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**ABSTRACT**

of the dissertation for the degree of Doctor of Philosophy

**INVESTIGATION OF SULFATED AMIDE DERIVATIVES  
SYNTHESIZED ON THE BASIS OF VEGETABLE OILS AS  
INHIBITORS OF HYDROGEN SULFIDE AND CARBON  
DIOXIDE CORROSION**

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## GENERAL CHARACTERISTICS OF THE WORK

**Relevance of the topic and the degree of elaboration.** The XX century was a century of rapid creation and application of techniques and technologies. In the XXI century, these processes are continuing rapidly. In this regard, the oil - gas extraction, oil - gas refining, petrochemical, chemical industries, vehicle manufacturing industries have also developed and are developing rapidly. As a result, the pollution of air, water bodies and soils with aggressive components has increased. In this case, the corrosion processes of metal structures and equipment intensify, they fail prematurely, the number and scale of accidents increase, the environment is intensively polluted and irreparable damage is caused to nature. It is difficult to ensure labor safety. The balance of the environment is disturbed, the living conditions of living things become difficult and in some cases impossible.

Given that the Caspian Basin is a rich oil - gas region, as well as a regional corridor for the transportation of oil and oil products, the solution of these problems is of scientific and practical importance.

It should also be noted that oil production in the Caspian Basin has a history of about 170 years. This has led to the depletion of oil fields and the intensive growth of sulfate-reducing bacteria in these waters and the increased corrosion aggression of these waters, so it is clear how relevant these problems are for the Caspian littoral states.

Sulfate-reducing bacteria are the main source of hydrogen sulfide in nature. They convert hydrogen sulfide from the cathode zone of the metal to sulfates with the help of the enzyme hydrogenase (this enzyme acts as a catalyst in the reduction reaction of hydrogen to various compounds) and converts them into sulfides. The resulting hydrogen sulfide increases their corrosion activity as a solution in both the oil in the formation and in the formation water. Sulfate-reducing bacteria combine with each other in the layer to form columns and occupy the pores of the layer. When there is a lot of such biomass, the water capacity of the injection wells decreases and the efficiency of the injection system is not high. Another

peculiarity of this phenomenon is that as the amount of adhesion of sulfate-reducing bacteria increases, hydrogen sulfide is formed more directly on the metal surface and has a more destructive effect. On the other hand, hydrogen sulfide in the oil solution causes rapid corrosion of the oil treatment plant's helmet pipe and air cooling equipment. Excessive use of neutralizers and inhibitors is required when there is too much hydrogen sulfide in the gas and liquid flowing through the helmet pipe.

One way to solve the corrosion problem is to use corrosion inhibitors. However, none of the Caspian littoral countries still produces enough inhibitors and most of them are not multifunctional. On the other hand, the corrosion aggressiveness of the products of each field and the wide range of ratio of produced water to extracted oil also limit the use of the same reagent.

The above shows that the creation of multifunctional, large-scale raw materials, low-toxic reagents is of great scientific and practical importance.

The dissertation is devoted to the synthesis of multifunctional reagents based on renewable raw materials, the creation of highly synergistic compositions, testing with modern research methods and making recommendations for application.

**Object and subject of research.** The object of research is the production of multifunctional corrosion inhibitors based on renewable raw materials, including vegetable oils.

**Goals and objectives of the study.** The aim is to synthesize alkyl amides, ethanolamides, salts and complexes of their sulfate derivatives on the basis of vegetable oils and to create multifunctional inhibitor-bactericides on their basis. For this purpose, the following tasks have been set and solved:

- synthesis and study of the properties of amides of alkylamines of sunflower, corn, cottonseed and palm oils;
- study of the synthesis and properties of ethanolamides of vegetable oils with monoethanolamine (MEA) and diethanolamine (DEA). Study of the dependence of the properties of ethanolamides on the mole ratios of vegetable oils, MEA and DEA;
- synthesis and properties of sulfate derivatives of ethanolamides

- and alkyl amides of vegetable oils, their salts, complexes;
- preparation of working solutions on the basis of synthesized substances and study of the effect on the kinetics of CO<sub>2</sub> corrosion and hydrogen sulfide corrosion;
  - study of the effect of sulfate-reducing bacteria on the activity of solutions prepared on the basis of synthesized substances;
  - selection of optimal ingredients and submission of proposals for application.

**Research methods.** Obtaining important scientific results in the dissertation and its accuracy was achieved using modern research methods: Infrared spectroscopy (IR-spectroscopy), infrared spectroscopy - Fourier microscope (IR - Fourier microscope), GIL ACE potentiometer for the study of CO<sub>2</sub> corrosion kinetics.

