathodic processes. Analysis of the research results shows that the mechanism of action of these inhibitors mainly meets the requirements of a mixed type and effectively affects both electrochemical reactions (anodic and cathodic processes).

Due to the presence of sulfate-reducing and other bacteria in the formation water, fighting against microbiological corrosion has recently become relevant. Thus, the long-term operation of the formations, the application of new technological processes for oil production, especially the irrigation method, have led to the infection of the formations with microorganisms. One of the main reasons for the breakdown of equipment used in the oil extraction industry is microbiological corrosion caused by microorganisms. In this regard, one of the most effective measures in the protection of oilfield equipment from microbiological corrosion is the application of compositions with a complex effect of both bactrecidal and inhibitory properties.

Considering that sulfate-reducing bacteria can cause more corrosion aggressiveness, the bactericidal effect of the compositions was studied on that group of microorganisms. In addition, the selection of SRB for this purpose is related to the fact that they can stop their life activity and destroy the biocenosis formed by other physiological groups of microorganisms. For this purpose, to study

the bactericidal properties of inhibitors, studies were conducted based on the alternating dilution method in Postgate medium.

It should be noted that the SRBs used in the research were separated from the reservoir waters of the "Bibiheybat" field. Determination of the bactericidal properties of reagents at a concentration of 100-600 mg/l was carried out on a culture of sulfate-reducing bacteria with a load of 10^3 cells/ml at a temperature of 30-32^0C for 15 days. The studies were carried out in triplicate. The research results are shown in graph 2.



Graph 2. Dependence of the degree of SRB suppression on the concentration of reagents
(1-"KAB" inhibitor, 2-"KAB-2014" inhibitor, 3-"KQÇİ-2014" inhibitor)

Analysis of the results obtained from the research shows that the compositions have both an inhibitory property and a strong bactericidal effect. When consuming 500 mg/l of these compounds, the proliferation of SRB stops, the bactericidal effect is 98-99%. The inhibitor's effect varies depending on the environment and changes in operating conditions. Therefore, studies were conducted to determine the durability of new complex inhibitors under aggressive and changing operating conditions. The applied inhibitors showed a strong inhibitory effect at different flow rates of liquid under

aggressive conditions, regardless of temperature and time. Under these variable operating conditions, the metal corrosion protection efficiency of the inhibitor varies in the range of 90-95%. However, if the inhibitors remain in the environment for a long time, its corrosion protection effect is slightly reduced. The reduction of the corrosion protection effect is due to the gradual disintegration of the "protective layer" of the inhibitors on the metal.

The reason for the significant decrease in the corrosion rate is that it has the property of creating a "protective layer".

Corrosion and erosion of oilfield equipment is caused by the presence of corrosive aggressive components and mechanical mixtures contained in formation water extracted from oil wells. The erosive effect of the well product flow containing mechanical impurities on the metal develops the electrochemical process with the disintegration of the oxide and hydroxide protective coatings formed on its surface. Therefore, in wells where corrosion occurs, erosion is considered as a factor that stimulates the corrosion of equipment, and the research of corrosion and erosion processes should be studied in parallel. Corrosion-erosion of well equipment leads to a decrease in the operational activity of wells and an increase in untimely stops spent on carrying out current repairs in wells. Therefore, experiments were conducted to study the use of new inhibitors developed in laboratory conditions as lubricant additives.

It should be noted that the determination of the friction coefficient in a mixed formation water environment is the main criterion for evaluating the properties of inhibitors as a lubricant additive. Thus, the reduction of the friction coefficient reflects the effectiveness of the lubricant. During the studies, it was determined that the friction coefficient was reduced by 1.9-2 times when inhibitors were added to the medium. New compositions have a positive effect on the reduction of friction coefficient as a lubricant additive in aggressive environments.

In order to determine that there is no negative effect on the quality parameters of oil during the use of new compositions, studies were conducted in the direction of studying their demulsifying properties. In the course of research, it was determined that the

amount of residual water was the same in the samples without reagents and those with added inhibitors.This means that the application of new inhibitors in the wells has no negative effect on the separation of oil from water.

The influence of different concentrations of inhibitors on the viscosity of the water-oil mixture was also studied in laboratory conditions. The influence of different concentrations of inhibitors on the viscosity of the water-oil mixture was also studied in laboratory conditions. Adding an optimal amount of inhibitors to a high-viscosity water-oil mixture reduces its dynamic viscosity. Effective viscosity of oil without inhibitor was 0.633 Pa·s. When adding 500 mg/l of each of the inhibitors to the water-oil mixture, the dynamic viscosity was 0.487, 0.420 and 0.221 Pa·s. The high result was obtained in the experiments of the "KQÇİ-2014" brand inhibitor. During the studies, it was determined that the application of inhibitors does not increase the viscosity of the water-oil mixture.

Complications related to corrosion and salt deposition occurring in the process of operating wells are more evident in the fields at the final stage of development. Therefore, studies were conducted to develop new compositions against corrosion and salt deposition.

In order to regulate the eco-use indicators of technological processes, complex effective compositions were developed based on mixtures of technical phosphatide emulsion, polypropylene glycol cubic residue, sodium hexametaphosphate and ammophos obtained from the hydration process during the production of vegetable oils against corrosion and salt precipitation.

Conducted to obtain new compositions of optimal composition the results of the studies showed that technical phosphatide emulsion, a mixture of cubic residue of polypropylene glycol and polyethers production and sodium hexametaphosphate meets the condition Ek/Er>1. In addition, technical phosphatide emulsion, polypropylene glycol cubic residue and ammophos mixture were found to satisfy the condition Ek/Er >1. According to their composition, these compositions are conventionally called "KDİ" and "KDÇQ" brand corrosion and salt deposition inhibitors.

The research methodology against salt deposition basically consists of monitoring the deposition process of calcium carbonate salts in laboratory conditions. The researches were carried out in the environment with the consumption of the composition in the interval of 50÷250 mg/l for 6 hours and at a temperature of 75^0C. As an aggressive medium, mixed reservoir water with high mineral content was used. Researches were conducted to determine the efficiency of protection against salt deposition and corrosion and the optimal use in the aggressive environment of the processed "KDİ" and "KDÇQ" brand compositions.

As a result of the research, it was determined that the optimal consumption of "KDİ" and "KDÇQ" brand inhibitors in the environment is 200 mg/l. In this case, the corrosion protection effect was 94-95% and the salt precipitation protection efficiency was 86-87%.

The influence of cathode and anode polarization curves of P-105 steel samples in the aggressive formation water of "KDI" and "KDÇQ" brand inhibitors was studied by electrochemical method. The conducted experiments showed that the mechanism of action of inhibitors mainly meets the requirements of mixed type, is consistent with gravimetric tests and it effectively affects both electrochemical reactions at a concentration of 200 mg/l. The proposed new "KDI" and "KDÇQ" brand composition can be used against corrosion and salt deposition in oil wells, mine internal transport systems, and also in formation pressure storage systems.

In order to ensure reliable operation of groove joints in pump-compressor pipes, it is important to research and develop the technology of application of compositions with lubricating, anti-corrosion, and sealing properties. In this regard, studies were conducted to develop a new plastic composition for corrosion protection of groove joints in pump-compressor pipes.

