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ABSTRACT

of the dissertation for the degree of
Doctor of Science

DEVELOPMENT OF THE PROTECTION METHODS AGAINST CORROSION BASED ON LIQUID RUBBER, AMIDES AND SALTS OF ORGANIC ACIDS

Specialty: 2314.01- Petrochemistry and
3321.01- Oil-gas-stone coal processing and technology

Chemistry

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INTRODUCTION

The actuality of the subject. Metal constructions exhibit thermodynamic instability due to the reduction of free energy by reacting to aggressive component of the environment, depending on operating conditions and eventually become corrosive. Corrosion of metal equipment in various fields of industries and techniques, including in the oil-gas production and processing sector leads to the environmental problems and the loss of large amounts of resources. The irreplaceability of mineral resources which are used against corrosion of metal equipment and devices shows the exceptional importance of metal corrosion protection and the importance of scientific - technical development in this area.

As a result of anthropogenic impact, contamination of the environment by aggressive components increases the corrosion of metal equipment and drastically reduces the metal stock. According to calculations by US experts, a two-fold increase in atmospheric pollution reduces the exploitation of industrial equipment by an average of 1.5 times until the first major repairs. Destruction of metal equipment and distribution of corrosion products to the environment during accidents has a very negative impact on the environment. At the same time, the use of the necessary products for the production of stainless materials and the creation of low-waste technologies for the processing of processed petroleum products is the actual scientific problem.

Corrosion processes, characterized by huge technical, economic and social losses require the creation of economically efficient and environmentally safe, highly corrosion-resistant materials. Therefore, to extend the life of metal equipment, to improve the quality and efficiency of the work in production processes, the creation of conservation liquids and lubricants are promising areas. Extensive research in the composition of conservation liquids is based on the economical efficiency and the simple application technology. Thus, the use of this method without making any changes to the existing technological system, the addition of substances with a small amount of inhibitory effect on the aggressive system protects metal for a long time in terms of corrosion. Therefore, in modern age, inhibitors that provide the passive protection method are widely used as the safest method to protect metals from corrosion.

The above-mentioned shows that, the creation of a new generation of the protection products against atmospheric corrosion and the development of the theoretical foundations of these processes are very relevant.

According to the existing environmental conditions, the preparation of conservation components with high corrosion resistance for the protection of metal equipment is very important in our republic. Considering the use of the composite-containing reagents in recent years as a corrosion inhibitor, in this area our research has been devoted to the creation of conservation liquids and lubricants containing different composition components in the form of compositions.

The purpose of the work. The purpose of the work is to prepare mineral oil distillation on the basis of liquid rubber and its oxidation product, synthesized derivatives of natural petroleum acids (amidoamines, imidazolines, alkyl-amine complexes, salts) and nitro compounds (aliphatic and light phlegm -based) and to prepare conservation liquids and lubricants in the presence of paraffin. The purpose of the work is also to investigate the theoretical foundations of the dependence of protective effect of these synergistic compositions on hetero-adsorption-active centers consisting of nitrogen and oxygen, as well as to investigate the principle of acquisition and corrosion protection.

Main provisions

- In order to create composition with liquid rubber, synthesizing polyamine derivations of NPA, mono-, di-, triethanolamine, alkyl-amine complexes, metal salts of NPA, and nitro compounds based on the appropriate reagents;
- The investigation of the various concentration solutions of compositions produced at optimum ratios on the basis of liquid rubber, polyamine derivations of NPA and nitro compounds in T-30 mineral oil distillate as a conservative liquid;

- The formulation and exploration of compositions on the basis of liquid rubber, NPA metal (Co, Ni, Zn, Mg, Ba) salts and nitro compounds;
- The investigation of the various concentration solutions of compositions produced at optimum ratios based on the oxidised liquid rubber, NPA polyamine derivations and nitro compounds in T-30 mineral oil distillate as a conservative liquid;
- The preparation and exploration of compositions on the basis of oxidised liquid rubber, NPA metal salts and nitro compounds;
- Synthesis of NPA complexes with mono-, di- and triethanolamine, dimethyl and diethyl amine, formulation and exploration of liquid rubber and oxidised liquid rubber compositions;
- Formulating lubricants of various contents by adding technical solid paraffin to conservation liquids that prepared in an optimal ratio and density based on the liquid rubber and other reagents, and examining their defence ability against corrosion.
- Studying physicochemical features of selected conservation liquids and lubricants with optimal content, determining their corrosion protection capability by various techniques, of acquisition technologies and formulation of material balance, and giving recommendations on the practical applications

The scientific novelty of the work. For the first time,

- various compositions have been made on the basis of liquid rubber, synthesized polyamine derivatives of NPA, salts, alkyl-amine complexes, mono-, di- triethanolamine complexes and nitro compounds (tetradecene and light phlegm), their T-30 mineral oil distillate and paraffin-containing solutions were developed and tested in a modern «CORROSİONBOX-1000E» experimental chamber such as conservation liquids and lubricants and high results were achieved;
- various (5, 7 and 10%) solutions of the compositions in T-30 mineral oil distillate which are formed at optimum ratios (1:1:1) based on liquid rubber, compounds obtained from the interaction of natural petroleum oils with polyethylene polyamines and nitrogen

derivatives (tetradecene and light phlegm nitro compound) have been investigated as conservation liquids and several times higher values were obtained;

- conservation liquids were prepared based on the composition of liquid rubber, metal (Co, Ni, Zn, Mg, Ca) salts of NPA and the compositions of nitro compounds (tetradecene and light phlegm - based) and they were determined to have a high corrosion protection effect;
- considering the positive effect of liquid rubber on the composition, the process was continued with oxidized liquid rubber, added as an active ingredient to the compositions and higher results were achieved;
- complexes of natural petroleum acid with mono-, di- and triethanolamine, dimethyl and diethyl amine were synthesized, compositions with liquid rubber and oxidized liquid rubber were prepared and investigated. The highest results were obtained from the studied compositions formed on the basis of the triethanolamine complex of natural petroleum acid;
- the mechanism of action of the studied compositions on the metal surface has been investigated by IR spectroscopy and the theoretical considerations regarding the formation of the protective coating have been confirmed;
- lubrication compositions have been prepared with the addition of solid n-paraffins to conservation liquids with higher performance than their analogues and have been found to be highly corrosion-protection;

Practical significance of the work. As a result of the experimental trials in the experimental chamber, it has been determined that, the prepared conservation liquids and lubricants are highly effective protective coatings, that prevent corrosion of metals in various aggressive environments and can be used as a protective surface for the metal constructions. Thus, «OLR+Amidoamine+Nitro compound» composition which showed maximum results in the group during the study protected the metal boards from corrosion for 391 days and «OLR+Imidazoline+Nitro compound» composition protected the metal boards from corrosion for 382 days. «OLR+Co salt of NPA+Nitro compound» based on oxidized liquid rubber, metal salts of NPA and the compositions of nitro-compounds had a protective effect for 387 days, «OLR+Triethanolamine complex of NPA+ Nitro compound» of the complexes of NPA with mono-, di- and triethanolamine, dimethyl and diethyl amine had a protective effect for 354 days.

The lubricatant compositions formed by adding solid n-paraffins to conservation liquids, which showed higher results than their analogs, protected the corrosion of the metal boards for a maximum of 461 days.

According to the results of the research, a principal scheme for the production of composite conservation liquids and synthesized lubricants from local raw materials has been prepared with the aim of creating temporary corrosion protective coatings at INCOR MMC, a technology park of ANAS. It has been determined that, the proposed compounds can be used in various industries, including the oil - gas extraction and processing sector for conservation of military equipment and agricultural machinery. The possibility of successful use of preserved remedies for corrosion protection of metal equipment is confirmed by the act of tests conducted by “Baku Steel Company” MMC.

The reliability of the results. The experimental process was carried out under the current standards in the «CORROSİONBOX-1000E» experimental chamber. ^{1}H NMR-, IR-, UV- -spectroscopies was used for the analysis of structural components of the initial components, conductometry for determining of dielectrical properties, derivatography - for DTA and thermogravimetric analysis, SEM - for following the metallic surfaces morphology and other physicochemical investigation methods. The accuracy of the actual results obtained by modern research methods has been proved by theoretical considerations.

The author's personal presence. The main ideas included in the dissertation, issues and their implementation, conducting of experimental tests, summarizing the results obtained, the report and publication were done by the author herself. The co-authored works also included the direction of the conducted research, the selection and justification of the issues and methods of the experiments.

Approbation of the work. The main results of the work have been reported and discussed at the following scientific conferences: "Actual problems of modern biology and chemistry" scientific-practical conference, dedicated to the 91st Anniversary of H.Aliyev (Ganja, 2014), Republican scientific-practical conference dedicated to the 100th anniversary of acad. S.C.Mehdiyev (Baku-2014), ECO-2014, 2nd International Conference on "Enercy, Regional Integration and Socio-Economic Development" (Baku 2014), III International Scientific Conference of Young Researchers, (Baku 2015), "Actual problems of modern biology and chemistry" scientific-practical conference, dedicated to the 92nd Anniversary of H.Aliyev. (Ganja, 2015) Center for Innovation in Education and Science Development, "Actual questions of natural and mathematical sciences" in the context of current development of the country (St. Petersburg-2016), IX Baku International Mamedaliyev Conference on Petrochemistry (Baku 2016), Republican scientific conference on "Macromolecular chemistry, organic synthesis and composite materials" devoted to the 50th anniversary of the Institute of Polymer Materials (Sumgait 2016), Conference dedicated to the 80th anniversary of the Institute of Catalysis and Inorganic Chemistry of ANAS named after acad. M.Naghiyev (Baku-2016), "Actual problems of modern biology and chemistry" The International Scientific Conference (Ganja, 2016). Scientific achievements of the third millennium, collection of scientific papers on materials of the VI international scientific-practical conference (Chicago 2017), International Scientific and Technical Conference dedicated to the 100th anniversary of acad. B.G. Zeynalov (Baku 2017), Scientific and Practical Conference "Defense and Security" of the Military Academy of the Armed Forces of the Republic of Azerbaijan (Baku-2017) The İnternational Scientific Conference "Actual Problems of Modern Chemistry". Dedicated to the 90th Anniversary of the Academician Y.H.Mammadaliyev İnstitute of Petrochemical Processes (Baku-2019).

Published scientific works. 47 scientific works, 25 articles, 7 conference materials and 15 thesis were published. The published works completely reflect the essence of the dissertation.

The size of the work. The dissertation consists of an introduction, 7 chapters, results and a list of literature with 330 sources. The dissertation consists of 68 figures, 5 schemes, 69 tables and 306 pages of published material.

In the introductory section the relevance of the topic, the purpose of the dissertation, the scientific novelty of the work, its practical significance, the accuracy of the results, the approbation, structure and volume of the work are justified and the essence of the chapters is summarized.

The first chapter is a literature review that contains information on atmospheric corrosion and the causes of its occurrence, protection from atmospheric corrosion through conservation components, classification of conservation liquids and origin history. The composition of modern conservation liquids has been analyzed and recent scientific literature on their mechanisms of action has been explored.

The second chapter is devoted to the research methods, to study of the physico-chemical properties of reagents required for research, confirmation of structures by spectral analysis methods, methods of determination of anticorrosion properties of oil distillates selected as a solvent medium and the working principle of the device used to determine the corrosion protection effect. NMR, IR, UV spectroscopy, derivatography, conductometry and other physical-chemical research methods were widely used in the research.

Chapter three is devoted to the synthesis of components for oil-based conservation liquids, the creation of compositions in various compounds and combinations, the preparation of conservation compounds in various concentrations in the oil distillate. Amidoamines, imidazolines, alkyl-amine complexes of NPA, metal salts of NPA and nitro compounds (tetradecene and light phlegm - based) were synthesized on the basis of the selected reagents. Their contents are confirmed by modern physical - chemical and spectroscopic methods. The compositions in the ratio of 1: 1: 1 were prepared on the basis of liquid rubber and synthesized components. The determination of these solutions, their specific resistance (specific electrical conductivity) and mass variations depending on temperature have been identified by differential thermal analysis.

Chapter Four is about analyzing the results of the effects of corrosion protection on the metal boards of corrosion liquids created on the synthesized various components and liquid rubber. Given the positive effect of the liquid rubber on the composition, the process was followed by oxidized liquid rubber. The results of the study were analyzed comparatively and found that, the advantage of the components of the same class was: oxidized liquid rubber in relation to liquid rubber; amidoamines in the composition of nitrogen-containing organic compounds; light phlegm- based nitro compound. Research results of liquid rubber as additive were discussed.