**The main provisions of the defense:**

- synthesis of alkyl amines and amides of sunflower, corn, cotton and palm oils;
- synthesis of ethanol amides of sunflower, corn, cotton and palm oils;
- synthesis of salts and complexes of alkyl amides of vegetable oils and sulfate derivatives of ethanol amides;
- preparation of solutions of synthesized substances in various solvents, study of physical and chemical properties of the prepared solutions, the effect on the kinetics of CO<sub>2</sub> corrosion, as well as the effect on H<sub>2</sub>S corrosion;
- study of the effect of solutions of synthesized compounds on the life activity of sulfate-reducing bacteria.

**Scientific novelty of the research:**

- one-step amidification of sunflower, corn, cotton and palm oils with ethanol amines (MEA, DEA) and alkyl amines was carried out, during amidation, the mole ratios of fat and amine molecules were taken as 1:1, 1:2 and 1:3, various amide derivatives were synthesized, and their physical and chemical properties were studied;
- amides of various vegetable oils were sulfated, salts of sulfate derivatives (Na, K, NH<sub>4</sub>) and complexes (based on MEA, DEA and triethanol amine (TEA)) were synthesized. Solutions of the

- synthesized compounds were prepared and their physical and chemical properties were studied;
- the effect of the prepared solutions on the kinetics of CO<sub>2</sub> corrosion, the course of H<sub>2</sub>S corrosion and the life activity of sulfate-reducing bacteria was studied;
  - the dependence of the inhibitory-bactericidal properties of the prepared solutions on the structure of the main components - the molecule of the corrosion inhibitor, the nature of the cation and the nature of the solvent was studied;
  - a high-defense composition has been identified and its high defense effect has been scientifically substantiated.

### **Theoretical and practical significance of the research.**

Based on the research, the following theoretically and practically significant results were obtained.

It has been determined that multifunctional reagents based on vegetable oils can be obtained and their effectiveness depends on both the composition of vegetable oils and the length of the alkyl radical alkyl amine involved in amide production, the mole ratio of alkyl amines and ethanol amines to triglyceride molecules and the nature of the cation.

The scientific explanation of the effect of reagents on H<sub>2</sub>S and CO<sub>2</sub> corrosion is given.

The practical significance is that a multifunctional inhibitor-bactericide based on renewable and extensive raw material reserves of vegetable oils and bioethanol has been developed and instructions for use are indicated. The prospects for using the results obtained in the creation of similar processes are also high.

The research is also of practical importance that the by-product formed during the refining of vegetable oils and containing up to 20-25% of saturated and unsaturated fatty acids can also be used as a raw material.

### **Approbation and application.**

13 scientific works on dissertation work, including 6 articles, theses of 7 reports were published at conferences of different levels.

The results of the dissertation were discussed at the following scientific conferences and published in the conference materials:

International scientific conference on “Actual problems of modern chemistry and biology” dedicated to the 93<sup>rd</sup> anniversary of national leader Heydar Aliyev (Ganja, May 12-13, 2016), International scientific conference on “Actual problems of modern natural sciences” dedicated to the 94<sup>th</sup> anniversary of national leader Heydar Aliyev (Ganja, 04-05 May 2017), International scientific-technical conference on “Petrochemical synthesis and catalysis in complex condensed systems” dedicated to the 100<sup>th</sup> anniversary of academician B.G. Zeynalov (Baku, June 29-30, 2017), International conference on “Actual problems of modern chemistry” dedicated to the 90<sup>th</sup> anniversary of the Institute of Petrochemical Processes named after academician Y.H. Mammadaliyev of ANAS (Baku, October 2-4, 2019).

**Name of the organization where the dissertation work is carried out.** The dissertation was completed at Sumgayit State University.

**Personal presence of the author.** The main ideas included in the dissertation, problem statement, research directions and their implementation, analysis and generalization of the obtained results, experiments were carried out by the author personally.

**The volume and structure of the work.** The dissertation consists of an introduction, 6 chapters, results, 113 references and addition. The dissertation is covered by 32 pictures, 1 scheme, 8 tables and 145 printed pages. The dissertation consists of 167997 characters, excluding pictures, tables, bibliography.

**The introductory part** shows the relevance of the dissertation, the purpose and scientific novelty of the work, the practical significance of the research, the reliability of the results, the approbation of the work, publications, the structure and volume of the work.

The scale of the corrosion problem, its causes, the importance of their solution for the Caspian littoral states, including Azerbaijan, were noted.

**Chapter I** explains corrosion processes, their types and mechanisms of processes. Research works on methods of corrosion control and rules of their use are explained. Analytical analysis of

scientific research in the field of synthesis of nitrogenous organic compounds widely used in the fight against corrosion. The use of inhibitors, one of the most effective and promising methods of corrosion protection, inhibitors, a systematic analytical analysis of the successful research of Azerbaijani scientists in this field was given and the need for multifunctional inhibitors was substantiated.

**Chapter II** provides information on the research methods of synthesized substances and their solutions, methods of testing them as corrosion inhibitors and bactericides and an explanation of some of the results obtained using these methods.

**Chapter III** explains the results of the study of the properties of solutions of amides of sunflower, corn, cotton and palm oils with alkyl amines and ethanol amines, prepared on the basis of synthesized substances.