Based on the research, two plastic compositions with optimal composition, made from economically more efficient domestic products, were developed from among many options. Based on their composition, those compositions are conventionally called PK-1 and PK-2. The optimal mass composition of the received PK-1 and PK-2

compositions is given below:

-PK-1 consists mainly of 70/30 brand bitumen sopstok, heavy pyrolysis resin, natural bitumen with a mixture of sand and clay as a filler, and bactericide-inhibitor brand "KAB";

-For PK-2, 70/30 brand bitumen was used as technical salomaz, heavy gasoil, natural bitumen with sand-clay mixture and "KAB-2014" brand bactericide-inhibitor were used as filler.

It should be noted that natural bitumen with sand-clay mixture was used as a filler for the first time.

Homogeneity, stability, flow temperature, corrosion, corrosion protection and bactericidal properties of PK-1 and PK-2 compositions were studied. The analysis of the obtained results shows that the softening temperature of the composition was above 78 ºC, which means that the probability of the softening of the composition is very low even when the temperature reaches 60 ºC on hot summer days. The sliding and dropping temperatures of the composition above 84°C indicate its good adhesion to the metal surface.

The biological durability properties of the processed plastic compositions were studied. For this, the effect of the compositions on mold fungi in the Çapek-Doks environment was studied in laboratory conditions . During the conducted tests, the development of mold fungus was not observed for 28 and 56 days in the environment with plastic compositions, and it was determined that they are biologically stable.

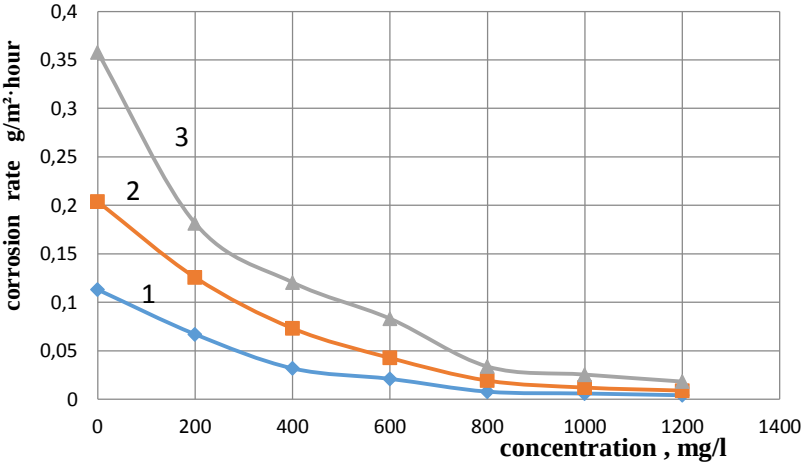
Environmentally friendly and economically viable drilling fluids used in the oil and gas industry should always be in focus. Accordingly, it is of particular importance to improve the technological properties of the drilling fluids used in well drilling, mining, and hydraulic testing. Taking into account the urgency of the current problem, studies were conducted to develop new compositions against the corrosion aggressiveness of clay solution. As a result of laboratory studies, new compositions with multifunctional properties against the corrosion aggressiveness of drilling fluids have been developed:

- a composition based on soapstock, technical lecithin,

nitroalcohol, light gasoil fraction or light oil (oil containing naphthenic acids and nitrogen compounds) against the corrosion aggressiveness of oil-based drilling solutions was developed;

- the composition is prepared on the basis of sulfonated, neutralized gas oil fraction, carbamide, technical phosphate emulsion against the corrosiveness of water-based drilling fluids.

These compositions are conventionally named A and B brand inhibitors according to their composition. In order to study the corrosion protection effectiveness of the A brand composition, laboratory studies were conducted in fresh, sea and formation water-based bentonite clay suspensions, and the results are shown in graph 3.



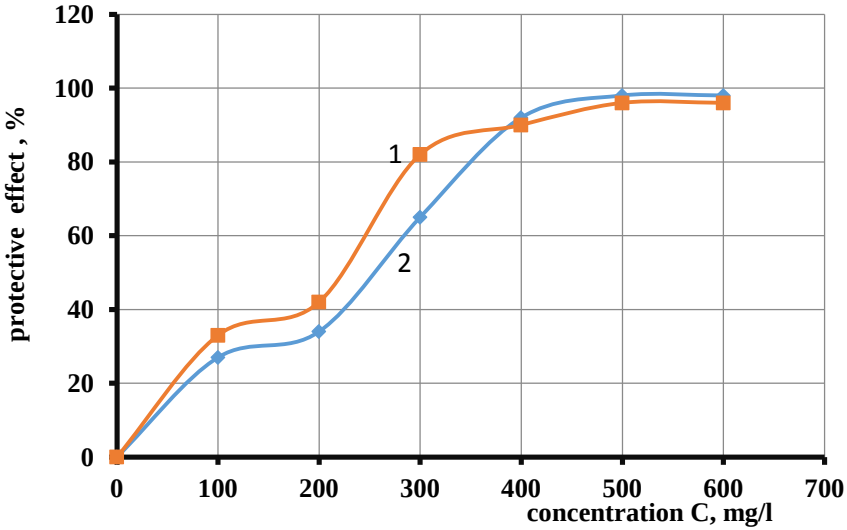
Graph 3. The A inhibiting properties of reagent in various environments
1-suspensions of bentonite based on fresh water
2-suspensions of bentonite based on sea water
3-bentonite suspensions based on formation waters

As can be seen from the graph, when studying the effect of a clay solution of inhibitor composition grade A on the corrosion rate, it was found that its optimal consumption in the aggressive environment is 1000 mg/l, and the effectiveness of corrosion protection is 94-95%. In addition, depending on the exposure time, the corrosion protection efficiency was 92-95%. It was determined that the corrosion aggressiveness of the drilling fluids added with the

inhibitor was reduced by 12-16 times depending on the time. It should be noted that the main reason for not using drilling solutions in research is that adding additional reagents to its composition affects the accuracy. Therefore, in addition to drilling fluids, clay solution suspensions were also used in the research.

Taking into account the negative impact of corrosion aggressiveness in water-based drilling solutions on the ecological environment, B brand composition with emulsion properties was developed.

Technical phosphatide has a biphilic structure and has the ability to form an emulsion. When used in a clay solution, it has the properties of both an emulsifier and a lubricant. The effect of the bactericidal-inhibitory properties of the composition on clay solution was determined and the obtained results are presented in graph 4.