Chapter five deals on the preparation and investigation of lubrication compositions by adding solid paraffin to highly effective samples such as conservation liquid. As a result of experiments with conservation lubricants, it was found that, lubricants have a higher protection effect than conservation liquids. Samples of oxidized liquid rubber, amidoamine and light phlegm - based nitro compounds show higher results compared to the lubricant compositions.

Chapter six investigates the corrosion protection mechanisms of the coating compositions by researching the adsorption of conservation compositions to the metal surface and determining the dependence of the corrosion protection effect on the metal coating compounds. At the same time, this chapter completes the process of mathematical optimization of the experimental results in the study of conservation liquids. It was found that, the difference between the results was 3.7-5% and it confirms the accuracy of the experimental results in the range of 95-96.3%.

Chapter seven illustrates the role of corrosion protection of the metal constructions in the solution of environmental problems, the formulation of the optimal composition of conservation liquids and lubricants in the form of various compositions, the use of the acquisition principle.

The material balance is compiled for the synthesis during the study. Technical - economic assessment has been carried out for the proposed production process and the cost of raw materials. The economic benefits of the process are calculated and shown.

The results reflecting the essence of the research, a list of references and the acts confirming the industrial tests are given at the end of the dissertation.

SUMMARY OF THE WORK

In the presented work, the compositions of various components in the presence of liquid rubber and oxidized liquid rubber were prepared and conservation compositions as a solvent medium were created on the naphtha-based T-30 oil distillate obtained from the "Azerneftyag" oil refinery factory (ORF).

The compositions were prepared by adding the synthesized derivatives (amidoamines, imidazolines, alkyl-amine complexes, salts) of natural petroleum acid and nitro compounds (aliphatic and light phlegm - based) to the liquid rubber (on the basis of 1.4-cis-polybutadiene with stereoregulatory structure with wide application field in industry). The physical - chemical properties and the structural composition required for conservation liquids of both primary components and compositions were analyzed by using appropriate methods. As a result of synthesis: polyamine derivatives of natural petroleum acid, alkyl-amine and mono-, di-, triethanol amine complexes, metal salts soluble in organic solvents, tetradecene and light phlegm - based nitro compounds were obtained. 5, 7 and 10% solutions of the compositions based on synthesized 25 inhibitory components were tested in T-30 oil distillate on standard metal boards in the experimental chamber. The lubricant compositions were created by adding 10% technical solid paraffin to the samples with high corrosion resistance and the corrosion protection of the metal boards was 461 days. The mechanism of action of the studied compositions on the metal surface was investigated by IR spectroscopy and confirmed the protective coating on the surface. Considering the adhesion properties of high-viscosity liquid rubber, it has been used as an additive to enhance the exploitation properties of bitumen in the study and favorable results have been obtained.The thermostability, identity, dielectric properties of compositions have been investigated and corrosion protection mechanisms have been justified by theoretical interpretations via IR-spectroscopy method. Taking into account the conservation contents, which are derived from the local raw materials, have industrial importance, economic benefits of the process have been determined through technical-economic assessment.

Synthesis of corrosion inhibitors for conservation liquids and the creation of oil - based compositions with their presence.

In order to achieve the goal of dissertation work the researches were conducted in two directions:

1) Preparation of the compositions based on amidoamines, imidazolines obtained from liquid rubber and the interaction of natural petroleum acid (NPA) with polyethylene polyamines (PEPA, DETA, TETA); alkyl-amine, mono-, di-, triethanolamine complexes of NPA and nitro compounds (tetradecene and light phlegm based)

2) Preparation of the compositions based on liquid rubber, metal (Co, Ni, Zn, Mg, Ca) salts of NPA soluble in organic solvents, $C_{14}H_{28}$ and LP nitro derivatives.

Nitrogen-organic derivatives, salts of NPA and nitro compounds were synthesized on the basis of the corresponding reagents for the preparation of conservation liquids and lubricants in both directions and a liquid rubber composition was created.

The components those have been used for producing conservation liquids are cost effective and environmentally – friendly, on the other hand, they have simple manufacturing technology and rich feedstock.T-30 oil, additives which are used as inhibitors and liquid rubber which are used in the reaction medium are produced on the basis of the feedstock which have enough reserves. Distillate being naphthenic based minimizes the amount of combination that contains carcinogen which is ecologically crucial. Production cost being more than twice as cheap as T-30 oil price enhances its industrial significance.

In order to improve the functionality, stability, viscosity and adhesion properties, liquid rubber has been used as a component in the investigation, taking into consideration of its applicability, due to the high-molecular weight and diversified structures. The key indicators of the technological properties of liquid rubber are significant for oil based conservation liquids.

The liquid rubber which is used in the process has been synthesized on the basis of stereo regular structured 1,4 cis – polybutadiene (low molecular weight, M_r ~5000-10000), which has a wide range of industrial application microstructure: 1,4 cis-75~80% ; 1,4 trans-18~22% ; 1,2-units-2~7%, number of units~80). The cis-position of the methyl groups in liquid rubber facilitates the adsorption on the metal surface.

Taking into account the effective outcomes of nitrogen-organic derivations as a corrosion inhibitor, in the investigation of ours, amidoamin and imidazoline compounds that are synthesized from NPA and polyamines have been used as a component to the conservation liquids.

Nitro compounds by the superior ability of chemisorption on the metal surface and producing stronger coating for protection from corrosion of these complexes. On the other hand, these compounds are stronger ligands than the water that is why they can substitute water molecules from the surface of the metal and create strong protection layer.In the synthesis of nitrocompounds that are used as corrosion inhibitors and conservative liquids, light phlegm that is derived from catalytic cracking and aliphatic based α-olefins have been used as a source of raw material.

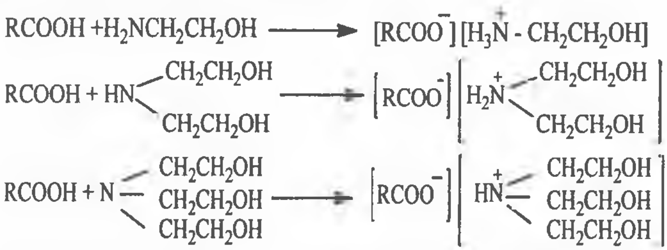
In the research, the selection of NPA as a component is because of its composition with polyamines that creates amidoamine and imidazole compounds and multifunctional metal salts which are highly effective corrosion inhibitor. Synthesis of salts on the basis of naphthenic acids that have enhanced raw material reserve and formulation of conservation liquids based on those salts is substantial in terms of both scientific and practical perspective.

The NPA which is used in the process has been obtained by the dearomatization of the diesel fraction with the boiling range of 220-

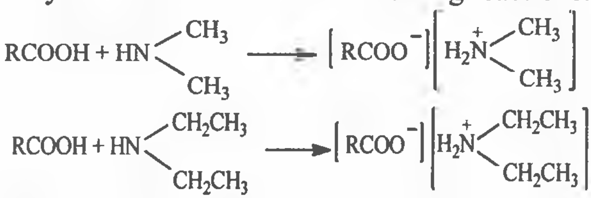
350^0 C. The phisical and chemical properties of the fraction which is obtained from the extraction process were like this: ρ_4^{20}= 0,8294 g/cm^3; n_d^{20}=1,4677; $M_в$ = 187; freezing point = -51°C; boiling point = 220-340°C, kinematic viscosity at 20°C ~5.52 mm^2/sec, total sulfur content~ 0,03%, the amount of aromatic hydrocarbos ~1% .

25 inhibitory substances containing heteroadsorption centers, such as nitrogen and oxygen were synthesized as a result of the synthesis of the study.

The general scheme of the synthesis of mono-, di-, triethanolamine complexes of NPA:



The dimethylamine and diethyl amine complexes of NPA have been synthesized based on the following reactions:

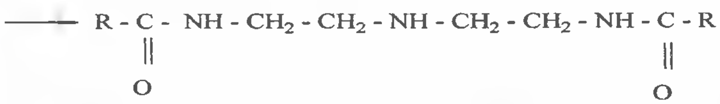


Below are some examples of DETA, TETA, and PEPA reactions with NPA for the synthesis of amidoamine in different mol ratios:

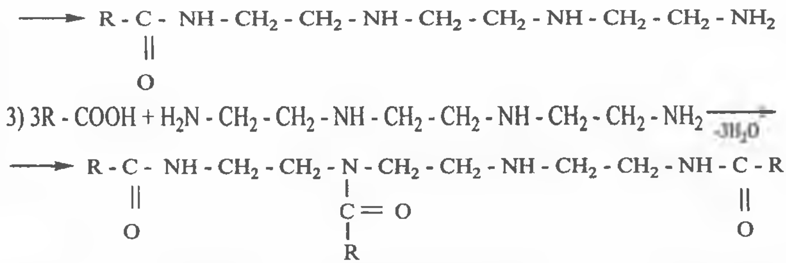
1) $RCOOH + NH_2 - CH_2 - CH_2 - NH - CH_2 - CH_2 - NH_2 \xrightarrow[-H_2O]{}$

$\longrightarrow R - C(=O) - NH - CH_2 - CH_2 - NH - CH_2 - CH_2 - NH_2$

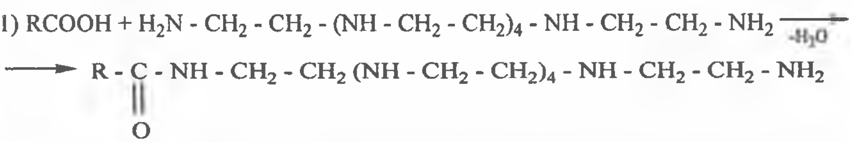
2) $2R - COOH + NH_2 - CH_2 - CH_2 - NH - CH_2 - CH_2 - NH_2 \xrightarrow[-2H_2O]{}$



Scheme of NPA reaction with triethylentetraamine (TETA) in the ratio of 1:1 and 3:1 mol for the synthesis of amidoamines:

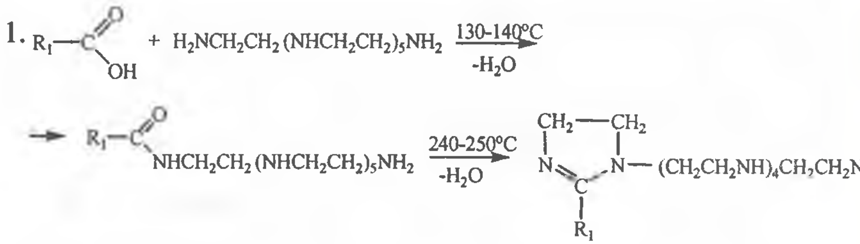


Scheme of the synthesis of NPA with polyethylene polyiamine (PEPA) in the ratio of 1:1 mol:



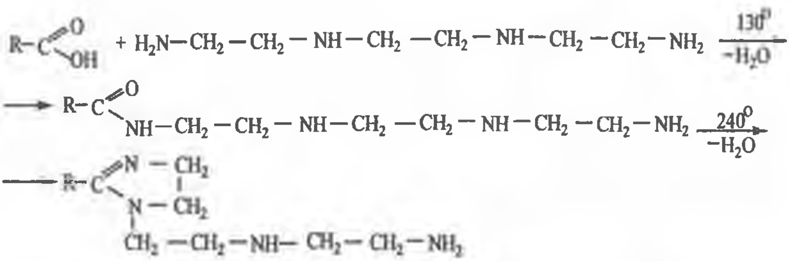
The number of amide functional groups in the synthesized amidoamines increases by increasing the concentration of the acid in the process. Increased acid consentration in the processes also results in an increase in the number of amide groups as a functional group in the synthesized amidoamines.With the investigation purpose, the physicochemical features of synthesized amidoamines, containing free amine group have been explored and their efficacy as an inhibitor which has dependency on the mole ratio of polythylene polyamine has been determined. Experiments demonstrate that with the increasing mole ratio of amidoamines taken from diethylene triamine, tetrathylene tetraamine and higher mole ratio polyethylene polyamines, its efficiency also rises.