**Chapter IV** provides an analysis of the results of sulfation of amides obtained on the basis of vegetable oils, the synthesis of salts and complexes of sulfate derivatives, the preparation of their solutions and the study of their properties.

**In Chapter V**, the results of the study of solutions of synthesized substances as an inhibitor-bactericide are compared and recommendations for application are given.

Changes in the inhibitory - bactericidal properties of salts and complexes of sulfated amides depending on the nature of the cation in the molecule were studied, the main factors in ensuring the effectiveness were identified. The test results of the synthesized salts and complexes were compared and the sequences of changes in efficiency were determined.

A comparative analysis of the effectiveness of solutions of synthesized substances in H<sub>2</sub>S and CO<sub>2</sub>-saturated media is given. At the same time, the role of solvents in the effectiveness of solutions of salts and complexes as H<sub>2</sub>S corrosion inhibitors and bactericides was studied and commented.

**In Chapter VI**, the effects of solutions of synthesized substances on the cleaning of oil-contaminated water bodies from contaminants were examined. The structure of reagents and the effect of solvent media are studied here. At the same time, the contrast of



the functional groups in the reagents to the oil-bearing properties was studied. Presents the results of the bactericidal study of solutions of synthesized reagents.

This chapter also provides a scheme for the simultaneous acquisition of the proposed reagents.

## SUMMARY OF THE WORK

**1. Experimental methods of corrosion inhibitors and the study of synthesized substances by modern methods.** Since we aim to create inhibitors that provide protection against H<sub>2</sub>S and CO<sub>2</sub> corrosion, we consider it important to note the test methods for H<sub>2</sub>S corrosion and CO<sub>2</sub> corrosion.

Tests of the H<sub>2</sub>S corrosion process are carried out as follows: 20×40×2 mm steel-3 samples are taken and the surface is polished before the test and wiped with ethyl alcohol.

The test medium is a two-phase system consisting of a 9:1 mass water-kerosene system in which H<sub>2</sub>S is dissolved. The amount of H<sub>2</sub>S in a two-phase system can vary between 500 ÷ 3000 mg/l depending on the purpose.

The mixture is mixed with such intensity that the phase separation does not occur. The tests are performed in an inhibitor-free and inhibitory environment with the same amount of H<sub>2</sub>S. If necessary, the water phase of a two-phase system can be used as a 1 and 3% NaCl solution. This method is based on the weight loss of the metal over time.

The ACM GILL AC potentiometer is used to study the effect of inhibitors on the kinetics of CO<sub>2</sub> corrosion.

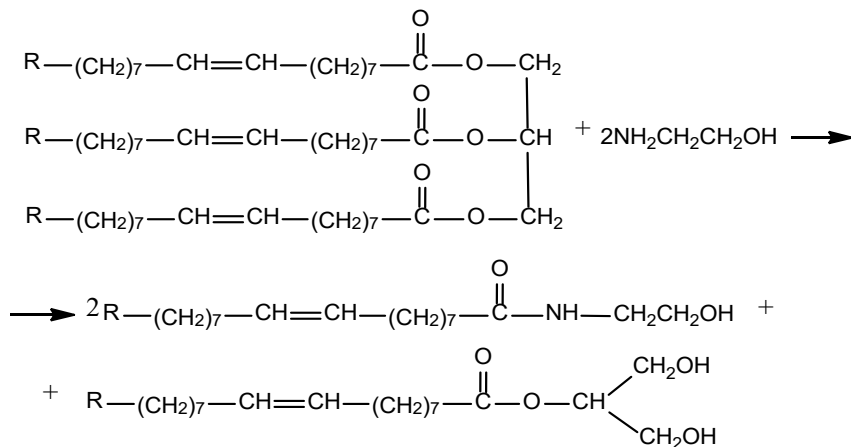
ALPHA IR-Fourier spectrometer and LUMOS IR-Fourier microscope manufactured by the German company BRUKER in the range of 600-4000 cm<sup>-1</sup> wavelength, NMR spectra of primary and synthesized products were recorded at room temperature on a 300 MHz spectrometer manufactured by BRUKER.

PHILIPS XL-30 model (SEM) scanning electron microscope took microphotographs of metal plates before and after testing.