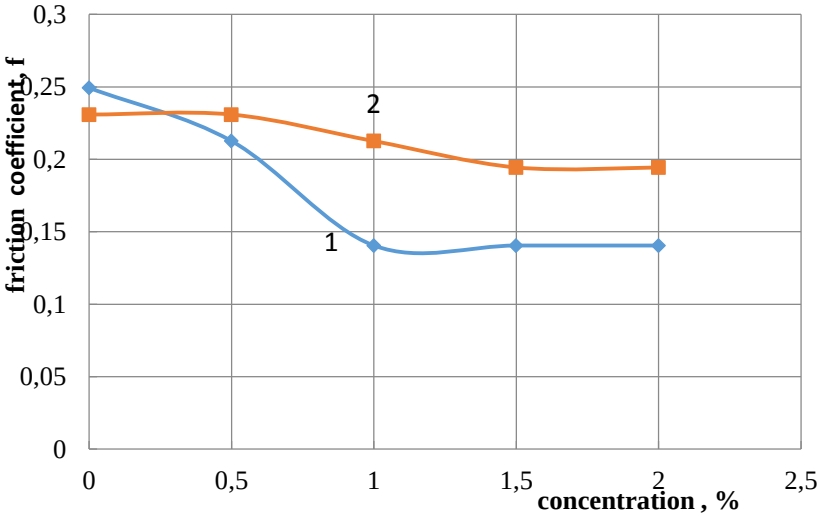


Graph 4. Dependence of the protective effect (1) and the degree of SRB suppression (2) on the concentration of the reagent

As can be seen from the graph, at the optimal consumption (600mg/l) of B brand inhibitor in clay solutions, the metal corrosion protection effect was 96% and the SRB destruction efficiency was 99%. Thus, laboratory studies have shown that this composition has bactericidal-inhibitory properties.

The study of corrosion aggressiveness in clay solution suspension shows that both of the processed compositions have inhibitory properties. Thus, the electrochemical method was used to study the mechanism of action of both inhibitors in the environment. In an aggressive formation water environment, the optimal consumption amount of A and B brand inhibitors was added. The analysis of the results of the conducted studies shows that the inhibitors meet the requirements of the mixed type based on the mechanism of action.

The purpose of this work is not only to study the properties of the obtained compositions as corrosion inhibitors, but also to reveal the effect of the drilling fluid on the erosion and friction of the equipment used in the environment. For this purpose, in laboratory conditions, the compositions were added to clay solutions in various quantities as a lubricant. The research results are shown in graph 5.



Graph 5. Dependence of the friction coefficient on the concentration of inhibitors (1- inhibitor A, 2- inhibitor B)

As can be seen from the graph, the friction coefficient of the clay shell without inhibitor was 0.2493. When 0.5-2% inhibitor was added to the used clay solution as a lubricant additive, the friction coefficient of the clay shell was 0.2126-0.1405, respectively. As it

can be seen, adding 0.5-2% of A brand inhibitor to the medium of clay solution reduces the coefficient of friction by 1.2-1.8 times, and the best indicator is observed at 1% concentration, when the coefficient of friction was 0.1405. When the A brand inhibitor was used, the friction coefficient of the clay shell decreased by 1.8 times, and the effectiveness of the inhibitor as a lubricant additive was 44%. It should be noted that the use of the inhibitor in a loading dose of 10 g/l allows it to be used as an additive to lubricants.

As can be seen from the other curve in the graph, the friction coefficient of the clay shell without inhibitor was 0.2309, and the addition of 0.5-2% B brand inhibitor to the clay solution reduces the friction coefficient by 1.1-1.2 times, and the best indicator is observed at 2% concentration. Thus, at this time, the friction coefficient of the clay shell was 0.1944, and the protective efficiency of the inhibitor as a lubricant additive was 21%. Laboratory studies show that when 1% of inhibitor compounds are used as a lubricant additive, the friction coefficient is reduced by 1.2-1.8 times.

Studies have been conducted to apply the developed new A and B inhibitors in production wells. During the studies, the corrosion rate of metal without inhibitors in formation water taken from 14 wells varied in the range of 0.4734-1.6691g/m^2·hour. When adding 1000 mg/l of A-brand inhibitor to formation water, the metal corrosion rate was 0.0207-0.0976 g/m^2·hour and the inhibitor's metal corrosion protection efficiency changed in the range of 94-96%. When 600mg/l inhibitor of brand B was added to formation water, the corrosion rate of metal changed from 0.0211 to 0.0940 g/m^2·hour and the corrosion protection efficiency was in the range of 94-96%. The newly developed A and B inhibitors can be used in drilling fluids and oil wells to protect equipment from corrosion.

The third chapter is devoted to improving the environmental and operational efficiency of the reservoir pressure maintenance system and infield transport systems.

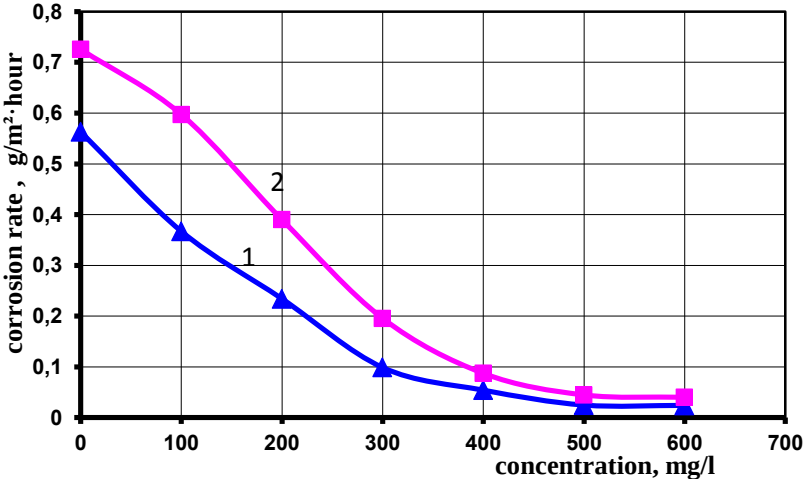
The highly mineralized formation water produced together with oil is also considered a source of pollution. In many cases, wastewater treatment by mechanical, biological and chemical methods does not fully meet the requirements. Therefore, it is

necessary to prevent the discharge of dirty formation water into the environment due to accidents caused by corrosion, erosion and salt precipitation in the devices and equipment operated during the technological processes in reservoir pressure storage tanks.

At the last stage of oil field development, oil production reaches the minimum level, and product dilution reaches the maximum level. In the final stages of development, it is necessary to implement various geological and technical measures to increase oil production. One of such measures is the corrosion protection of the equipment used in the formation pressure stabilization systems and the mine transport systems.

Taking this into account, as a result of laboratory research, a new multifunctional composition was developed based on sulfonated and neutralized gasoyl fraction (SNQF), isopropyl alcohol, technical phosphatidyl emulsion obtained from the hydration process of vegetable oils, and sodium salts of naphthenic acid. The possibility of using this composition as a compressing agent both in the fight against corrosion and in compressing oil has been studied.

The effect of the new composition on the corrosion rate in various aggressive environments was studied and the results are given in graph 6.



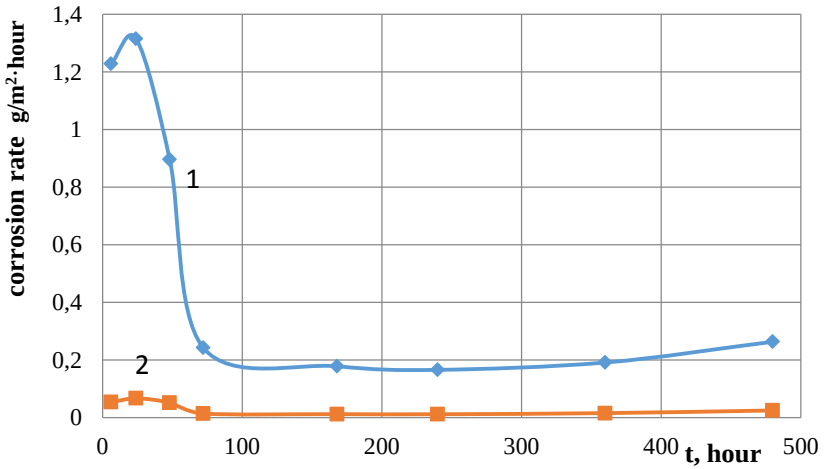
Graph 6. Corrosion rate dependence on the amount of composition (1-alkaline, 2- acidic)

The analysis of the obtained results shows that it is appropriate to take the optimal consumption of the applied composition at 500g/l. In this case, the corrosion protection effect is 94-96%.