The production of imidazolines based on the interaction of polyamines with NPA follows the following scheme:

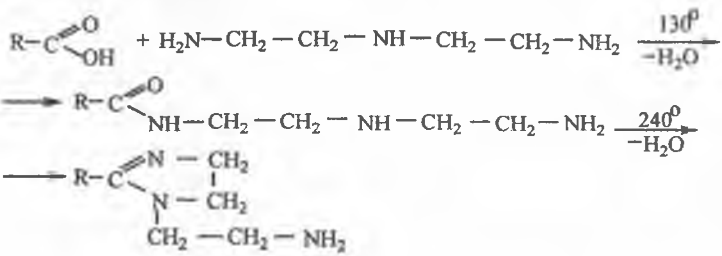


The reaction shown above shows the scheme of the getting of imidazoline from the interaction of NPA with polyethylene polyiamine (PEPA) in the ratio of 1:1 mol.

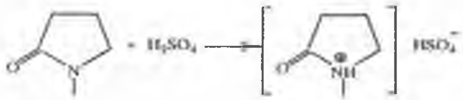
2. Scheme of the getting of imidazoline from the reaction of NPA with triethylentetraamine (TETA):



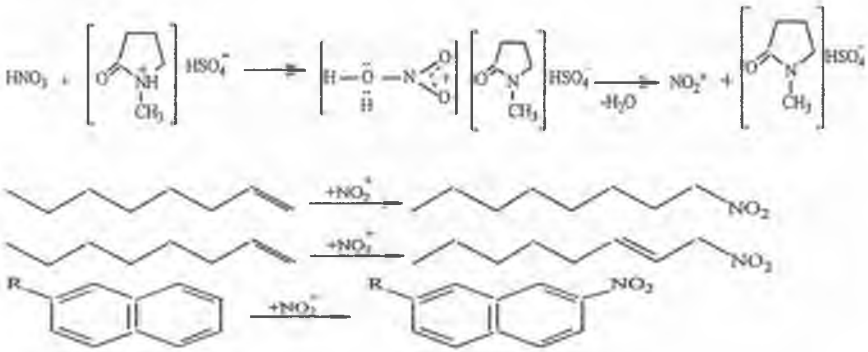
3. Scheme of the getting of imidazoline from the reaction of NPA with dietylentriamine in the ratio of 1:1 mol:



In the presented work, N-methylpyrrolidone hydrosulfate ($[NMP]^+[HSO_4]^-$) ionic liquid was used as a catalyst for the reaction of nitrolysis of light phlegm. The synthesis of ionic liquid due to the interaction of N-methylpyrrolidone and sulphate acid is given below:



The mechanism of the nitrolysis reaction ends in the following scheme:



25 inhibitory substances containing heteroadsorption centers, such as nitrogen and oxygen were synthesized as a result of the synthesis of the study. In the ratio of 1:1:1 the compositions of nitrogen-containing organic derivatives, nitro compounds and metal salts soluble in organic solvents with liquid rubber and oxidized liquid rubber were prepared for use as a component for conservation liquids.

In order to simplify the investigation conditions and analysis of results, the compositions have been classified as in the following:

1) Liquid rubber and of NPA to polyamines the synthesis of amidoamines
2) Liquid rubber, Amidoamines and tetradecene based nitro compounds
3) Liquid rubber, Amidoamines and light phlegm based nitro compound
4) Oxidized liquid rubber, Amidoamines and tetradecene based nitro compound
5) Oxidized liquid rubber, Amidoamines and light phlegm based nitro compound
6) Liquid rubber and of NPA to polyamines the synthesis of

imidazolines

7) Liquid rubber, imidazolines and tetradecene based nitro compound
8) Liquid rubber, imidazolines and light phlegm based nitro compound
9) Oxidized liquid rubber, imidazolines and tetradecene based nitro compound
10) Oxidized liquid rubber, imidazolines and light phlegm based nitro compound
11) Liquid rubber, of NPA mono-, di- triethanolamine complexes and tetradecene based nitro compound
12) Liquid rubber, of NPA mono-, di- triethanolamine complexes and light phlegm based nitro compound
13) Liquid rubber, of NPA dimethyl and diethyl amine complexes and tetradecene based nitro compound
14) Liquid rubber, of NPA dimethyl and diethyl amine complexes and light phlegm based nitro compound
15) Oxidized liquid rubber, of NPA mono-, di- triethanolamine complexes and tetradecene based nitro compound
16) Oxidized liquid rubber, of NPA mono-, di- triethanolamine complexes and light phlegm based nitro compound
17) Oxidized liquid rubber, of NPA dimethyl and diethyl amine complexes and tetradecene based nitro compound
18) Oxidized liquid rubber, of NPA dimethyl and diethyl amine complexes and light phlegm based nitro compound
19) Liquid rubber and metal salts of NPA
20) Liquid rubber, metal salts of NPA and tetradecene based nitro compound
21) Liquid rubber, metal salts of NPA and light phlegm based nitro compound
22) Oxidized liquid rubber, metal salts of NPA and tetradecene based nitro compound
23) Oxidized liquid rubber, metal salts of NPA and light phlegm based nitro compound.

The physical and chemical properties of the produced compositions have been studied and the morphology of inhibited carbon steel surface was analyzed and characterized by Fourier transform-infrared (FT-IR) and scanning electron microscopy (SEM) techniques. The effect of the temperature on the inhibition efficiency, various thermodynamic parameters were also calculated to investigate the mechanism of corrosion inhibition.

The physical - chemical properties of some samples of the compositions based on liquid rubber, amidoamines and nitro compounds are analyzed and shown inTable 1.

Table 1. The basic physical - chemical parameters of conservation liquids

Name of the property	Name of the device	ASTM	Samples			
			1	2	3	4
Freezing point. °C	Stanhope Seta	ASTM D2386	-25	-28	-30	-30
Viscosity, mm^2/s ,°C40	TW4000	ASTM D445	53.99	65.59	56.47	65.3
Viscosity, mm^2/s,C100	TW4000	ASTM D445	7.63	8.64	7.98	8.51
Density, g/cm^3	DMA 4500 M	D5002	0.9090	0.9058	0.9093	0.9042

Compound of samples:

1.T-30 oil + liquid rubber+ amidoamine (NPA:PEPA 2:1)+ nitro compound

2.T-30 oil +liquid rubber+ amidoamine (NPA:DETA 2:1)+ nitro compound

3.T-30 oil+ liquid rubber+ amidoamine (NPA:TETA 3:1)+ nitro compound

4.T-30 oil+ liquid rubber+ amidoamine (NPA:PEPA 5:1)+ nitro compound.

The physical - chemical properties for the protection effect of conservation liquids have been investigated and homogeneity has been confirmed by IR spectroscopy. The termogravimetric (TG) analysis of the prepared conservation liquids and the mass variation depending on the temperature, the description of the differential thermal analysis (DTA) are given.

The dependence of the change in the mass loss on the temperature is given in the Table 2. The process was carried out under nitrogen gas flow and temperature increase by 20°C per minute. The mass taken for analysis of the sample was 13.5 mg.

Sample 1.«T-30 oil dist.+LR+Amidoamine(NPA+PEPA 2:1)+nitro compound»

Table 2.

Temp . °C	The mass loss, mg	The mass loss, %
100	0	–
120	0	–
140	0.2	1.48
160	0.6	4.44
180	0.8	5.92
200	1.0	7.40
220	1.8	13.30
240	2.6	19.25
260	5.0	37.03
280	7.0	51.85
300	9.0	66.60
320	10.6	78.51
340	11.2	82.90
360	11.2	82.90
380	11.6	85.92
400	11.6	85.92
420	11.6	85.92
460	12.4	91.85
480	12.9	94.80

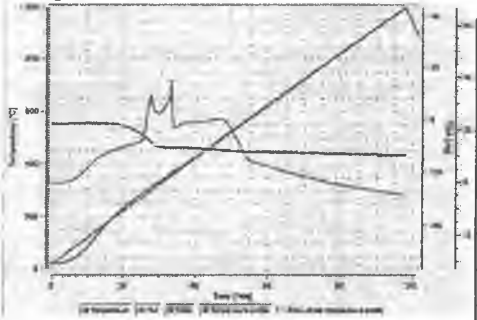
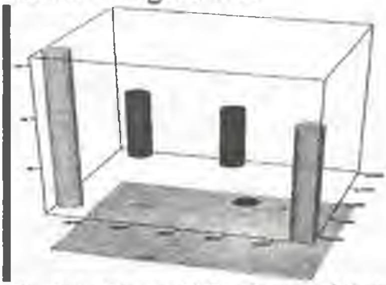


Figure1. TG /DTA curve of example 5.

The intensity of the loss of melted mass in the TG curve is observed after the temperature of 220°C, that is, the composition retains thermostability to this temperature. The peak temperature at the DTA is between 340 and 400°C. At this temperature, the mass loss is ~ 82% and ~ 85%, respectively. Because of the uniform distribution of the components in the T-30 oil distillate medium and thermostability property of the amidoamine, conservation liquids can be utilized for a long time without losing quality. The curve for the mass loss is observed in the TG curve which proves the homogeneity of the composition.

5 different points were selected on a given sample to determine the identity of conservation liquids and weighed the IR spectra separately. (amidoamine(NPA:PEPA2:1)+nitro compound

($C_{14}H_{28}$)+MK) conservation composition showed the corresponding spectra of wavelengths compatible to different groups during spectral analysis. Microscopic figures and spectra of the studied sample are shown in Figure 1-6:



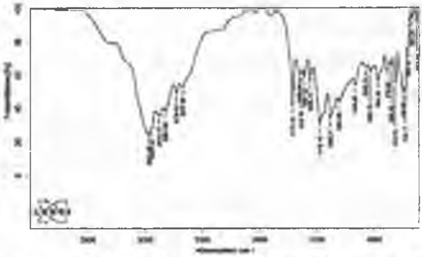
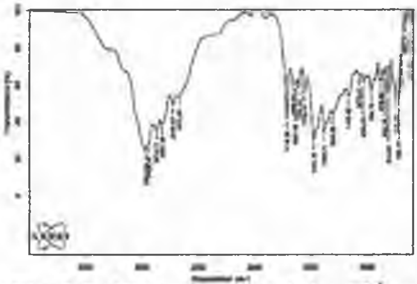


Fig.2.1. Space(3D) form of dots on a sample. Fig.2.2. IR spectrum of the 1st point.



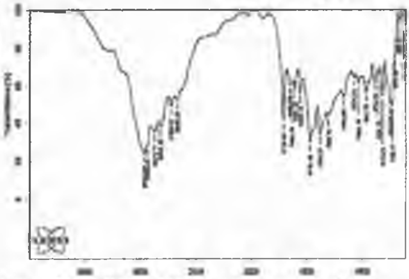
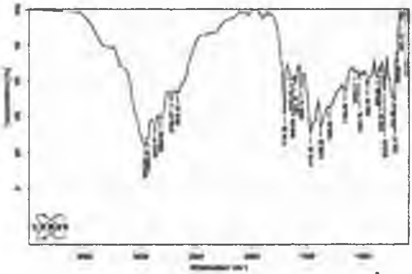


Fig.2.3. IR spectrum of the 2nd point Fig.2.4. IR spectrum of the 3rd point



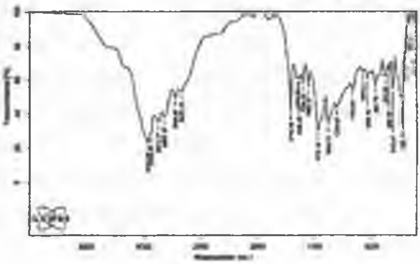


Fig.2.5. IR spectrum of the 4th point Fig.2.6. IR spectrum of the 5th point

The valence and deformation oscillations of CH_3 and CH_2 groups were observed at a wavelength of 721, 1380, 1470, 2827, 2873, 2939 and 2967 cm^{-1} in the IR spectra of the 1^{st} point. At the same time, the deformation oscillations of C–H bond of CH_2 naphthenic group were observed at a wavelength of 966 cm^{-1}. The valence oscillations of $C–NO_2$ group were observed at a wavelength of 1531 and 1558 cm^{-1} and C=O group which belongs to amidoamines show valence oscillations at a wavelength of 1708cm^{-1}.

When comparing the IR spectra of points 1, 2, 3, 4, and 5 on the sample, they appear to be virtually identical, thus ensuring that conservation material is uniformly distributed on the metal surface.

Conservation liquids consisting of 2 and 3 compounds, including amidoamine, liquid rubber and nitro compounds (tetradecene and LP-based) were prepared separately and in different combinations and the results were investigated. The experiments were carried out within the existing standards in the experimental chamber «CORROSİONBOX-1000E». Based on these parameters, the experiments were conducted in two phases in the experiment chamber: the condensation phase and the environmental phase. The standard settings for continuous testing in the experimental chamber are adjusted by electronic devices.