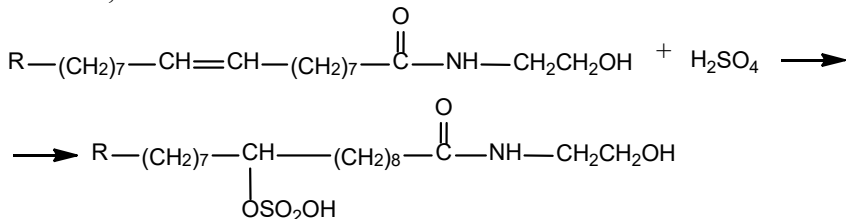
The electrical conductivity of solutions of synthesized

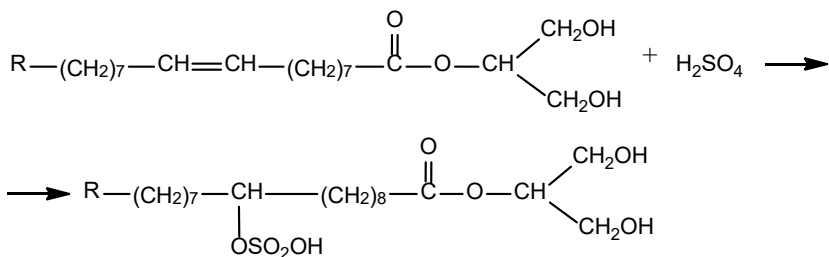
compounds was determined with the help of ANION-4120 conductometer manufactured by the Russian Federation.

**2. Synthesis of sulfate derivatives and their salts and complexes on the basis of vegetable oils.** We performed direct amidation with monoethanol amine (MEA) to synthesize multifunctional inhibitors based on palm (PO), cotton (Cot.O), sunflower (SO) and corn (CO) oils. Ethanol amines play both a hydrolyzing and aminating role. For this purpose, a certain amount of suitable vegetable oil is taken and heated to 100°C. The oil and MEA are then added dropwise to the flask in a ratio of 1:2 mol, then the temperature is raised to 120°C and mixed for 3 hours. In this case, the process of amidation takes place:



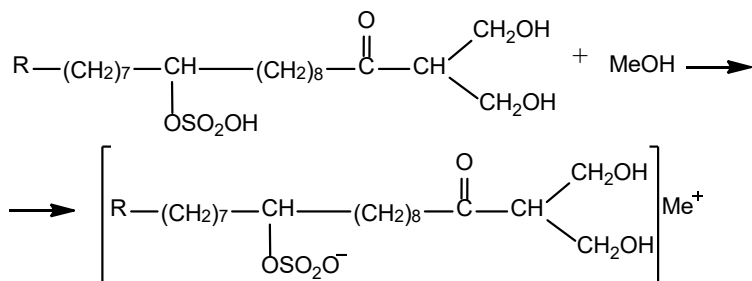
The mixture is then cooled to 60°C and 30% sulfuric acid is added in the calculated amount. Mixing is continued for 12-16 hours, as a result, suitable sulfate derivatives are obtained:





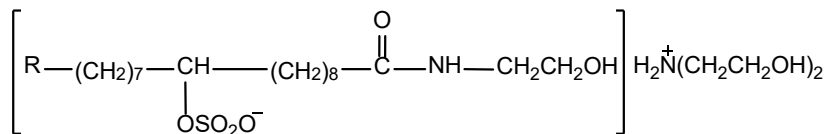
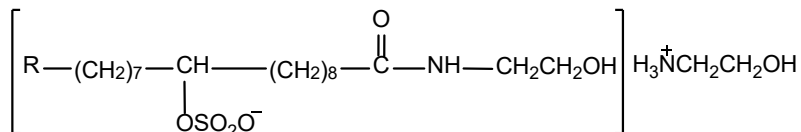
The obtained sulfate derivatives do not have a double bond. The presence of a molecular sulfate group allows the production of more active complexes.

$\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$  salts of sulfate derivatives, MEA and diethanolamine (DEA) complexes were synthesized:



$\text{Me} = \text{Na}^+, \text{K}^+, \text{NH}_4^+$ .

Complexes of sulfate derivatives have also been synthesized:



To prepare solutions of salts and complexes, a solvent mixture consisting of 70% IPA and 30% water and 10% solutions were prepared in this solvent. The use of IPA - water mixture is important for two reasons. On the one hand, IPA provides a good solution of the synthesized substances, on the other hand, the freezing point of the resulting solution is low. We have determined that the solvent obtained by taking 70% and 30% of IPA and water, respectively, achieves the intended purpose.

The solutions were tested as a H<sub>2</sub>S corrosion inhibitor at room temperature in a mixture of H<sub>2</sub>S dissolved water and kerosene in a 9:1 mass ratio.

We used the solutions in concentrations of 50, 100, 150, 200 and 300 mg/l. The amount of active substance in these solutions was 5, 10, 15, 20 and 30 mg/l, respectively. The effect of 10% solutions of various salts and complexes of monoethanolamide sulfate derivatives based on sunflower oil on H<sub>2</sub>S corrosion is given in Table 1.

**Table 1**

**Inhibitory properties of 10% solutions of salts and complexes of monoethanol amidine sulfate derivatives based on SO (In H<sub>2</sub>S environment)**

Reagents	Inhibitor consumption, mg/l	Corrosion rate, g/m <sup>2</sup> ·hour	Delay coefficient - $\gamma$	Corrosion protection effect, %
Na <sup>+</sup> salt	100	2,001	1,8	44,4
	200	1,285	2,8	64,3
	300	–	–	100,0
K <sup>+</sup> salt	100	1,141	3,1	68,3
	200	0,284	12,7	92,1
	250	–	–	100,0
NH <sub>4</sub> <sup>+</sup> salt	100	1,454	2,5	59,6
	200	0,669	5,4	81,4
	250	0,223	16,1	93,8
MEA c.	100	0,428	8,4	88,1
	150	–	–	100,0
DEA c.	50	0,284	12,7	92,1
	100	–	–	100,0

The highest results were obtained when using DEA complex solution.