The bactericidal properties of the composition were determined and the analysis of the results shows that the composition also has a strong bactericidal effect. The composition stops the development of SRB by 90% at a concentration of 400 mg/l, and by 99% at a concentration of 500 mg/l, in other words, it shows bactericidal efficiency.

The mechanism of action of the composition was studied using the electrochemical method. As can be seen from the obtained results, the potentiostatic studies correspond to the gravimetric tests and, moreover, both electrochemical reactions are delayed at a concentration of 500 mg/l in the composition medium.

The results of the protection effectiveness of the composition in an aggressive formation water environment depending on time are given in graph 7.



Graph 7. Dependence of the metal corrosion rate on the exposure time of the samples (1 - without inhibitor, 2 - with inhibitor)

It can be seen from the graph that when 500 mg/l was added to the medium, the corrosion protection effect of the metal was 90-

96% depending on the time. Apparently, the applied composition shows a strong inhibitory effect for 168 hours. During the 240-480 hours of testing, this indicator slightly decreased to 90-93%. The reason forthe reduction of the general corrosion protection effect in aggressive conditions is the result of the gradual dissolution of the "protective layer" created by the composition as an inhibitor on the metal as an absorption. Therefore, after 240 hours, the composition should be added to the medium again. The effect of different concentrations of the new composition on oil viscosity was studied in laboratory conditions.

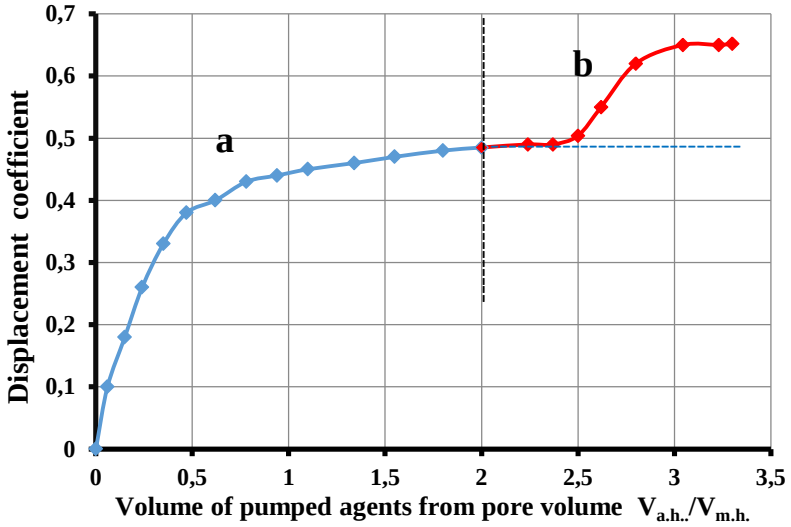
Studies have shown that the dynamic viscosity of high-viscosity oil decreases with increasing reagent concentration. When the optimum amount of reagent was added to the high-viscosity oil, the dynamic viscosity decreased by 3 times, and the effect of the reagent was 67%.

The best indicator of the value of the surface tension at the oil boundary with solutions of different concentrations in formation water of the new composition is obtained in a 3% solution. The value of the surface tension at the oil-solution boundary decreased 19 times (from 15.2 mN/m to 0.79 mN/m) and was less than unity at the given density. Therefore, a 3% solution of the composition in formation water can be taken as the optimal concentration.

To compress the residual oil, a 3% solution was pumped into the reservoir model, which we consider to be the optimal concentration of the composition in the formation water. At this time, the experiment continues until the oil is completely washed off. The influence of the new multifunctional composition on oil recovery was determined, the results are presented in graph 8.

As seen from part b of the curve on the graph, in this case it was possible to compress 16% of the residual oil (graph 8, b) by pumping into the model 1.4 volume of the working agent. As shown by the experiment, a 3% solution of a novel reagent in plastic water allows an increase in the compression ratio by 16% compared to the formation water.Thus, on the basis of the results of the experimental studies carried out, it can be said that the composition includes complex substances, which gives it a multifunctional property and

allows it to be used in various directions.



Graph 8. Dependence of oil displacement coefficient from the porous environment with layer water (a) and 3% solution of reagent (b)

The use of the composition in the formation pressure maintenance system both protects the mining equipment from corrosion, and when added to the injected water as a compression agent, it improves its physical and chemical properties, which in turn allows it to increase the oil yield.

Researchs were conducted for the development of new bactericidal effective compositions against microbiological corrosion in laboratory conditions. As a result of them, new bactericidal compositions were developed and conventionally named SB and NB brand bactericides.

- The component composition of the SB brand bactericidal composition is made from a mixture of sulfonated and neutralized gasoyl fraction, 45% sulfanol, isopropyl alcohol, sodium salts of naphthenic acids.

-The component composition of the NB brand bactericidal composition is made from a mixture of isopropyl alcohol, nitroalcohol and light gasoyl fraction.

The bactericidal effect of the composition was studied on sulfate-reducing bacteria. In order to study the bactericidal properties of the composition, studies were conducted based on the alternating dilution method in Postgate medium. According to the guidelines, the studies were conducted at a titer of SRB of 10^2-10^3 cells/ml at 28-30 ^{0}C for 15 days. The optimal dose of bactericidal compositions to be applied has been determined.

The analysis of the results obtained from the studies showed that the SB brand composition has a high bactericidal effect for 72 hours of contact (exposure). This composition stops the reproduction of SRB at a concentration of 600 mg/l and shows a bactericidal effect of 98%. NB branded composition had a high bactericidal effect during 48 hours of contact (effect), so it shows a bactericidal effect of 97% at a concentration of 500 mg.

Based on results of the conducted laboratory studies, it can be concluded that the composition of the SB brand at a concentration of 600 mg/l can be used in the reservoir pressure storage system in irrigation wells, and the composition of the NB brand at a concentration of 500 mg/l can be used in production wells to prevent microbiological corrosion of equipment.

In laboratory conditions, the resistance of the new composition to the influence of mold fungi was tested in the Çapek-Doks environment. Thus, after 28 and 56 days of storage, it was determined that the composition is resistant to the effects of mold fungi. These compositions can be used for the treatment of formation waters and also to prevent contamination of productive formations with microorganisms.

Increasing the quality of the water injected into the reservoir is one of the issues that are always relevant. Taking into account the mentioned problems, the possibility of use of bacteriacidal SB brand in oil compression (effect on the physico-chemical indicators of water) has been studied, since the bactericidal SB brand composition has surface-active properties.

In the research, it was determined that as the water content of the new SB brand composition increases, the value of the surface tension at the border with oil decreases sharply, and the values of oil

washing ability and pH begin to increase. The best indicator is observed at a concentration of 1% of the solution. This also shows the possibility of using the composition in oil compression.