The experiments were carried out with «08Ю» (QOST 4041-71) carbon steel specimens. The mainly chemical composition (wt%) of the carbon steel was listed as follows: C%~0.07; Si%~0,01; Mn%~0.2-0.35; Ni%~0.06; S%~0.025; P%~0.02; Cr%~0.03; Al%~0.02-0.07; Cu%~0.06; Fe balance. The carbon steel plates were prepared, degreased and cleaned with deionized water and alcohol.

The test results of liquid rubber, amidoamines and tetradecene-based nitro compound in the form of individual and composition as conservation liquids are presented in Tab. 3. As can be seen from the table 3, the metal boards are protected against corrosion for 41 and 73 days during the individual protection of T-30 oil distillate and liquid rubber. These indicators are quite high in the presence of the inhibitor. Thus, 10% of the inhibitor (Sample5 - Liquid rubber + Amidoamine (NPA:PEPA 2:1) + $C_{14}H_{28}$ Nitro compound), which showed the highest efficiency in this group continued the process of corrosion protection of the metal boards in the condensation phase for 289 days and in the environmental phase for 386 days.

Table 3. The test results of liquid rubber, amidoamines and nitro compounds ($C_{14}H_{28}$) in the form of individual and composition as conservation liquids.

Solution of the compositions in T-30oil distillate			The duration of corrosion protection, days	
Composition	The amount of the components in the solution%		Condensation phase	Environmental phase
	Inhibitor	Solution		
Liquid rubber	-	10	41	73
$C_{14}H_{28}$ nitro compound	-	10	74	108
Liquid rubber AmidoamineNPA:PEPA 1:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	179	265
Liquid rubber Amidoamine NPA:PEPA2:1	5 5	10	89	128
Liquid rubber Amidoamine NPA:PEPA2:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	**289**	**386**
Liquid rubber Amidoamine NPA:PEPA3:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	271	344
Liquid rubber Amidoamine NPA:PEPA4:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	266	338
Liquid rubber Amidoamine NPA:PEPA5:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	281	356
Liquid rubber Amidoamine(NPA:TETA2:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	296	363
Liquid rubber AmidoamineNPA:DETA2:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	281	346

Note:. *The ratios of 1:1 and 2:1 and so on. show the ratio of NPA to polyamines during the synthesis of amidoamines.*

By analyzing the results in the table, we can conclude that, the test results of liquid rubber, amidoamines, and nitro compounds ($C_{14}H_{28}$) in the form of composition as conservation liquids are higher than the standard requirement. It should be noted that, the corrosion protection of the metal boards is 90 days in accordance with QOST 9054-75 which is based in our country.

It was determined that, the protective effect of conservation liquids which is created in the form of composition is much higher than that of conservation liquids with individual inhibitors.

The dependence of the test results of conservation liquids on the inhibitor intensity is graphically summarized below:

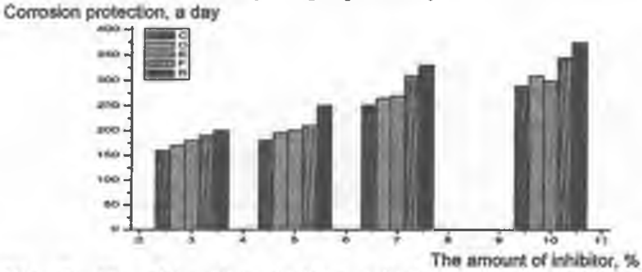


Fig 3. Graphic description of the test results of amidoamines as conservation liquid in the form of the composition.

B- LR+Amidoamine (NPA:PEPA2:1)+ $C_{14}H_{28}$ nitro compound

F- LR +Amidoamine (NPA:DETA2:1)+$C_{14}H_{28}$ nitro compound

E- LR +Amidoamine (NPA:PEPA3:1)+ $C_{14}H_{28}$ nitro compound

D- LR +Amidoamine (NPA:TETA2:1)+ $C_{14}H_{28}$ nitro compound

C- LR +Amidoamine (NPA:DETA3:1)+ $C_{14}H_{28}$ nitro compound

As can be seen from the graph, an increase in inhibitor concentration (within 10% of the limit) increases the protective effect.

The second type of the reagent which is tested as an inhibitor in conservation liquid is the complex of light phlegm-based nitro compound with amidoamines synthesized by the interaction of natural petroleum acid with polyethylene polyamines (Tab. 4).

As shown in Tab.4, the metal boards are protected against corrosion for 91 and 183 days during the individual protection of T-30 oil distillation and light phlegm - based nitro compound. These indicators are quite high in the presence of conservation liquid. Thus, 10% of the inhibitor, which showed the highest efficiency in this group (Sample 3-Liquid Rubber+Amidoamine (NPA:PEPA 2:1)+LP Nitro compound) continued the process of corrosion protection of the metal boards for 307 days in the condensation phase and for 391 days in the environmental phase.

Table 4. The test results of conservation liquids based on liquid rubber, amidoamines and LP nitro compound.

Solution of the compositions in T-30 oil distillate			The duration of corr. protection, by days	
Composition	The amount of the components in the solution%		Condensa -tion phase	Environ-mental phase
	Inhibi-tor	Soluti-on		
LP nitro compound	5 5	10	91	183
Liquid rubber AmidoamineNPA:PEPA1:1 LP nitro compound	3,33 3,33 3,33	10	195	287
Liquid rubber Amidoamine NPA:PEPA2:1 LP nitro compound	3,33 3,33 3,33	10	**307**	**391**
Liquid rubber AmidoamineNPA:PEPA 3:1 LP nitro compound	3,33 3,33 3,33	10	281	354
Liquid rubber Amidoamine NPA:PEPA4:1 LP nitro compound	3,33 3,33 3,33	10	278	346
Liquid rubber Amidoamine NPA:PEPA5:1 LP nitro compound	3,33 3,33 3,33	10	294	374
Liquid rubber Amidoamine NPA:TETA1:1 LP nitro compound	3,33 3,33 3,33	10	295	386
Liquid rubber Amidoamine NPA:DETA2:1 LP nitro compound	3,33 3,33 3,33	10	293	371

It has been determined that, the protection effect of conservation liquids which is created by compositions of light phlegm - based nitro compound is higher than that of standard tetradecene-based conservation liquids. Note that, during the individual protection of tetradecene-based nitro compound, the protective effect of the metal boards was 74 days in the condensation phase and 108 days in the environmental phase, light phlegm - based nitro compound 91 and 183 days. This difference in the individual protection of nitro compound is also reflected in the compositions.

The test results of liquid rubber, imidazolines, and $C_{14}H_{28}$ nitro compounds in the form of individual and composition as conservation liquids are given in Table 5.

Table 5. The test results of LR, imidazolines, and $C_{14}H_{28}$ nitro compounds in the form of individual and composition as conservation liquids

Solution of the compositions in the oil distillate T-30			The duration of corr. protection, by days	
Composition	The amount of the components %		Condensa -tion phase	Environ-mental phase
	Inhibitor	Soluton		
Liquid rubber ImidazolineNPA:PEPA 1:1	5 5	10	71	118
Liquid rubber ImidazolineNPA:PEPA 1:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	265	321
Liquid rubber ImidazolineNPA:PEPA 2:1	5 5	10	76	121
Liquid rubber Imidazoline NPA:PEPA2:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	**278**	**364**
Liquid rubber ImidazolineNPA:TETA1:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	263	308
Liquid rubber İmidazolineNPA:TETA2:1 $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	256	324

As shown in Table 5, the metal boards are protected against corrosion for 71 and 118 days during the individual protection of Liquid rubber+ Imidazoline (NPA:PEPA 1:1). The experimental process continued for 278 days in the condensation phase with 10% of conservation liquid (Sample 8-Liquid Rubber+Imidazoline (NPA:PEPA 2:1)+$C_{14}H_{28}$ Nitro compound), which showed the highest efficiency and in the environmental phase for 364 days.

It has been determined that, the protection effect of conservation liquids obtained by amidoamine compounds is much higher than the indicators of conservation liquids obtained by imidazoline. The dependence of the test results of conservation liquids on the inhibitor intensity is graphically summarized below:

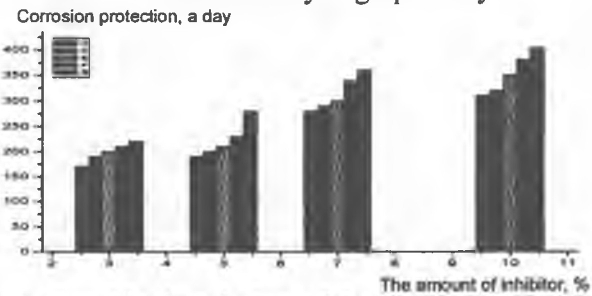


Figure 4. Graphic description of the test results of conservation liquids containing liquid rubber, imidazoline and $C_{14}H_{28}$ nitro compound.
B-Liquid rubber + Imidazoline (NPA:PEPA2:1) + nitro compound
F-Liquid rubber + Imidazoline (NPA:PEPA 3:1) + nitro compound
E-Liquid rubber + Imidazoline (NPA:DETA 2:1) + nitro compound
D-Liquid rubber + Imidazoline (NPA:TETA 1:1) + nitro compound

Another reagent which is tested as an inhibitor in conservation liquid is a complex of imidazolines with light phlegm-based nitro compound. As can be seen from Tab.6, the metal boards are protected against corrosion for 107 and 201 days during the individual protection of «liquid rubber+light phlegm nitro compound» composition. In this group, the protection of conservation liquid which has the highest efficiency in a 10% of concentration of «Liquid Rubber+Imidazoline (NPA: PEPA 2:1)+LP nitro compound» continued for 293 days in the condensation phase and 382 days in the environmental phase. It has been determined that, the protection effect of conservation liquids created by LP nitro compound compositions with imidazolines is higher than the indicators of conservation liquids of tetradecene-based nitro compound.

Table 6. The test results of conservation liquids based on liquid rubber, imidazolines and LP nitro compound.

Solution of the compositions in T-30 oil distillate			The duration of corr. protection, by days	
Composition	The amount of the components %		Condensation phase	Environmental phase
	Inhibitor	Solution		
Liquid rubber LP nitro compound	5 5	10	107	201
Liquid rubber ImidazolineNPA:PEPA1:1 LP nitro compound	3,33 3,33 3,33	10	244	317
Liquid rubber Imidazoline NPA:PEPA2:1 LP nitro compound	3,33 3,33 3,33	10	**293**	**382**
Liquid rubber Imidazoline NPA:PEPA3:1 LP nitro compound	3,33 3,33 3,33	10	231	314
Liquid rubber ImidazolineNPA:TETA1:1 LP nitro compound	3,33 3,33 3,33	10	265	327
Liquid rubber ImidazolineNPA:TETA2:1 LP nitro compound	3,33 3,33 3,33	10	269	348
Liquid rubber ImidazolineNPA:TETA2:1 LP nitro compound	3,33 3,33 3,33	10	258	324
Liquid rubber ImidazolineNPA:DETA1:1 LP nitro compound	3,33 3,33 3,33	10	264	325

The following compositions tested as conservation liquid are: composition of mono-, di-, triethanol amine and dimethyl, diethyl amine complexes of NPA with liquid rubber and nitro compounds.

Table 7. The test results of LR, amino complexes of NPA and $C_{14}H_{28}$ nitro compound in the form of composition as conservation liquids

Solution of the compositions in T-30 the oil distillate			The duration of corr. protection, by days	
Composition	The amount of the components, %		Condensa-tion phase	Environ-mental phase
	Inhibitor	Solution		
Liquid rubber NPA:monoethanolamine	5 5	10	40	76
Liquid rubber NPA: monoethanolamine $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	171	259
Liquid rubber NPA: diethanolamine $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	186	264
Liquid rubber NPA:triethanolamine	5 5	10	56	87
Liquid rubber NPA:triethanolamine $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	**249**	**311**
Liquid rubber NPA: dimethylamine	5 5	10	43	71
Liquid rubber NPA: dimethylamine $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	149	235
Liquid rubber NPA: diethylamine comp.	5 5	10	45	78
Liquid rubber TNT: diethylamine comp. $C_{14}H_{28}$ nitro compound	3,33 3,33 3,33	10	182	287

As can be seen from the table, the metal boards are protected from corrosion for 40 and 76 days during the individual protection of the «liquid rubber+NPA:monoethanolamine complex» composition. In this group, the experimental process continued to protect the metal boards from corrosion in the condensation phase for 249 days and in the environmental phase for 311 days in a 10% concentration of conservation liquid (Liquid rubber+ NPA:triethanolamine complex + $C_{14}H_{28}$ nitro compound).Analysis of the results of alkylamine complexes of NPA shows that, the results of the dietylamine complex are higher than that in both binary and triple compositions. Thus, the composition "liquid rubber + NPA: diethylamine complex" protects against the corrosion of metal samples for 78 days in the atmospheric phase, "liquid rubber + NPA: diethylamine complex + $C_{14}H_{28}$ nitrocompound" in that phase for 287 days.