10% solutions of Na<sup>+</sup>, K<sup>+</sup>, NH<sub>4</sub><sup>+</sup> MEA and DEA complexes of monoethanol amide sulfate derivatives synthesized on the basis of CO were also tested as corrosion inhibitors (tab. 2).

**Table 2**

**Results of tests of 10% solution of monoethanol amide sulfate derivative based on CO as an inhibitor of H<sub>2</sub>S corrosion**

Reagents	Inhibitor consumption, mg/l	Corrosion rate, g/m <sup>2</sup> ·hour	Delay coefficient - $\gamma$	Corrosion protection effect, %
Na <sup>+</sup> salt	50	2,239	1,6	65,8
	100	1,231	2,9	90,0
	200	0,857	4,2	76,2
	250	0,360	10,0	100,0
	300	–	–	100,0
K <sup>+</sup> salt	100	1,008	3,6	72,0
	150	0,223	16,1	93,8
	200	0,072	50,0	98,0
NH <sub>4</sub> <sup>+</sup> salt	100	1,343	2,7	62,7
	150	0,893	4,0	75,2
	200	0,558	6,4	84,5
	250	–	–	100,0
MEA c.	50	0,857	4,2	76,2
	100	0,360	10,0	90,0
	150	–	–	100,0
DEA c.	50	0,144	25,0	96,0
	100	–	–	100,0

The effects of Na<sup>+</sup>, K<sup>+</sup>, NH<sub>4</sub><sup>+</sup> salts of monoethanol amidine sulfate derivative synthesized on the basis of PO, as well as 10.0% solutions of MEA and DEA complexes as H<sub>2</sub>S corrosion inhibitors were tested (tab.3).

**Table 3**

**Results of tests of Na<sup>+</sup>, K<sup>+</sup>, NH<sub>4</sub><sup>+</sup> salts of PO-based monoethanolamide sulfate derivative, 10.0% solutions of MEA and DEA complexes as H<sub>2</sub>S corrosion inhibitor**

Reagents	Inhibitor consumption, mg/l	Corrosion rate, g/m <sup>2</sup> -hour	Delay coefficient – $\gamma$	Corrosion protection effect, %
Na <sup>+</sup> salt	200	1,929	1,8	46,4
	500	1,429	2,5	60,3
K <sup>+</sup> salt	100	2,858	1,2	20,6
	200	1,785	2,0	50,4
	500	1,001	3,6	72,2
NH <sub>4</sub> <sup>+</sup> salt	200	0,857	4,2	76,2
	400	0,284	12,7	92,1
MEA c.	100	0,572	6,3	84,1
	150	0,072	50,0	98,0
DEA c.	50	0,284	12,7	92,1
	100	0,072	50,0	98,0

Similar salts and complexes were synthesized on the basis of Cot.O, 10% solutions were prepared. The prepared solutions were tested as an H<sub>2</sub>S corrosion inhibitor (tab.4).

**Table 4**

**Results of tests of 10.0% solutions of salts and complexes of monoethanolamide sulfate derivative obtained on the basis of Cot.O as an inhibitor of H<sub>2</sub>S corrosion**

Reagents	Inhibitor consumption, mg/l	Corrosion rate, g/m <sup>2</sup> -hour	Delay coefficient – $\gamma$	Corrosion protection effect, %
Na <sup>+</sup> salt	200	1,645	2,2	54,3
	500	0,857	4,2	76,2
K <sup>+</sup> salt	200	1,285	2,8	64,3
	500	0,428	8,4	88,1
NH <sub>4</sub> <sup>+</sup> salt	200	0,785	4,6	78,2
	500	0,216	16,6	94,2
MEA c.	100	0,5	7,2	86,1
	150	–	–	100,0
DEA c.	50	0,284	12,7	92,1
	100	–	–	100,0

A mixture of 70% water and 30% isopropyl alcohol (IPA) was prepared for the preparation of 10.0% solutions of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$  salts and a solution containing 30% water and 70% IPA was prepared for the preparation of MEA and DEA complexes.

DEA was also obtained on the basis of PO, its sulfate derivatives were synthesized and  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$  salts of sulfate derivative, MEA and DEA complexes were obtained, 10% solutions of which were prepared.  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$  salts, MEA and DEA complexes, respectively water : IPA 70%:30%; 40%:60% 40%:60%, 40%:60% and 30%:70% ratios were prepared in solutions.

The solutions have been tested as an  $\text{H}_2\text{S}$  corrosion inhibitor.