In the course of research, it was determined that the corrosion protection effectiveness of the compositions as an inhibitor at the optimal concentration is 70÷80%.

In the process of applying modern methods to intensify oil production, in a number of cases negative phenomena such as environmental pollution are observed. From this point of view, it is important to improve impact methods implemented to intensify oil production.

Taking these into account, a microemulsion with a new composition was developed for impacting the bottom zone with the aim of intensifying production during the development of fields with high viscosity, anomalous oil reserves. Studies were conducted to determine the optimal composition of microemulsion.

In the research, it was determined that the most effective microemulsion was obtained from a mixture of an inhibitor with isopropyl alcohol, a technical phosphatide emulsion obtained from the hydration process of inkerosin or light pyrolysis resin and vegetable oils with surface-active properties. Water is not added to its composition because the technical phosphatide emulsion itself contains 40-70% water. During laboratory studies, it was determined that the technical phosphatide obtained from the hydration process of the active ingredients in the inhibitor used in the preparation of the microemulsion improves the physical and chemical indicators of the microemulsion such as surface active substances.

The new solution of the microemulsion allowed to increase the oil release by 13.7% (increased from 0.501 to 0.638) and the coefficient of permeability in 2 times (increased from0,68• $10^{-12}m^2$ artaraq 1,19• $10^{-12}m^2$).

According to the research results, it was found that the injection of the developed microemulsion into the bottomhole zone creates favorable conditions for the dissolution of deposits containing heavy hydrocarbon compounds.

Corrosion and erosion of the pipes cause accidents and

accidents lead to an increase in the number of repairs, a decrease in operational efficiency, the creation of environmental problems and the consumption of additional funds to eliminate them.

In order to increase the uninterrupted service life of pipelines in the intra-mining transport system, reduce the cost of transport costs and reliably protect the environment, regular study of the corrosion aggressiveness of transported mining products, investigation of the factors that cause erosion and mechanical corrosion, and improvement of protection methods against it is one of the urgent issues. Therefore, studies were conducted to study the factors affecting the eco-operation indicators of technological processes in mine pipelines and to develop a multifunctional composition to increase their efficiency.

The intensity of corrosion of the outer surface of pipelines depends on the environment where the pipeline is located, the amount of aggressive salts, moisture, oxygen and other chemical compounds in the soil, the electrical potential of the soil, the presence of microorganisms that lead to corrosion localization, etc.. In addition, corrosion is also caused by the minerality of the groundwater, the grade of the metal, deformation, stress, etc. factors also have an effect.

The corrosive aggressiveness of soil contaminated with groundwater has been studied. In order to study the influence of the corrosive aggressiveness of contaminated soils on the corrosion of the external surfaces of pipelines, a chemical analysis was carried out to determine the amount of aggressive ions present in soil samples taken from certain sections of the Oil and Gas Production Department Bibieybatneft and A. Amirova.

The presence of more than 300 mg/l of sulfate and chloride ions isolated from the studied samples indicates a high aggressiveness of the rock. The high content of sulfate ions in these rocks creates not only chemical aggressiveness, but also favorable conditions for the growth of sulfate-reducing bacteria.

As a result of the research, it was found that the soils of the commercial area, contaminated with formation waters, have a high corrosive aggressiveness - up to 2 times compared to uncontaminated

soils. This is due to an excess of aggressive sulfate and chloride ions in groundwater. In addition, for an accurate characterization of the aggressiveness of the rock, it is important, among other factors, to determine the microbiological aggressiveness of not only soils, but also groundwater. These factors should be taken into account in the corrosion protection of underground pipelines passing through contaminated soil areas.

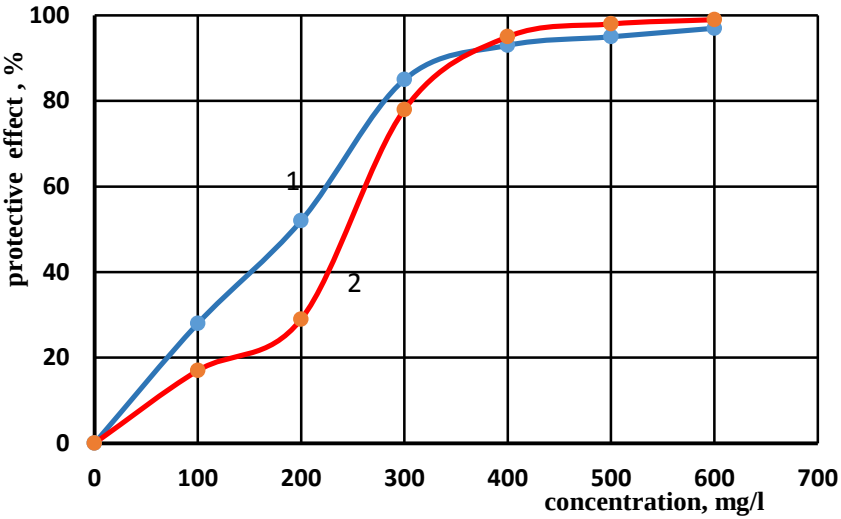
The effect of corrosion inhibitors used in the intra-mine transport system varies depending on the aggressive environment and changes in operating conditions. Because the temperature of the aggressive environment, the speed of movement of the liquid and many other factors affect the effectiveness of the use of inhibitors. From this point of view, the development of new complex effective inhibitors for the protection of pipelines from corrosion is becoming urgent. The high viscosity of the liquid transported by pipelines is one of the main factors that lead to a decrease in transportation efficiency and an increase in transportation costs. Therefore, reduction of hydraulic losses caused by transported high-viscosity fluid is always relevant. Researchs have been conducted for the development of a multi-functional composition that allows for the protection of underground pipelines from corrosion and the reduction of hydraulic losses caused by the viscosity of oil.

As a result of laboratory studies, a composition was prepared on the basis of technical phosphatide concentrate, nitro alcohol monoethanolamine, light pyrolysis resin or light gasoyl fraction against corrosion aggressiveness. Laboratory studies were conducted to study the properties of the composition as a corrosion bactericide-inhibitor, and the obtained results are shown in graph 9.

The analysis of the results obtained from the studies shows that the applied composition has a strong inhibitory and bactericidal property in environments with a hydrogen-sulphide content of 630 mg/l. It is desirable to take the optimal consumption of the composition at 500 mg/l. In this case, the corrosion protection effect is 95% and the SRB destruction efficiency is 98%.

The mechanism of action of the composition was also studied. The obtained results show that potentiostatic studies are

compatible with gravimetric tests and slow down both electrochemical reactions.



Graph 9. Dependence of the protective effect (1) and the degree of SRB suppression (2) on the concentration of the reagent

The surfaces of metals are heterogeneous and characterized by the presence of centers with different activity. The composition passives the corrosion process by shielding the active centers with high energy on the surface of the metal, isolating them from the aggressive environment.

The rapid corrosion of pipes that are part of the transport system is influenced by the temperature of the aggressive environment and the speed of fluid movement. In order to determine the effectiveness and durability of the special composition of the new complex-acting inhibitor, studies were conducted to study its stability over time under variable operating conditions - various aggressive conditions, at different flow rates and temperatures of the liquid. In this aggressive environment, when the concentration of the composition was 500 mg/l, the efficiency of metal corrosion protection was 90-95%.