The test results of conservation liquids based on liquid rubber, mono-, di-, triethanol and dimethyl, diethyl amine complexes of NPA and LP nitro compound are shown in Table 8:

Table 8. The test results of LR, amino complexes of NPA and LP nitro compound in the form of composition as conservation liquids

Solution of the compositions in T-30 oil distillate			The duration of corr. protection, by days	
Composition	The amount of the components, %		Condensa-tion phase	Environ-mental phase
	Inhibitor	Soluti on		
Liquid rubber NPA:monoethanolamine LP nitro compound	3,33 3,33 3,33	10	176	264
Liquid rubber NPA: diethanolamine LP nitro compound	3,33 3,33 3,33	10	189	278
Liquid rubber NPA: triethanolamine LP nitro compound	3,33 3,33 3,33	10	**251**	**324**
Liquid rubber NPA: dimethylamine LP nitro compound	3,33 3,33 3,33	10	159	237
Liquid rubber NPA: dimethylamine LP nitro compound	3,33 3,33 3,33	10	159	237
Liquid rubber NPA: diethylamine LP nitro compound	3,33 3,33 3,33	10	187	296

As can be seen from the table, the metal boards are protected from corrosion for 51 and 86 days during the protection of the composition of «liquid rubber+NPA:monoethanolamine complex». In this group, the experimental process continued for 251 days to protect the metal boards from corrosion in the condensation phase with a 10% concentration of conservation liquid (Liquid Rubber+NPA:Trietanolamine complex+LP nitro compound) and for 324 days in the environmental phase. It has been determined that, the protection effect of conservation liquids based on the compositions of LP nitro compound of amino complexes is higher than that of the indicators of conservation liquids based on the tetradecene-based nitro compound.

The next reagent composed of liquid rubber in the composition of conservation liquid is a complex of metal salts and nitro compounds of natural petroleum acid.

The test results of conservation liquids which is prepared by liquid rubber, metal salts of NPA and the compositions of tetradecene-based nitro compound are given in Table 9.

Table 9. The test results of conservation liquids consisting of LR, metal salts of NPA and $C_{14}H_{28}$ nitro compound.

Solution of the compositions in T-30 oil distillate			The duration of corrosion protection,	
Composition	The amount of the components , %		Condensa-tion phase	Environ-mental phase
	Inhibitor	Solution		
Ni salt of NPA Liquid rubber	5 5	10	89	132
Ni salt of NPA $C_{14}H_{28}$Nitro comp. Liquid rubber	3,33 3,33 3,33	10	241	314
Co salt of NPA Liquid rubber	5 5	10	98	165
Co salt of NPA $C_{14}H_{28}$Nitro comp. Liquid rubber	3,33 3,33 3,33	10	**276**	**362**

Continuation of Table 9.

Zn salt of NPA Liquid rubber	5 5	10	78	151
Zn salt of NPA $C_{14}H_{28}$Nitro comp. Liquid rubber	3,33 3,33 3,33	10	223	312
Mg salt of NPA Liquid rubber	5 5	10	71	142
Mg salt of NPA $C_{14}H_{28}$Nitro comp. Liquid rubber	3,33 3,33 3,33	10	192	256
Ca salt of NPA Liquid rubber	5 5	10	67	134
Ca salt of NPA $C_{14}H_{28}$Nitro comp. Liquid rubber	3,33 3,33 3,33	10	241	286

As can be seen from the table, the effectiveness of conservation liquids to protect against corrosion based on mixed complexes of metal salts of NPA with nitro compounds is higher than expected. Thus, the experimental process continued for 276 and 362 days in a 10% concentration of the inhibitor «Co salt of NPA+Nitro compound (based on $C_{14}H_{28}$) » which showed maximum efficiency.

The test results of conservation liquids prepared by liquid rubber, metal salts of NPA and the compositions of LP-based nitro compound are shown in Table 10.

As can be seen from the Table 10, the experimental process continued to protect the metal boards from corrosion in the condensation phase for 281 days and in the environmental phase for 378 days in a 10% concentration of the composition (Liquid Rubber+Co salt of NPA+LP nitro compound).

It was determined that, the test results of conservation liquids consisting of metal salts of NPA and the composition of LP nitro compound are higher than the composition of that compound with tetradecene-based nitro compound.

Table 10. The experimental results of conservation liquids containing liquid rubber, metal salts of NPA and the composition of LP nitro compound

Solution of the compositions in T-30 oil distillate			The duration of corrosion protection, by days	
Composition	The amount of the components , %		Condensa-tion phase	Environ-mental phase
	Inhibitor	Solution		
Ni salt of NPA LP nitro comp.	5 5	10	127	214
Liquid rubber Ni salt of NPA LP nitro comp.	3,33 3,33 3,33	10	263	331
Co salt of NPA LP nitro comp.d	5 5	10	138	226
Liquid rubber Co salt of NPA LP nitro comp.	3,33 3,33 3,33	10	**281**	**378**
Zn salt of NPA LP nitro comp.	5 5	10	103	197
Zn salt of NPA LP nitro comp. Liquid rubber	3,33 3,33 3,33	10	231	297
Mg salt of NPA LP nitro comp. Liquid rubber	3,33 3,33 3,33	10	226	295
Liquid rubber Ca salt of NPA LP nitro comp.	3,33 3,33 3,33	10	254	302

Given the positive effect of the liquid rubber on the composition, the process was continued with oxidized liquid rubber.

Liquid rubber as one of the three main components in the conservative fluids developed in T-30 oil distillation medium was substituted by its oxidizing product and tested on metal plates.

The compositions were grouped according to the following contents:

1) organic derivatives of OLR, NPA (amidoamines, imidazolines, alkylamine and ethanolamine complexes of NPA) and nitro compounds.

2) Acid salts of OLR, NPA and nitro compounds.

The most efficient compositions selected in the result of the tests carried out in the test cell are given in Table 11.

Table 11. Test results of conservative fluids containing of OLR, amidoamines and nitro compounds ($C_{14}H_{28}$ and LP-based)

Solution of the compositions in T-30 oil distillate			The duration of corrosion protection, by days	
Composition	The amount of the components , %		Condensa-tion phase	Environ-mental phase
	Inhibi-tor	Solu-tion		
OLR	-	10	49	84
OLR AmidoamineNPA:PEPA2:1	5 5	10	87	142
OLR AmidoamineNPA:PEPA2:1 $C_{14}H_{28}$Nitro compound	3,33 3,33 3,33	10	316	394
OLR AmidoamineNPA:PEPA2:1 LP nitro compound	3,33 3,33 3,33	10	324	415
OLR Imidazoline NPA:PEPA 2:1	5 5	10	91	132
OLR Imidazoline NPA:PEPA 2:1 $C_{14}H_{28}$Nitro compound	3,33 3,33 3,33	10	298	365
OLR Imidazoline NPA:PEPA 2:1 LP nitro compound	3,33 3,33 3,33	10	312	403
OLR NPA:triethanolamine LP nitro compound	3,33 3,33 3,33	10	298	354

Continuation of Table 11.

OLR NPA:triethanolamine $C_{14}H_{28}$Nitro compound	3,33 3,33 3,33	10	287	342
OLR Co salt of NPA $C_{14}H_{28}$Nitro compound	3,33 3,33 3,33	10	295	374
OLR Co salt of NPA LP nitro compound	3,33 3,33 3,33	10	322	401

As is evident from Tab. 11, as 10% solution of oxidized liquid rubber in T-30 oil distillate protects metal plates against corrosion for 49 and 84 days, but "OLR + Amidoamine (NPA:PEPA 2:1)" sample – for 87 and 142 days, these indices are significantly higher in the presence of conservative fluid with different compositions. So, that conservative fluid consisting of "OLR + Amidoamine (NPA:PEPA 2:1) + LP nitro compound" having maximum efficiency in this group have protected metal plates against corrosion for 324 days in 10% concentration of condensation phase, 415 days – in environmental phase.

Analysis of the table makes it clear that test results of conservative fluids consisting of the components of other classes in the presence of oxidized liquid rubber are many times higher than standard requirements.

It has been determined that protection efficiency of conservative fluids formed by oxidized liquid rubber compositions are higher than the indices of the conservative fluids having liquid rubber compositions. This difference is explained by a stronger interaction of oxygen atom, having free electron pair in the oxidized liquid rubber, with metal atoms, that results in chemosorption on metal surface and formation of permanent protective cover.

The results of the study of prepared conservation liquids were summarized and analyzed.

Based on the analysis conducted, the test results of conservation liquids which are highly effective compared to their analogues are shown in Table 12.

Table 12. The test results of conservation liquids which showed high-efficiency

Solution of the compositions in T-30 oil distillate			The duration of corrosion protection, by days	
Composition	The amount of the components , %		Condensa-tion phase	Environ-mental phase
	Inhibi-tor	Solu-tion		
OLR AmidoamineNPA:PEPA2:1 LP nitro compound	3,34 3,33 3,33	10	324	415
OLR Imidazoline NPA:PEPA 2:1 LP nitro compound	3,33 3,33 3,33	10	312	403
OLR NPA:triethanolamine LP nitro compound	3,33 3,33 3,33	10	298	354
OLR Co salt of NPA LP nitro compound	3,33 3,33 3,33	10	322	401

Comparative analyzes have been carried out to clarify the effects of synthesized compounds and the compositions based on them, the protective properties of conservation liquids and the chemical processes occurring between the components and the surface during the interaction with metal surfaces.

The strength of protection is determined by characterizing the surface interaction of the structural groups of the components of conservation liquid with the active centers located on the metal surface. These or other features may be dominant in conservation, but in the component selection the emphasis is placed on the whole complex of closely related and interconnected groups. Because the positioning of functional groups in the molecules of reagents to be synthesized in a multicomponent system has a significant effect on the protection ability of the coating.

The comparable conservation components were selected from among the most effective results of the group to which they belong during the tests.

Comparative analyzes of all the studied groups suggest that, increasing the number of heteroatoms such as nitrogen and oxygen in the composition of the components leads to an increase in the protective capacity of conservation liquid. Thus, reduction of the ability of corrosion elements to penetrate oxygen bridges in the functional groups, stability of the coating structure, strengthening of adhesion bonding of amide groups with metal surface centers provides long-term protection against corrosion. Information on the spectroscopic method of these considerations will be explained in detail after talking about lubricants.

Conservation liquids are mainly used to protect metallic details, spare parts and interior parts of cars from corrosion. Protection lubricants are mainly used for the protection of devices and equipments during storage and delivery.

The formation of synergistic effect on the compounds used in the creation of high-quality lubricant compositions and the enhancement of the coating ability depend on the functional groups and heteroatoms that comprise these compounds, as well as their intermolecular interactions. In general, the presence of free electrons in the molecule of corrosion inhibitor which can be used to protect metals from corrosion can create a contact surface with metal surfaces. The inhibitory properties of these compounds mainly depend on adsorption-chemosorption processes on the protected surface, the electron density of the functional groups at the adsorption center and the solid contact of the surface protective screen to the metal. Taking into account these properties, conservation lubricants have been developed based on the best-performing compositions such as liquid rubber, amidoamines, imidazolines, metal salts of NPA and conservation liquid of nitro compound. The obtaining process of lubricants based on different solids conservation liquids was carried out with the addition of 10% (mass) paraffin to the selected liquid.

The paraffin used is suitable with the grade C of QOST

23683-89 and consists of solid wax used in the industry for industrial purposes. The prepared conservation lubricants were tested in 2 ways (by lubrication and liquid) on the surface of pre-polished metal boards. Samples of the lubricant compositions pepared with the addition of paraffin to conservation liquids and the highest results are given in Table 13.