When SO-based Na salt solution was added at a concentration of 100 mg/l, the corrosion protection effect was 48.0%, 72.0% and 80.0%, respectively, when 200 mg/l of K salt solution was added, the protective effect was 76.0%, when  $\text{NH}_4$  salt was given to the environment at 100 mg/l, the protective effect was 56.0%.

When the MEA complex solution is added in an amount of 100 mg/l, the protective effect is 94%, the DEA complex solution is 100% when added to the medium in an amount of 100 mg/l.

Protective effects of  $\text{Na}^+$ ,  $\text{NH}_4^+$  salts, MEA and DEA complex at a concentration of 100 mg/l were 48%, 56%, 94% and 100%, respectively.

Solutions of salts and complexes of diethanolamide sulfation products obtained on the basis of SO have been tested as an inhibitor of  $\text{H}_2\text{S}$  corrosion.

Na salt at a concentration of 100 mg/l shows - 60%; K salt - 64%;  $\text{NH}_4$  salt - 64%; MEA complex - 92%; DEA complex - 100% protective effect.

Na salt  $\rightarrow$  K salt =  $\text{NH}_4^+$  salt  $\rightarrow$  MEA complex  $\rightarrow$  DEA complex.

$\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$  salts of diethanolamide sulfate derivative of Cot.O, 10% solutions of MEA and DEA complexes were also tested as  $\text{H}_2\text{S}$  corrosion inhibitors.

Na salt solution at a concentration of 100 mg/l shows - 33%; K salt solution - 42%;  $\text{NH}_4$  solution - 40%; MEA complex - 86%; DEA complex solution -96% protective effect.

Results of tests of Na<sup>+</sup>, K<sup>+</sup>, NH<sub>4</sub><sup>+</sup> salts, MEA and DEA complexes of diethanolamide sulfation product obtained on the basis of PO:

Na salt solution at a concentration of 200 mg/l shows - 42%; K salt solution - 54%; NH<sub>4</sub> salt solution - 36%; MEA complex solution - 84%; DEA complex solution - 96% protective effect.

Solutions of MEA complexes based on SO, CO, Cot.O and PO at a concentration of 100 mg/l, respectively 94%; 92%; 86% and 84% showed a defensive effect. Solutions of DEA complexes of these oils in a concentration of 100 mg/l, accordingly 100%; 100%; 96%; and 96% showed a defensive effect.

**3. Testing solutions of salts and complexes of sulfate derivatives synthesized on the basis of vegetable oils as a CO<sub>2</sub>-corrosion inhibitor.** The following solutions have been prepared for testing:

1) 15% solution of octyl amine (OA) complex of monoethanolamide sulfonation product obtained in a ratio of 1:1 mole with SO-based MEA in a mixture of 90% IPA and 10% water.

2) 10.0% solution of DEA complex of ethanol amidine sulfation product obtained in a ratio of 1:1 mol with SO DEA in a mixture of 80.0% IPA and 20% water.

3) 10% solution of sodium salt of alkyl amidine sulfation product obtained in a ratio of 1:2 mol with SO and OA in IPA.

4) 10% solution in a mixture of 90% IPA and 10% water of MEA complex of diethanol amidine sulfation product obtained in a ratio of 1:1 mol of SO and DEA.

5) 10% solution in a mixture of 70% IPA and 30% water of triethanol amine complex of ethanolamide sulfation product obtained in a ratio of 1:1 mole of OA with SO.

6) 10% solution in a mixture of 90% IPA and 10% water of OA complex of alkyl amidine sulfation product obtained in a ratio of 1:1 mol of OA with SO.

7) 10% solution in a mixture of 90% IPA and 10% water of triethanol amine complex of OA sulfation product obtained in the ratio of OA 1:2 mol with SO.



8) 10% solution of Na salt of OA sulfation product obtained in the ratio of SO and OA 1:3 mol in a mixture of 90% IPA and 10% water.

9) 12.5% solution of diethanolamide sulfation product obtained in the ratio of 1:3 mol of SO and DEA in IPA of MEA complex.

10) 10% solution of Na salt of OA sulfate solution obtained in a ratio of 1:1 mol with SO and OA in a mixture of 90% IPA and 10% water.

11) 10% solution of MEA complex of OA sulfation product obtained in the ratio of SO and OA 1:3 mol in a mixture of 70% IPA and 30% water.

12) 10% solution of potassium salt of ethanolamide sulfation product obtained in a 1:1 mole ratio of SO and MEA in a mixture of 90% IPA and 10% water.

13) 10% solution in IPA of sodium salt of diethanol amidine sulfation product obtained in the ratio of 1:3 mol of SO and DEA.

14) 10% solution in IPA of DEA complex of diethanol amidine sulfation product obtained in a ratio of 1:3 mol of SO and DEA.

15) 10% solution in a mixture consisting of 60% IPA and 40% water of OA complex of octylamide sulfation product obtained from SO and OA in a ratio of 1:3 mol.