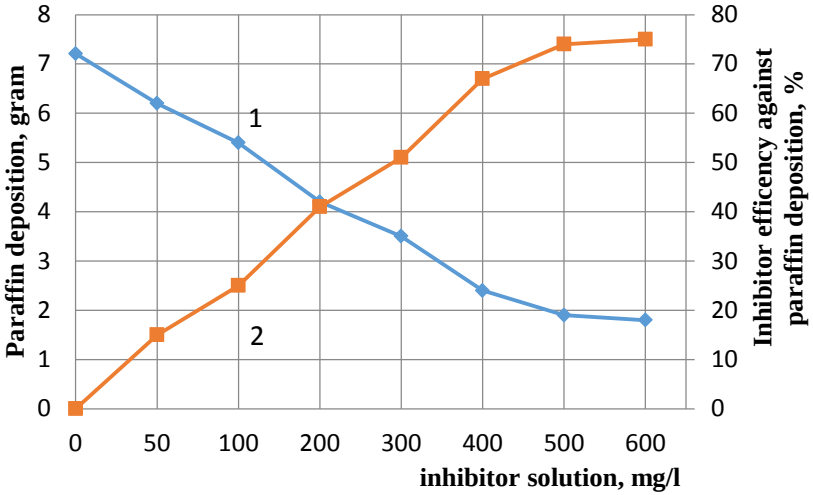
In laboratory conditions, the effect of different concentrations of the new composition on the viscosity of high-

viscosity oil was studied. When the amount of the composition in the oil increased, its effective viscosity decreased. Thus, when the composition is added in the amount of 50-600 mg/l, the viscosity of oil is 6.3-2.6 Pa·s. When the composition of 500 mg/l optimal consumption amount was added to the composition of high viscosity oil, the effective viscosity was 2.4Pa·s, and the efficiency index was 59%.

At the same time, the multifunctional composition had a positive effect on reducing the viscosity of oil. The improvement of oil viscosity can be explained by the fact that the composition has surface-active properties. A multifunctional composition acts as a surface-active agent and reduces friction between the well product and the pipeline wall. This, in turn, leads to a reduction in hydraulic losses. The prepared composition, as a corrosion inhibitor, creates a "protective layer" on the metal surface, and since it contains surfactants, it has the property of reducing oil viscosity and, accordingly, hydraulic losses.

Problems related to paraffin crystallization and precipitation during oil production and transportation cost the oil industry billions of manats every year. Paraffin precipitation depends on the flow rate, temperature difference and surface properties. Deposition of asphaltene-resin-paraffin sediments in mine internal transport systems is one of the factors causing complications. The effect of the developed new complex effective composition on the cleaning of the inner surface of the pipelines in use in mine internal transport systems from asphaltene-tar-paraffin sediments was studied and the results are shown in graph 10.

In the studies, the optimal consumption rate of the composition was determined to be 500 mg/l. The effect on paraffin precipitation was reduced by 2.1 times (3.4g) and the protective effect was 53%. The rate of consumption of the composition against corrosion and paraffin precipitation is 500 mg/l, which corresponds approximately to the rate of consumption for reducing oil viscosity and hydraulic losses. Therefore, the multifunctional composition has a positive effect on reducing oil viscosity and paraffin precipitation at the same time.



Graph 10. Effect of inhibitor on Paraffin deposition rate.
1 - Paraffin deposition rate depending on reagent concentration;
2 - The effectiveness of the reagent against paraffin deposition.

In order to prevent the processes of corrosion and salt deposition in the equipment, various physical and chemical control methods are used. Studying the application efficiency of permanent magnetic couplings in oil wells is one of the actual issues.

Taking into account the urgency of the current problem, studies were conducted in laboratory conditions to study the effect of permanent magnetic inductors of different voltages on the intensity of steel corrosion and salt precipitation in sea and formation water environments.

As a result of laboratory studies, it was determined that the maximum effect is achieved in the protection of the intensity of corrosion and salt precipitation under the influence of a constant magnetic field with a voltage of 280 kA/m. Thus, due to the influence of permanent magnetic connections, the aggressiveness of the environment also changes due to changes in the composition of the studied formation water. Under the influence of the magnetic field, the dissolved salts change their structure and do not percipitate as solid deposits, but are removed from the well as a crystalline small dispersed slurry. The simplicity of this method is considered one of its advantages.

In this regard, studies were conducted to study the joint effect of “KDİ” and “KDÇQ” inhibitors in a constant magnetic field with a voltage of 280 kA/m. The presence of a synergistic effect was determined as a result of the combined effect of inhibitors in a constant magnetic field with a voltage of 280 kA/m.

As can be seen from the results obtained from laboratory studies, the optimal consumption of "KDI" and "KDÇQ" brand inhibitors in the environment with a stable magnetic field was determined to be 150 mg/l. In this case, the corrosion protection effect was 94-95% and the salt precipitation protection efficiency was 85-86%. As can be seen from the comparative analysis of the obtained results, 25% of the reagent consumption is saved during the joint application of the composition with a constant magnetic field. This shows that the combined application of the composition with a fixed magnetic field is more efficient from an economic point of view.

Studies were conducted to study the joint effect of "KAB", "KAB-2014" and "KQCİ-2014" inhibitors in a constant magnetic field with a voltage of 280 kA/m. As can be seen from the comparative analysis of the results obtained from the effect of inhibitors without the effect of a constant magnetic field and in combination with a constant magnetic field, the combined application of a constant magnetic field with inhibitors is more efficient from an economic point of view. In aggressive environments, the optimal consumption of inhibitors was determined to be reduced from 500 mg/l to 400 mg/l, and in this case, 20% of the consumption of inhibitors was saved.

The fourth chapter reflects the results of the application of the composition developed to improve the efficiency of technological processes in oil and gas production.

In order to increase the eco-operation efficiency of underground and surface oil mining equipment operated in oil wells in oil and gas extraction, new multifunctional compositions have been developed for protection against corrosion and salt deposition. The component composition of the compositions was determined in laboratory conditions, their physico-chemical properties and

bactericidal properties were studied along with their effectiveness of protection against corrosion and salt precipitation. The results of the laboratory research were summed up and proposed for mining tests of microbicide-inhibiting compounds with the selected optimal composition.

When selecting oil wells and prefabricated transport lines (pipelines), before starting the process of application of microbicide-inhibiting compounds, the quantity of petroleum products produced, the performance of wells, the technical condition of equipment and pipes is determined, composition of the oil and gas system, reservoir pressure maintenance systems, chemical composition of the technical waters used, presence of various microbiological groups actively involved in corrosion in the reservoir water environment, the course of observed physical and chemical processes (paraffin, hydrate formation), carefully studied the presence of corrosion products in the space behind the pipe, the manifestation of deposits of salts. The injection technology for the inhibitors was chosen to be continuous and periodic depending on the method of operation. The injection technology of inhibitors was chosen to inject continuously and intermittently into the wells depending on the operating methods.