Table 13. The test results of lubricant compositions

Composition of samples % Conservation liquid 90% + paraffin 10%	The duration of corrosion protection, by days			
	Condensation phase		Environmental phase	
	Liquid method	Friction method	Liquid method	Friction method
Liquid rubber AmidoamineNPA:PEPA2:1 LP nitro compound	**354**	**376**	**431**	**442**
Liquid rubber ImidazolineNPA:PEPA 2:1 LP nitro compound	**351**	**372**	**413**	**422**
Liquid rubber Co salt of NPA LP nitro compound	**293**	**307**	**393**	**416**
OLR AmidoamineNPA:PEPA 2:1 LP nitro compound	**355**	**378**	**447**	**461**
OLR Imidazoline NPA:PEPA 2:1 LP nitro compound	**322**	**347**	**419**	**433**
OLR Co salt of NPA LP nitro compound	**303**	**317**	**403**	**426**

Generally, research in this area has shown that, the tested lubrication compositions have a high corrosion protection effect.

It has been revealed that the conservative lubricants that is produced by the composition of the synthesised inhibitor and nitro compound in the presence of liquid rubber has a great protection against corrosion, meets the requirements and has a great practical importance.

Research has been carried out to improve adhesion and other quality characteristics by adding a small amount of bitumen. Samples were prepared by adding a certain percentage (0.4 - 0.6%) of liquid rubber to bitumen. 0.4 and 0.6 grams of liquid rubber were mixed with 99.6 and 99.4 grams of bitumen and heated at 140°C for 30 min for the experiment and followed by quality indicators of bitumen (softening temperature, injection depth (25°C), tension (at 25°C), brittle temperature and adhesion were checked in accordance with GOST 11508-90. The results obtained are given in Table 14.

Table 14. The test results of the addition of liquid rubber to bitumen as an additive

Sample	Adhesion supple-ment	Softe-ning temp., °C	Injection depth, 25°C *0,1mm	Tension 25°C, cm	Brittle temp., °C	Adhe-sion point
Bitumen БН 50/70	no	48	48	71	-18	3
Sample1	0,6	46,4	52	84,7	-27	2
Sample2	0,4	46,8	51	82,32	-25	2

According to GOST 11508-90, sample of liquid rubber in the amount of 0.4 and 0.6% was added to the bitumen. The softening temperature change was determined after heating the bitumen for 5 hours at the thermostat at 163°C and is given in Table 15.

Table 15. Changes in the brittle temperature of bitumen after heating

Adhesion supplement	Amount, %	Change of the softening temperature after heating, °C
Without adhesion	no	4
Sample-1	0,6	2,4
Sample-2	0,4	2,2

It can be concluded that, samples obtained with the addition of liquid rubber exhibit high thermostability. Based on the analysis of the results, it is advisable to use liquid rubber as an adhesion supplement to bitumen.

IR-spectroscopy was used to investigate the corrosion protection mechanisms of conservation coatings. The IR spectra both of initial and compositional samples were obtained directly on metal without breaking the layer, thus revealing detailed structural changes in the testing process. Samples of research are:

1. Liquid rubber+T-30 oil distillate
2. Liquid rubber+Amidoamine(NPA:PEPA 2:1)+ nitro compound ($C_{14}H_{28}$)+T-30 oil distillate
3. Liquid rubber+Co salt of NPA + nitro compound ($C_{14}H_{28}$) + T-30 oil distillate

The IR spectra of the 10% solution of liquid rubber in T-30 oil distillate both in initial position and after 1 month in the experimental cell are shown in Figure 5.1. and 5.2 .

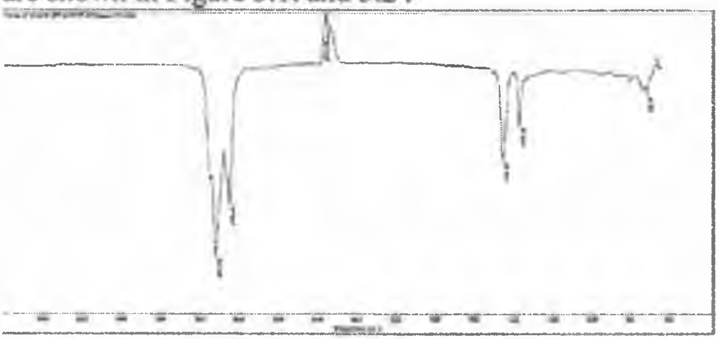


Fig.5.1. IR spectrum of Sample 1 in initial state.

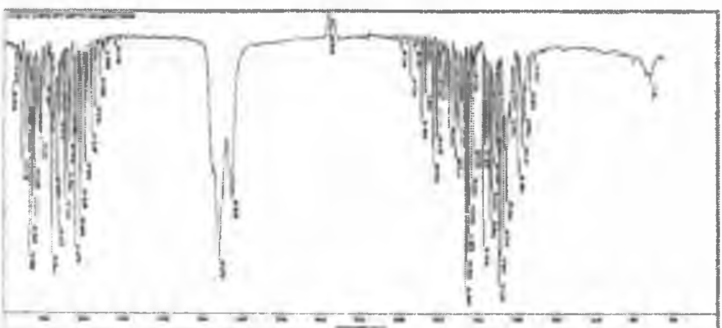
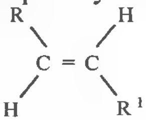


Fig.5.2. IR spectrum of Sample 1 on metal.

In both figures - the deformation oscillations were observed at a wavelength of 965 cm^{-1} group of hydrogen atoms in the IR



The valence and deformation oscillations of group - CH_2 -, - CH_3 - and - $(CH_2)_n$ were also observed at the corresponding wavelength.

After the sample was stored in a humid atmosphere in the experimental cell, new wavelength deformation and valence oscillations occurred on the spectrum:

= C – O – C epoxy group was observed at a wavelength of – 1230 cm^{-1}, -1220 cm^{-1}, -1050 cm^{-1}, -920 cm^{-1}, - CH =.metine group was observed at a wavelength of 3005 cm^{-1}; deformation and valent oscillations of - OH group were observed at a wavelength of -3000 cm^{-1}. The oscillations coinciding with the deformation oscillations of C –O - C - O - C - group - OH band at a wavelength of –1313 cm^{-1} were observed. There are oscillations in the spectrum that coinciding with liquid rubber at a wavelength of 967 cm^{-1} and -734 cm^{-1}.

The observed changes allow for a change in the structure of the coating due to the epoxy groups that increase the adhesion effect.

Sample 2 in the Fig. 5.3. and 5.4. presents the descriptions of the IR spectrum in initial state and a month later on metal:

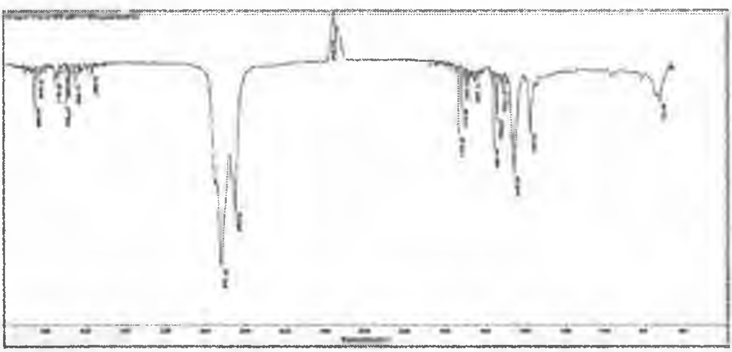


Fig. 5.3.IR spectrum of Sample 2 on metal in initial state.

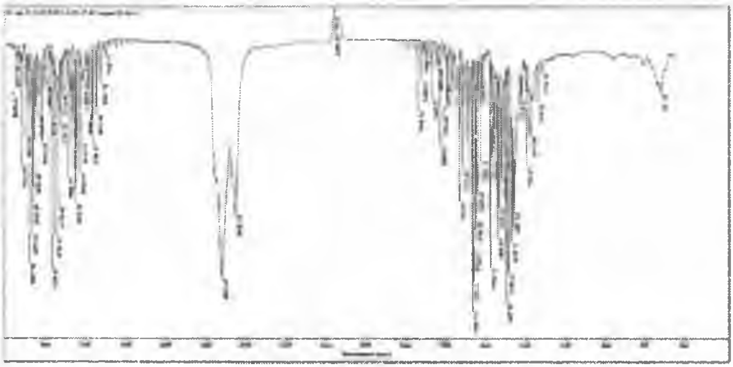


Fig.5.4. IR spectrum of Sample 2 after 30 days on metal.

In addition to the valence and deformation oscilations mentioned in Sample1, surface deformation vibrations were observed at the corresponding wavelength of NH_2 group of amidoamine at a wavelengths of 1653 cm^{-1} in the spectra of Sample 2 (Liquid Rubber+Amidoamine (NPA:PEPA 2:1)+Nb ($C_{14}H_{28}$)+T-30 oil dis.).

Figure 5.5. and 5.6. presents the descriptions of the IR spectrum of Sample 3 (Liquid Rubber+Co salt of NPA+Nb ($C_{14}H_{28}$)+T-30 oil dis.) in initial state on metal and a month later in the experimental chamber.

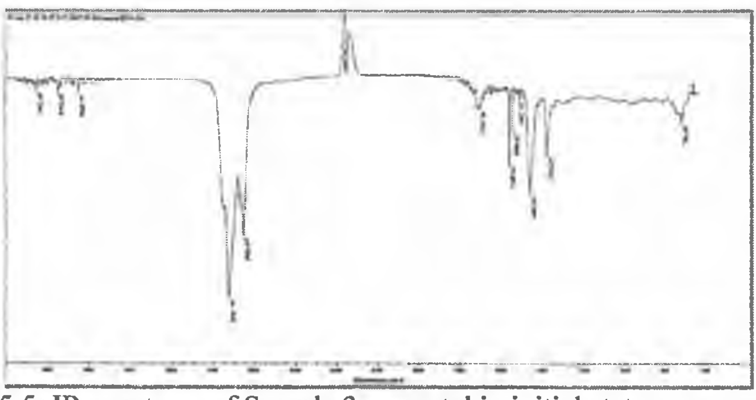


Fig 5.5. IR spectrum of Sample 3 on metal in initial state.

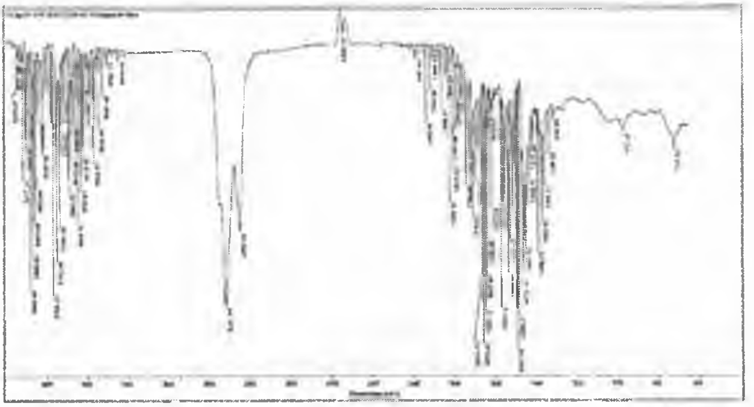


Fig 5.6. IR spectrum of Sample 3 after 30 days on metal.

As can be seen from the figures, in addition to the valence and deformation oscillations recorded in the Sample 1, additional stripes of the C = O group of Co salt of NPA were observed at a wavelength of -1706.41 cm^{-1}. After being stored in a humid atmosphere, - = C - O - C group absorption was recorded at -1250 cm^{-1}; -1050 cm^{-1} wavelengths

Analyzing the data obtained, we can conclude that, the addition of cobalt salt of NPA and nitro compound (Sample 3) to the initial sample results a reduction in the oxidation rate of coating. The formation of epoxy groups results in the stability of the stratum structure, reducing the ability of corrosion agents to penetrate and slowing down the corrosion process.

Conservation liquid with amidoamine (Sample 2.) is not subjected to the oxidation in practice under these test conditions, indicating the stability of the layer. It should be noted that, atmospheric moisture absorption is observed at 4000 - 3500 cm^{-1}, 2000 - 1300 cm^{-1} areas in all of the initial samples tested. This is also due to the absorption of water vapor in the micro-pores resulting from the test within the sheet-metal coating.

The quantitative indices of the integrated absorption in the 2000–1300 cm^{-1} range indicate less absorption in the Sample 2 than in the Sample 1. This indicates that, the coating has a higher adhesion in this sample.