16) 10% solution in a mixture consisting of 70% IPA and 30% water of OA complex of octyl amidine sulfation product obtained in the ratio of SO and OA 1:2 mol.

The solutions have been tested as a CO<sub>2</sub> corrosion inhibitor (at a concentration of 500 mg/l):

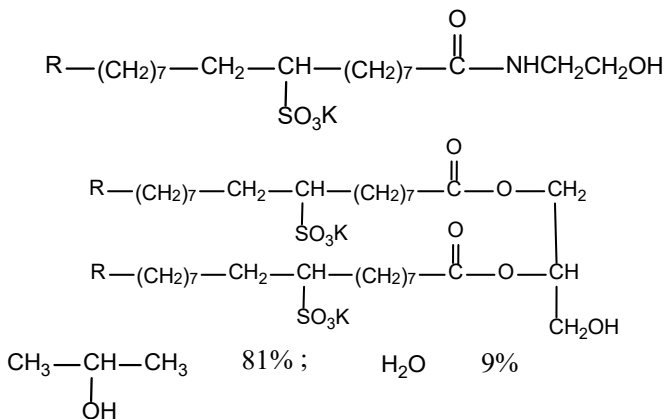
N. 1 protective effect – 99.2%; N. 2 – 99.5%; N. 3 – 99.5%; N.4 – 99.4%; N. 5 – 99.4%; N. 6 – 99.2%; N. 7 – 99.4%; N. 8 – 99.4%; N. 9 – 99.4%; N.10 – 99.6%; N. 11 – 98.9%; N. 12 – 99.4%; N. 13 – 99.6%; N. 14 – 99.6%; N. 15 – 99.1%; N. 16 – 99.3%.

2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15 and 16 solutions containing 50 mg/l of active substance from 16 samples used provide 99.5% corrosion protection at a concentration of 500 mg/l, respectively, 99.5%; 99.4%; 99.4%; 99.2%; 99.4%; 99.6%; 98.9%; 99.4%; 99.6%; 99.6%.

Although the active substance with a total concentration of 500

mg/l in sample (solution) 1 was 75 mg/l, the protective effect was 99.2%. In sample 9, when the total concentration was 500 mg/l and the amount of active substance was 62.5 mg/l, the protective effect was 99.4%.

The most important of the 16 compositions tested is composition number 12:



Too much solvent in this composition provides a lower freezing point of the resulting solution.

**4. Investigation of oil - collecting properties for cleaning oil - contaminated water bodies.** We have studied the oil-collecting properties of the solutions we have prepared on the basis of the substances we have synthesized. Naftalan (NO) and Garasu field (GO) oils were used for the study. 16 solutions were used to study the oil-collecting properties. 40 g of sea water and 2 g of oil are poured into a Petri cup, 0.04 g of reagent is prepared as a 5% solution in isopropyl alcohol and added to the Petri Cup. Measurements were performed immediately after administration of the reagent, with retention for 6, 24, 48 and 72 hours. During this time, the diameter of the oil layer (OL) accumulated on the surface was recorded.

The composition of the samples is as follows:

1) 10% solution of Na salt of amide sulfonation product obtained in a ratio of 1:2 mol SO and OA in IPA.

- 2) 10% solution of K salt of amide sulfonation product obtained in a ratio of 1:1 mol SO and MEA in 90% aqueous solution of IPA.
- 3) 10% solution of amidine sulfonation product obtained in a ratio of 1:1 mol SO and OA in 90% aqueous solution of IPA.
- 4) 10% solution of DEA complex of amide sulfonation product obtained in a ratio of 1:3 mol SO and DEA in IPA.
- 5) 10% solution of OA complex of amidine sulfonation product obtained in a ratio of 1:1 mol SO and OA in 90% aqueous solution of IPA.
- 6) 10% solution of Na salt of amide sulfonation product obtained in a ratio of 1:2 mol SO and OA in 90% aqueous solution of IPA.
- 7) 10% solution of OA complex of amidine sulfonation product obtained in a ratio of 1:3 mol SO and OA in 60% aqueous solution of IPA.
- 8) 10% solution of OA complex of amidine sulfonation product obtained in a ratio of 1: 2 mol SO and OA in 70% aqueous solution of IPA.
- 9) 15% solution of OA complex of amidine sulfonation product obtained in a ratio of 1:1 mol SO and MEA in 90% aqueous solution of IPA.
- 10) 10% solution of TEA complex of amidine sulfonation product obtained in a ratio of 1:1 mol SO and OA in 70% aqueous solution of IPA.
- 11) 10% solution of MEA complex of amidine sulfonation product obtained in a ratio of 1:3 mol with SO and OA in 70% aqueous solution of IPA.
- 12) 10% solution of Na salt of amide sulfonation product obtained in a ratio of 1:3 mol SO and DEA in IPA.
- 13) 10% solution of MEA complex of amidine sulfonation product obtained in a ratio of 1:1 mol SO and DEA in 90% aqueous solution of IPA.
- 14) 10% solution of DEA complex of amidine sulfonation product obtained in a ratio of 1:1 mol SO and DEA in 80% aqueous solution of IPA.
- 15) 12.5% solution of MEA complex of amidine sulfonation product obtained in a ratio of 1:3 mol SO and DEA in IPA.