Field tests of the "KAB" brand inhibitor were carried out at the flooded (90%) well № 3293 of the "Bibiheybatneft" OGPD of the Azneft Production Association. During the tests, a bactericide-inhibitor was pumped into the annulus of the well with a dosing pump for 30 days. The first three days the reagent was administered at a loading dose (10 g/l), and the remaining 27 days - at a working concentration of 0.5 g/l.

The influence of the bactericide-inhibitor brand "KAB" on corrosion and microbiological corrosion of equipment was determined. The rate of corrosion and the effect of corrosion protection were determined by the mass loss occurring in witness samples made of steel pump-compressor pipes , placed in the pressure line of the well in an environment without a reagent and pumped with a bactericide-inhibitor.

While the average corrosion rate in steel samples before injection of bactericide-inhibitor was 0.5423 and 0.6642 g/m^2·hour,

respectively, for 14 and 30 days, after injection of “KAB” brand bactericide-inhibitor into the well, the average corrosion rate in steel "control" samples was speed was determined to be 0.0657g/m^2·hour and 0.0674g/m^2·hour, respectively. After injecting "KƏB" brand bactericide-inhibitor into the well, the effect of corrosion protection in steel "witness" samples was 88-90%.

As a result of the use of the bactericide-inhibitor of the brand "KAB" in the OGPD named after G.Z. Tagiev, in the OGPD "Bibiheybatneft" and "Siyazanneft" within one year, an economic effect in the amount of 96,537 manats was obtained.

Field tests of the bactericide-inhibitor "KAB-2014" were carried out at wells № 474, 743 of OGPD "Absheronneft" and at wells №. 107, 142 of OGPD named after A.Amirova.

The protective effect of this inhibitor during field tests at the Absheronneft oil and gas production department was 96%. This creates conditions for extending the service life of pipelines, equipment and reducing accidents.

After the application of a corrosion inhibitor in well № 474 of the “Absheronneft” OGPD, the overhaul period increased by 3 times during the year, and the number of repairs decreased from 3 to 1. After the use of the inhibitor in well № 743, the overhaul period doubled during the year, and the number of repairs decreased 2 times. It should be noted that as a result of the use of inhibitors in two wells, an additional 53.8 tons of oil were produced.

Field tests in wells № 107, 142 OGPD im. A. Amirov showed that before the injection of the inhibitor, the average corrosion rate of “witness” samples was 0.9710 g/m^2·hour and 0.4925 g/m^2·hour, respectively. 30 days after periodic injection of the bactericide-inhibitor “KAB-2014”, the average corrosion rate was determined, which was 0.1040 g/m^2·hour and 0.0473 g/m^2·hour, respectively. The protective effect of the inhibitor was 89-90%.

After a year of using the inhibitor in well № 107 of the OGPD named after A. Amirov, the overhaul period increased by 1.6 times - from 33 to 52 days, and the number of repairs decreased by 1.7 times - from 12 to 7. After a year of using the inhibitor in well №142, the overhaul period increased from 24 to 36 days, and the

number of repairs decreased from 15 to 10. As a result of the use of inhibitors, an additional 48 tons of oil were produced at two wells. As a result of the use of the bactericide-inhibitor of the "KAB-2014" brand in wells № 474, 743 of the "Absheronneft" OGPD and in wells №107, 142 of the OGPD named after A. Amirov received an economic effect in the amount of 6753.8 manats.

Field testing of a reagent obtained from a mixture of naphthenic acid salts and technical phosphatide was also carried out in the pressure maintenance system of OGPD "Bibieybatneft".

According to the developed technology, a 3% solution of the reagent with a pore volume of 25% was continuously supplied with a shock dose during the day (as an oil compressor) to the fields of OGPD "Bibieybatneft". After that, for each liter of formation water, 0.5 g of the reagent was added as a corrosion inhibitor.

Protection during continuous and periodic application of the inhibitor the effect is 89-91%, periodically used composition reduces the consumption, minimizes the expenses incurred, ensures protection of the system from corrosion. As a result of the effect of composition, oil production increased by 11% on average, and as a result, 92,800 manats were saved.

The mining test of "KQCI-2014" brand multifunctional inhibitor was carried out in well № 2888, where the product of "Bibiheybatneft" OGPD was diluted to 88%. After the 30-day mining test before the inhibitor was injected, the average corrosion rate in the steel "witness" samples was 1.3761 g/m^2·hour and after the test, the corrosion rate was 0.1356g/m^2·hour. After injecting the "KQCİ-2014" multifunctional inhibitor into the well, the corrosion rate in the steel "witness" samples decreased by 10 times, and the corrosion protection effect of the inhibitor was 90%.

Injection of a multifunctional inhibitor into the well bottom zone, product № 3851 of "Bibiheybatneft" OGPD was applied in a 91% diluted production well. Within 3 months after implementation, the inter-repair period increased by 2.7 times, i.e. from 11 to 30 days, and the number of repairs decreased by 2.6 times, from 8 to 3. As a result, oil production increased by 22% on average.

Thus, oil production before injection of inhibitor was 1.4

tons per day, and after injection of inhibitor - 1.7 tons, which means additional oil production of 33 tons. After injection of the inhibitor, the flow pressure decreased from 0.12-MPa to 0.096 MPa due to the reduction of oil viscosity and hydraulic losses. This also created conditions to increase the operating efficiency of the mine transport system by 20%. As a result of the application of the multi-functional inhibitor of the "KQCI-2014" brand, 5087 manats were saved.

"KQCI-2014" brand in 2015 at "Bibiheybatneft" OGPD as a result of applying the inhibitor in 12 wells, 64.3 tons of additional oil was produced and 38,945 manats of economic benefit was achieved. Production wells № 3119 and 518 of "Bibiheybatneft" OGPD were selected for conducting mining tests of PK-1 and PK-2 plastic composition, which can provide protection of groove joints of pump-compressor pipes.

According to the work plan of the acceptance tests, in order to determine the corrosion protection ability of the plastic composition, the thread joints of some of the pump-compressor pipes were isolated, and some of them were let into the well without isolation. During inspection, it was found that non-insulated groove surfaces were covered with strong corrosion products, and no corrosion products were encountered in isolated groove joints. The threaded connections of the pump-compressor pipes were easily opened by rolling, and it was determined that their surfaces remained practically unchanged from the pre-test condition.Easy application of PK during mining tests, good isolation of the surface, solidification and non-flowing of the drawn composition were determined. The economic benefit expected from the application of the proposed PK-1 and PK-2 plastic compositions was 8879.84 AZN.

According to the work plan, new bactericide-inhibitors against the corrosion aggressiveness of clay solutions were tested in well No. 1191 dug in the "Pirallahi" area of the "Absheron" Production Department. The corrosion protection effect of the inhibitor was 91% and the degree of destruction of SRB was 99.0%.

Field tests of reagents “KDÇQ” and “KDİ” as inhibitors of corrosion and salt deposition were carried out in oil producing wells № 2877 and 2879 with sucker rod pumps, in field transport systems,

as well as in the reservoir pressure maintenance system of “Bibiebatneft” OGPD. It has been established that the protective effect against corrosion and salt deposition is 90% and 70%, respectively. As a result of the use of a corrosion and scale inhibitor of the “KDÇQ” brand, an economic effect of 7,120 manats was obtained.

In 2012, “KDÇQ” corrosion inhibitor was injected into 14 production wells, where 336 operations were performed during the year, resulting in an economic effect of 42236.