In this regard, hypothesis can be put forward on the different mechanisms of corrosion protection in these samples. For example, in the Samples 1 and 3 if the effect of the inhibitor is related to the reduction of penetration by the epoxy groups and oxygen bridges and the stability of the coating structure, in the Sample 2 the amide groups of the inhibitory effect are related to the metal surface centers and play an important role.

The inhibitory effect of an organic inhibitor is reinforced by the presence of hetero adsorption active centre such as sulphur (S), nitrogen (N) and oxygen (O) atoms in its molecule. In addition to the molecular electronic structure with a number of these active centres, the molecular size, the mode of adsorption, the formation of metallic complexes, and the projected area of the inhibitor on the metallic surface also effect the efficiency of inhibition.

Former studies concluded that the adsorption on the mild steel surface depends mainly on the physicochemical properties of the inhibitor group such as the planarity of the system, the presence of multiple adsorption active centres with alone pair and, or π orbitals, the electronic density of the donor atom and the molecular size. Therefore, the choice of effective inhibitors is based on their structure, mechanism of action and electron donating ability.

The dielectric properties of the original compositions as well as conservation liquids in the form of coating on metals were investigated to reveal the mechanisms of corrosion protection. Measurements were made using standard coaxial cylindrical electrodes. The results of the study are presented in Table 16.

The inclusion of amidoamines and salts of NPA as the inhibitors in the composition significantly reduces the specific resistance of the tested compositions.

Table 16. Dielectric properties of the studied samples

№	ϱ_1 initial compositions	ϱ_2 after testing	ϱ_2/ϱ_1	ln (ϱ_2/ϱ_1)	The duration of corrosion protect-tion, by days
1	$70*10^6$	$15*10^{10}$	$0,214*10^4$	3,3304	73
2	$1,5*10^6$	$14*10^{10}$	$9,3*10^4$	4.9685	375
3	$1,4*10^6$	$6,9*10^{10}$	$4,93*10^4$	4,6925	362

ϱ_1 –special electrical conductivity of initial compositions;;
ϱ_2 - special electrical conductivity of the compositions after testing.

As a result of the tests, the relative changes in specific resistance were calculated to assess the effect of the tests on the dielectric properties of the coatings.

The graph below shows the relative changes in special electrical conductivity of the protective coatings depending on the logarithm of the protection effect shown by them:

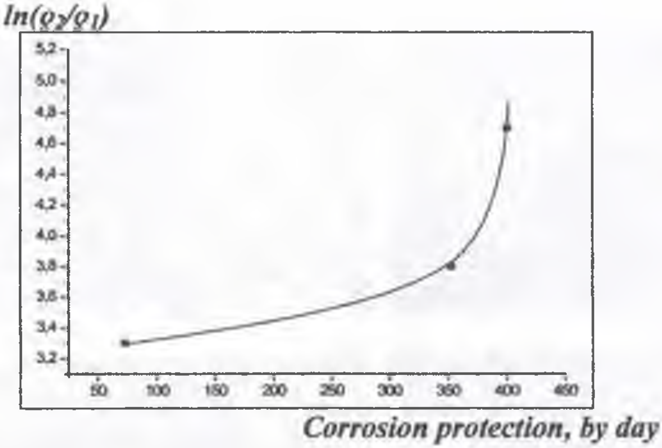


Fig 6. The dependence graphic of the relative changes in special electrical conductivity from the logarithm of the protection effect of coating.

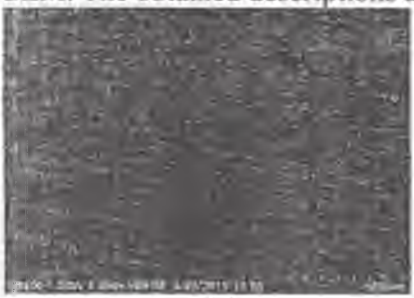
As can be seen from the graph, the maximum variation of the specific resistance has the greatest effect on the compositions with higher protection effect.

As it can be seen from the graph, the influence of specific resistance's maximal change to compositions with higher protective effect is substantial and is non-linear. It indicates that the superiority of adhesion processes in the investigated samples is directly related to the replacement of load centers in corrosion processes in metal-dielectric boundaries.

The dielectric properties of the coating also confirm its protective properties. At this time, the corrosion process is delayed due to the reduction of ionic loads and electrons between the metal surface with high electrical resistance. Thus, corrosion slows down both the anode and the cathode process.

Scanning electron microscope (SEM) was performed to investigate the protection mechanism of the compounds studied and the properties of the corrosion damage of the metal surface during corrosion processes.

The pre- and post-corrosion appearance of metal samples both in conservation liquid and in the pure form was investigated by SEM. The obtained descriptions are shown below in Figure 7(a)- (d).



Picture 7(a)

Picture 7(b)

Picture 7(c)

Picture 7(d)

Figure 7(a). The appearance of the metal sample before the corrosion without conservation liquid in initial state,

Figure 7(b). The appearance of the metal sample after the corrosion without conservation liquid,

Figure 7(c) 100-fold increase of the metal surface after corrosion in a 7% conservation liquid,

Figure 7(d) 100-fold increase of the metal surface after corrosion in a 10% conservation liquid

In Figure 7(b), the experimental cell is given a 100-fold increase of the surface of the metal sample after corrosion without preservation liquid. The oxide layer is uneven in the SEM image and its morphology does not differ sharply at different points. The corrosion layer is uneven, soft in all areas, and partly settles into the environment.

Figure 7(c) shows a description of metal sample in the experimental chamber after the completion of probation period in 7% conservation liquid. It can be seen that, the long-term effects of aggressive environments lead to the gradual collapse of the protective layer of the metal surface and the coating loses its function.

Figure 7(d) shows a description of metal sample in the experimental chamber after the completion of probation period in 10% conservation liquid. As can be seen from the microphoto of metal surface, there are very few corrosion traces on the surface for a certain period of time. As a result of the application of conservation liquid, there are practically no microstructures and corrosion on the metal surface.

The study investigated the adsorption of amidomine and imidazoline compounds based on NPA and polyamines, which we used as corrosion inhibitors in acidic environments and the formation of metal surfaces was studied. In this process, corrosion rates of the studies were compared to study the mechanism of corrosion inhibition of substances and the degree of coverage was calculated.

Langmuir isotherm is used to characterize the efficacy of amidoamine as an inhibitor. The tests are carried out as follows. The corrosion inhibitory properties of these compounds were investigated in 1.5 M HCl solution. Metal sheets were treated with an acidic medium for a period of 24 h at room temperature, and the inhibition efficiencies were determined via weight loss measurements. Before the immersion test, the metal samples were immersed in 1.5 M HCl solution, polished lightly with paper tissue, washed with deionized water and immersed in acetone. Control tests were performed in the same way without the inhibitors. After immersion in 1.5 M HCl with and without the addition of 100 ppm of the prepared inhibitors at room temperature for 24 h, the metal samples were cleaned with distilled water and dried in a vacuum desiccator, and then, the surface was evaluated using a SEM.

Amidoamine and imidazoline surface coating ratios were calculated based on the equation $\theta = 1 - \frac{\rho_1}{\rho_0}$ in order to investigate the results of studies in the hydrogen sulphide environment and are shown in Table17. Here, ρ_0 - experiment without inhibitor, ρ_1 - the corrosion rate of the experiment with the inhibitor is measured in $q/m^2 \cdot hour$.

Table 17. Surface coefficients of amidoamine and imidazoline compounds synthesized by NPA and PEPA

Inhibitors	Density, C, (mg/l)	Corrosion speed, ρ, $g/m^2 \cdot hour$	Surface coefficient, θ
Amidoamine	5	0,35	0,865
	10	0,2	0,923
	25	0,07	0,973
	50	0,04	0,984
	100	0,02	0,992
Imidazoline	5	0,75	0,711
	10	0,52	0,8
	25	0,2	0,923
	50	0,11	0,957
	100	0,06	0,977

The correlation (R^2) constant at 0.999 is a clear expression of the isotherm forming a metal surface. The linear structure of the described isotherms indicates that both compounds form a monolayer.

After determining adsorption constants (K_{ad}) from the graphs above, adsorption energies of each compound were calculated. At this point, the following formula was used:

$$K_{ad} = \frac{1}{55}\exp\left(-\frac{\Delta G^0_{ads}}{RT}\right)$$

ΔG^0_{ads} was calculated using K_{ad} values, the isotherms of the amidoamine and imidazoline compounds, this price was -42.8 kC/mol for amidoamine and -40.2 kC/mol for imidazoline.The price of adsorption energies confirms the chemosorption on the metal surface.

Inhibitor density and its relation to surface coefficient is expressed by the Langmuir isotherm:

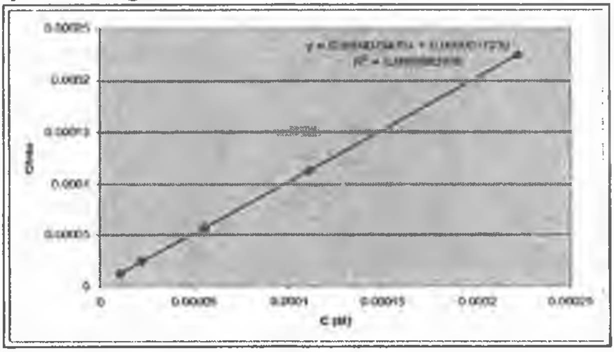


Fig 8.1. Langmuir adsorption isotherm of amidoamine

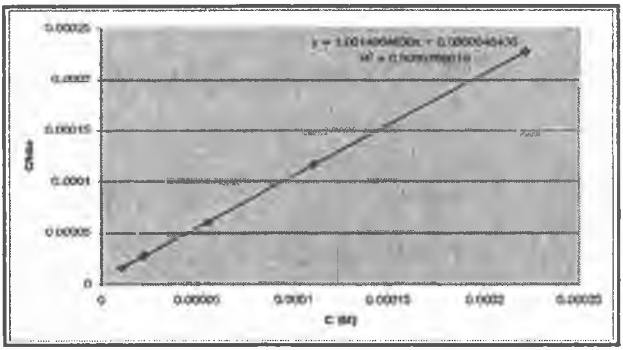


Fig 8.2. Langmuir adsorption isotherm of imidazoline

The results obtained in the research process coincide with theoretical judgments. So, it's possible to have synergistic effect corresponding to the groups' characteristics in formation of compositional conservative fluids on the basis of different types of functional group substances. As a result of the studies carried out by us, it has been proved the possibility of forming effective conservative fluids on the basis of the nitro compounds having long-chain (C_{12}, C_{14} and C_{16-18}) radicals, amidoamines having enough long chain ($C \geq 13$) radical and organic acids metal salts having this radical.

Synergistic effect formed among the compounds in the composition simultaneously causes increase in the layer density chemisorbed on metal surface, therefore the transition of agressive components onto the surface is prevented, on the other hand, it allows to maintain protective effect of the surface for a long time.

It's also proved by the properties of active (functional) groups of oil-soluble surface active substances. The functional groups in the composition – amine group ($-NH_2$) has medium positive effect (+2), nitro group ($-NO_2$) – strong negative effect (-3). At the expense of such side effects ($-NO_2$) and ($-NH_2$), the groups doesn't push each other in the absorption of them on the metal surface, vise versa they attract each other. Therefore the conservative fluids containing nitro compounds, amidoamines and imidazolines are more intensely chemisorbed on the metal surface and it causes a sharp increase in protective effect.

Discussion of protection process mechanism from the point of view of adsorption on a metal surface allows to make a result that the groups having double bonds and indivisible electron pairs cause significant increase in adsorption. Therefore amidoamines and imidazolines of natural petroleum acids have definitely higher adsorptional energies in value and correspondingly have high protective effect. It's may be explained by chemosorption of them on the metal surface corresponding to above-mentioned adsorption energies.

Enhance in the adsorption of the groups having double bonds and indivisible electron pairs simultaneously is also proved in the test process by increase in protective effect while substituting liquid rubber in the composition by oxidized liquid rubber.

Generally, as a result of the studies carried out in this direction, it has been determined that tested compositions have high protective effects against corrosion. That is why, it's clear that the result of the studies carried out on testing of inhibitor efficiency of a series organic compounds containing different functional groups against steel corrosion is availability of these compositions against metals corrosion in industry.

The process optimization was performed using mathematical statistical methods to analyze the practical results obtained in the research process. The compositions, mainly containing OLR component have been used in optimization process. At first, the composition obtained on the basis of OLR, amidoamine (NPA:PEPA 2:1) and nitro compound (light phlegm) optimized.

The process consists of the following stages:

- determination of the dependence between factors influencing the process in the form of regression equations
- estimation of the model coefficients;
- analysis of the model sensitivity;
- finding out optimal conditions for the process.

The first stage illustrates the correlation that results from the statistical analysis that characterizes the interaction effect in the experimental data. The correlation coefficient is determined by the dependence of x_i on y.

The main technological indices of the studies - the molar ratio of natural acids and polyamine (PEPA) have been namely called as x_1 mol / mol, their concentrations as x_2, and the process properties as Y_i (cell corrosion protection time, day) and studied through active scheduling by mathematical and statistical calculations.

The mathematical indication of the optimization parameters dependent on the initial math variables is given in the following regression equation:

$$Y_k = a_0 + \sum_{i=1}^{n} a_i x_i + \sum_{\substack{i=1 \\ i \neq j}}^{n} a_{ij} x_i \cdot x_j$$

Y_k is the value of the output parameters of the model, X_i and X_j - the number of coded model factors, n - the number of the factors, a_0 - the independent members in the regression equation, k - the number of output parameters, a_i and a_{ij} are the constants of linear effect and coupling factors connection, respectively.

The S-plus 2000 Professional software developed for automated mathematical analysis of the experimental data has been used for determination of the equation constants. The programme includes advanced algorithms that address linear programming issues.

The indices for planning the tests in the presence of 3 different samples according to the changes in the ratios of NPA:PEPA for obtaining amidoamines are set into Table 18. The "+", "-" and "0" symbols in the table are - down, up and base indicators levels.

Table 18. Planning matrix for the amidoamines obtained on the basis of NPA:PEPA (1:1, 2:1, 3:1) and experimental results

Exp.№	Input parameter (variable values)				Output parameter, day	
	Encoded		Used			
	X_1	X_2	Z_1 mol/mol	Z_2 %	$y_{2\,exp.}$	$y_{2cal.}$
1.	+	+	3:1	10	316	318
2.	–	+	1:1	10	337	340
3.	+	–	3:1	3	157	156
4.	–	–	1:1	3	179	176
5.	0	0	2:1	6,5	250	251

As optimization criteria, the limitations on the process properties (limits for output parameters change) $1:1 \leq X_1 \leq 5:1$ mol/mol; $3\% \leq X_2 \leq 10\%$ functional maximum have been taken.

The process optimization was carried out analyzing practical results obtained in the research process by mathematically statistical methods. A comparison of the experimental results with the results obtained from the regression equations by the mathematical calculation is presented in Tab. 19.

Two of the active components that create the composition of the samples - oxidized liquid rubber and light phlegm-based nitro compound remained stable. Variable quantities were only due to NPA and amidoamine derived from the interaction of polyamines.

The optimization problem was solved on the basis of the mathematical model . To determine the optimal values of the input variables it is necessary to select the optimization criterion.

For the process of receiving amidoamines based on (NPA to DETA, PEPA and TETA), the maximum number of days of operation in the test chamber was chosen as the criterion in which surface corrosion is not yet observed. To solve the optimization problem, the Matlab-6.5 program was used.

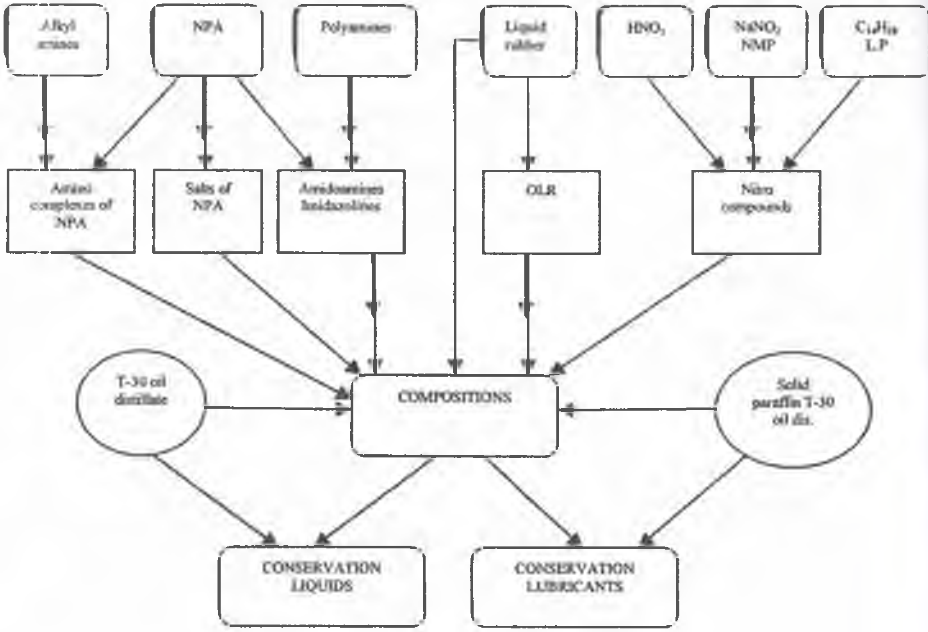
Table 19. Comparison of mathematical and experimental results

Composition of conservation liquids, %	The duration of corrosion protection, by days					
	Condensation phase			Environmental phase		
	Mathe-matical	Practi-cal	Difference %	Mathematical	Prac-tical	Difference %
T-30 oil dis. 90 % OMK Nitro compound (LP) AmidoamineNPA+PEPA 2:1	319	324	1,8	410	415	3,7
T-30 oil dis. 90 % OMK Nitro compound (LP) Amidoamine NPA+TETA 2:1	306	311	1,3	359	371	4,9
T-30 oil dis. 90 % OMK Nitro compound (LP) Amidoamine NPA+DETA2:1	286	293	1,9	341	358	5

As can be seen from the table 19, the difference between the results of the three samples studies was 3.7-5%, which confirms the accuracy of the experimental results at 95-96.3%.

The most influencing factor for environmental problems is the presence of components such as sulphur, phosphorus, chlorine and lead, which are highly toxic. It is known that conservations cause very little environmental problems because of the small amount of the elements mentioned in oil distillates. Most of the inhibitory additives are among the less hazardous substances.

As a result of the research conducted in the dissertation, a new scheme that describes the principle of obtaining of conservation liquids and lubricants with a new, optimal composition, high corrosion protection efficiency is presented as follows (Scheme).



Scheme. Generalized scheme of the principle of obtaining of conservation liquids and lubricants with optimal composition.

"Baku Steel Company" MMC confirms, conservation components made under the scheme are high-impact protective coatings that prevent metal corrosion in various aggressive environments and can be successfully applied as corrosion inhibitor and conservation liquid as a means of protection.

The technical - economic assessment was conducted to determine the economic effect of the production process of conservation liquids on the basis of T-30 oil distillation.

Based on the calculations it was determined that, compared to the analogue, taking into account both the duration of exposure and the cost of raw materials it is possible to save 190,000 AZN for each new 500 tonnes of conservation liquid with a protective effect of 415 days.

RESULTS

1. For the first time, various compositions based on nitrogenous organic compounds, alkyl-amine complexes, salts of NPA and nitro compounds with liquid and oxidized rubber were prepared, conservation liquids and lubricants were created in T-30 oil distillation and paraffin environments (5, 7 and 10%) and were recommended for industrial application based on the high test results of modern "CORROSIONBOX-1000E" and Baku Steel Company MMC. (Act presented). [13;22;31;35;38]
2. Polyamine derivatives of NPA - were synthesized by the addition of aminoamines and imidazolines with NPA at different ratios (1 : 5) to dethylentriamine (DETA), triethylentetramine (TETA), and polyethylenpoly amines (PEPA) The components obtained were tested with liquid rubber and nitro compounds as a conservation liquid in various concentrations in T-30 oil distillation. The highest result was for 391 days with the sample «LR+amidoamine (NPA+PEPA 2:1)+nitro compound (LP) ». [2;12;15;20;23]
3. Conservation liquids of liquid rubber made with imidazolines and nitro compounds have higher results than those required (90 days in accordance with GOST 9054-75). The highest result was for 382 days in the sample «LR+imidazoline (NPA+PEPA 2:1)+nitro compound (LP)» among the conservation compounds taken with imidazolines. [11; 16; 26; 29; 39; 43]
4. Mono-, di- and triethanolamine, dimethyl and diethyl amine complexes with NPA have been synthesized as a component of conservation liquid, the compositions with liquid rubber and nitro compounds were prepared and investigated. The highest result was for 324 days in the sample «LR+triethanolamine complex of NPA+nitro compound (LP)» [5;18;19;21]
5. Nitro compounds were synthesized by affecting HNO_3 to the boiling fraction of 170-200^{0}C of light phlegm and tetradecene (with $NANO_2$ initiator). N-methylpyrrolidone hydrosulfate ([NMP]+[HSO_4] -) ionic liquid was used as a catalyst for the reaction of nitrolysis of light phlegm. As a result of the

experiments it was found that, both the composition and individual LP nitro compound have a higher protective effect than the $C_{14}H_{28}$-based nitro compound: «$C_{14}H_{28}$+T-30»-108 days, «LP nitro compound+T-30»-193days. [6;8]

6. Conservation liquids were prepared based on liquid rubber, metal (Co, Ni, Zn, Mg, Ca) salts of NPA and nitro compound compositions ($C_{14}H_{28}$ and LP - based) and the highest result was the composition of CO salt for 378 days «LR+NPA CO+nitro compound (LP)» .[1;2;3;4;7;10;24; 34;42]
7. Given the positive effect of liquid rubber on the composition, the process was continued with oxidized liquid rubber and it was found that, the compositions with OLR had a higher effect on the results of the experiments. Thus, the sample that showed the maximum efficiency (415 days) for corrosion protection in the study process is the composition of the OLR: "OLR+Amidoamine (NPA:PEPA 2:1) +Nitro compound (LP)." [36;37;40]
8. Lubricants were prepared by adding 10% of solid n-paraffins to the compositions that had a high corrosion protection effect as a conservation liquid and "OLR+Amidoamine (NPA:PEPA 2:1)+Nitro compound (LP)" composition protects the metal boards from corrosion for 461 days in the experimental chamber. [9; 14;28]
9. The physical - chemical properties of the compositions obtained were investigated, the identification was determined using structural analysis methods, especially IR spectroscopy and the homogeneity of compositions which is a key factor for the conservation liquid has been confirmed. The effect of the electrical conductivity on the anti-corrosion properties and the mass variations depending on the temperature were determined by differential thermal analysis. The mechanism of action of the studied compositions on the metal surface was investigated by means of IR spectroscopy and the formation of protective coating has been proven. [25; 27;30]
10. The surface condition was captured by SEM to study the protection mechanism of compounds used as a component and

the features of corrosion collapse of the metal surface during corrosion processes and to follow the surface morphology. The appearance of metal samples in the experimental cell, both in the conservation liquid environment and in the pure form before and after corrosion was investigated SEM and the effectiveness of defense has been proven. [41;44]

11. The dielectric properties of the original compositions, as well as conservation liquids in the form of coating on metals were investigated to reveal the mechanisms of corrosion protection. It was determined that, the inclusion of inhibitors on the composition significantly reduced the specific resistance of the tested compositions, that is, the maximum variation of the specific resistance has the greatest effect on the compositions with higher protection effects. [44;47]
12. The process optimization was performed using mathematical statistical methods to analyze the practical results obtained in the research process, the difference between the results was 3.7-5% and it confirms the accuracy of the experimental results in the range of 95-96.3%. Technical - economic evaluation of the process was conducted and it was determined that, compared to the analogue, the production of conservation liquid with effect of 415 days, according to the new process allows to save up 190 000 AZN per 500 t. [32;33]
13. Considering the adhesion properties of high-viscosity liquid rubber, it has been used as an additive to enhance the exploitation properties of bitumen in the study and favorable results have been obtained. [46]

THE MAIN CONTENT OF THE DISSERTATION WORK IS PUBLISHED IN THE FOLLOWING SCIENTIFIC WORKS

1. Abbasov, V.M. Nitrobirleshmenin tebii neft turshularinin duzlari ve amidle kompozisiyasindan yaradilmish konservasiya mayesinin tedqiqi /V.M. Abbasov, Y.J. Aghazada, E.SH. Abdullayev [ve b.] //Azerbaijan Kimya Jurnali, - Baki: - 2013. №3, – s.16-20.
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