In production well № 3268 in operation at "Bibiheybatneft" OGPD, corrosion and salt precipitation inhibitor of "KDİ" brand and permanent magnetic couplings were applied together. As a result, the effectiveness of underground and surface equipment in oil extraction against corrosion and salt precipitation was determined to be 89% and 70%. The efficiency of application of permanent magnet coupling without inhibitor was determined to be 58% and 61%, respectively. As a result of the consumption of "KDİ" brand inhibitor at 100 mg/l and combined application with fixed magnetic couplings, it was determined that the corrosion protection efficiency was 90% and the flatness protection efficiency was 74%. 3723 manats were saved as a result of joint application of inhibitor and magnetic couplings.

Corrosion-erosion causes a decrease in the operating efficiency of the equipment used in the wells. Therefore, mining tests were conducted to study the combined effect of physical and chemical methods and the use of the new "KAB" brand inhibitor as a lubricant additive.

In order to study the joint effect of physical and chemical methods, "KAB" brand inhibitor was applied in 2012 in the production well № 3398 of "Bibiheybatneft" OGPD, together with the coupling centralizer. As a result of the joint application of the "KAB" brand inhibitor and the inter-coupling centralizer, it was determined that the protective efficiency of the inhibitor was 89%. During the application in production well № 3398 together with inhibitor coupling centralizer, it was determined that the number of repairs decreased by 6 times, the period between repairs increased by

2.5 times, and as a result, 4,972 manats of economic efficiency were obtained.

Mining tests of microemulsion developed for the purpose of impacting the bottom zone in wells working from low-permeability layers were conducted in production well № 3305 of "Bibiheybatneft" OGPD. The technology of microemulsion preparation and its injection into oil wells has been developed.

Based on the results of mining tests, it was determined that injecting the processed microemulsion into the well bottom zone created favorable conditions for the dissolution of sediments consisting of heavy carbohydrate compounds percipitants there, and a 27% increase in oil production due to a sufficient increase in the permeability of that zone also was determined. Thus, productivity was 0.8 tons/day before inhibitor injection, and 1.1 tons/day after inhibitor injection.

The mining tests of the developed new compositions were carried out in 90-95% watered wells of H.Z. Taghiyev, A. Amirov, "Bibiheybatneft", "Absheronneft" and "Siyazanneft" oil refineries. Mining tests of the developed new compositions have shown that they are economically profitable. As a result of the application, the number of repairs in the wells decreased, the interval between repairs and oil production increased.

RESULTS

1. The corrosive aggressiveness of the environment was studied in order to ensure the reliable operation of hydraulic devices and equipment operated in marine conditions and protection against corrosion in a planned manner. Based on this, the correct choice of method in regulating environmental and operational indicators was ensured.
2. During the operation of the wells, bactericidal-inhibitory compositions, which mainly consist of a mixture of technical phosphatide, acidol, isopropyl alcohol, fatty acids, soapstock, polyethylene polyamine, dimethylethanolamine, naphthenic acids, nitro alcohol, and a mixture of light and heavy gasoyl fractions, were developed agains the corrosion process.The fact that the composition of the compositions consists of complex substances gives it a multifunctional property and allows it to be used in various aggressive conditions. When the consumption of bactericidal-inhibitory compounds in various aggressive environments is 500 mg/l, the corrosion protection efficiency is 94-96%, and the SRB destruction efficiency is 98-99%.
3. New compositions consisting of technical phosphatide emulsion, polypropylene glycol cubic residue, sodium hexametaphosphate and ammofos mixtures were developed for the regulation of eco-use indicators of technological processes. At the rate of 200 mg/l consumption of compositions in an aggressive environment, the effect of corrosion protection was 94-95%, and the effectiveness of protection against salt precipitation was 86-87%.
4. Compositions based on soapstock, nitro alcohol, technical lecithin, light gasoyl fraction and also sulfonated, neutralized gasoyl fraction, carbamide, technical phosphatide emulsion were prepared against the corrosion aggressiveness of oil and water-based drilling solutions. At the consumption amount of 600-1000mg/l of the composition, the corrosion protection effect was 94-96%, and the bactericidal efficiency was 98-99%. When 1% of the compositions were added to the drilling solution as a lubricant additive, the friction coefficient decreased by 1.2-1.8 times.

5. In order to ensure corrosion protection and increase hermeticity of pump-compressor pipes, the composition are developed mainly consisting of 70/30 brand bitumen, soapstock, heavy pyrolysis resin, technical salomaz, heavy gasoil fraction, bactericide-inhibitors and a natural bitumen mixture containing sand and clay as a filler.
6. A new multi-functional composition based on sodium salts of naphthenic acid, sulfonated and neutralized gasoyl fraction, isopropyl alcohol and technical phosphatide emulsion has been developed for the protection of equipment from corrosion in the formation pressure maintenance system and complex solution for increasing oil production.The possibility of using 500mg/l of this composition in the fight against corrosion, and its 3% solution as a compression agent in oil compression was studied.
7. In order to prevent microbiological corrosion occurring in the reservoir pressure storage system and equipment operated in production wells, new bactericidal effective compositions were developed from sulfonated and neutralized gasoyl fraction, sulfanol, isopropyl alcohol, sodium salts of naphthenic acid, as well as mixtures of isopropyl alcohol, nitroalcohol, light gasoyl fraction. It has been determined that the compositions are used in the prevention of microbiological corrosion at a concentration of 500-600 mg/l.
8. A new microemulsion was developed using bactericide-inhibitor (technical phosphatide emulsion with surface-active properties, isopropyl alcohol) kerasin or light pyrolysis resin for treatment of the well bottom zone. As a result of the research, it was determined that using a 10% solution of the new microemulsion, it is possible to increase the permeability of the porous medium up to 2 times.
9. In order to protect pipes from corrosion in the underground transport system, as well as to reduce oil-water mixture viscosity , a new multi-functional composition was developed based on technical phosphatide concentrate, nitro alcohol, monoethanolamine, light pyrolysis resin and it was proposed to accept its normal consumption as 500 mg/l.
10. It has been determined that the combined effect of physical and chemical methods is more effective against the process of corrosion and salt precipitation in oil-gas-mining equipment. As a result of

research, it was determined that the consumption of inhibitors in the environment decreased by 20-25% during the combined effect of physical methods.

11. The mining tests of the developed new compositions were carried out in 90-95% watered wells of H.Z. Taghiyev, A. Amirov, "Bibiheybatneft", "Absheronneft" and "Siyazanneft" oil refineries, and as a result, the effectiveness of corrosion protection was 90-91%, and the effectiveness as a bactericide was 95- 98%. As a result of the application, the number of repairs in small production wells has decreased, the interval between repairs and oil production has increased, and reliable protection of the environment has been ensured.

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Personal contribution of the researcher in the published works:

[2,3,5,6,7,8,9,12,14,15,16,17,19,21,22,23,25,27,30,31,32, 33,34, 35, 36,38,39,40,41,42,43,44,45,46,47,48,50,52,54,55,57] issue, conduct and analysis of results in experimental studies;

Conducting investigations, summarizing and systematizing the results of the cases [1,4,10,11,13,18,20,24,26,28,29,37,49,51,53,56] cases are free;

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