16) 10% solution of Na salt of amide sulfonation product obtained in a ratio of 1:3 mol with SO and OA in 90% aqueous solution of IPA.

The diameter of the Petri dish is 9.8 cm and OL completely covers the surface of the water in the Petri dish.

The above solutions (16) are converted into 5% solution in IPA and given in the amount of 0.8 g.

M-1. At first, the diameter of the OL decreases to 2 cm. Surface cleaning is 79.6%. The diameter of the OL does not change after six hours. After 24 hours, the diameter of the OL increases to 2.35 cm and does not change for 48 hours. After 72 hours, the OL diameter is 2.6 cm.

M-2. Initially, the OL diameter decreases to 2 cm and does not change for 6 hours. After 24 hours, the diameter of the OL increases to 2.6 cm. This measurement remains unchanged for 48 and 72 hours.

M-3. At first, the OL diameter was reduced to 1.85 cm and in 6 hours it was further reduced to 1.5 cm. When stored for 24, 48 and 72 hours, it remained 1.75 cm.

M-4. At first, the OL diameter was 1.5 cm, and after 6 hours it was 2.1 cm, after which it is stored for 24, 48 and 72 hours full spread occurred.

M-5. At first, OL diameter was 1.75 cm, after 6 hours it was 2 cm and at 24, 48 and 72 hours it remained stable at 2.25 cm.

M-6. At the first time and for 6 hours, OL remained 1.75 cm and when stored for 24, 48 and 72 hours, it remained 2 cm.

M-7. At first, the OL diameter was 2.25 cm and when stored for 6, 24, 48 and 72 hours, it was 2.35 cm.

M-8. At first, the OL diameter was 2 cm, 2.1 cm after 6 hours, 2.15 cm after 24 hours and 2.25 cm after 48 and 72 hours.

M-9 At first, the diameter of the OL was reduced to 1.75 cm, after 6 hours to 2.1 cm, after 24 hours to 2.6 cm and within 48 hours it spread to the water surface again.

M-10. Initially, the OL diameter was reduced to 2 cm and remained at 1.75 cm for 6, 24, 48 and 72 hours of storage. The percentage of surface cleaning was 82.15%.

M-11. At first, the OL diameter was reduced to 2.25 cm, 2 cm after 6 hours, 2.15 cm after 24 hours, 2.35 cm after 48 hours and 2.6 cm after 72 hours.

M-12. Initially, the diameter of the OL was 2 cm, it remained unchanged at 6 cm for 6 hours and after 24 hours of storage, the complete spread of the OL took place.

M-13. At first, the diameter of the OL was reduced to 2.35 cm, after 6 hours it was 2 cm and after 24 hours of storage, full spread occurred.

M-14. Initially, the OL diameter was reduced to 2.0 cm, remained unchanged for 6 hours, 2.15 cm for 24 hours, 2.25 cm for 48 hours, and 2.6 cm for 72 hours.

M-15. At first, the diameter of the OL was reduced to 2.0 cm, after 6 hours it was 2.05 cm and within 24 hours there was a complete spread.

M-16. At first, the diameter of the OL was reduced to 26 cm, after 6 hours it was 2.35 cm and after 24 hours there was a complete spread.

The best results were obtained with solutions 3, 6 and 10.

When these solutions were used, even after 72 hours of storage, the diameter of the OL on the water surface was 1.75, 2 and 1.75 cm, respectively. The water surface clearance rate was 82.5%; 79.6% and 82.5%, respectively.

The same experiments were conducted with the GO.

M-1 At first, the diameter of the OL was 1.5 cm and after 6, 24, 48 and 72 hours of storage, the diameter of the OL was 1.75 cm and remained stable.

M-2 At first, the diameter was reduced to 1.75 cm, after 6 hours it was 2 cm and after 24 hours or more, the spread occurred.

M-3 At first, the diameter of the OL on the water surface was reduced to 2.6 cm and after 6 hours it spread.

M-4 At first, the diameter of the OL on the water surface decreased to 1.5 cm, after 6 hours it was 2.25 cm, and after 24 hours it spread.

M-5 At first, the diameter of the OL on the water surface was reduced to 1.75 cm and remained constant at 2.0 cm when stored for

6, 24, 48 and 72 hours.

M-6 At first, the diameter of the OL on the water surface was reduced to 2.6 cm and after 6 hours it spread again.

M-7 At first, the diameter of the OL on the water surface was reduced to 2.25 cm and after 6, 24, 48, 72 hours, the diameter of the OL remained unchanged at 2.35 cm.

M-8 At first, the diameter of the OL on the surface of the water was reduced to 2.6 cm, after 6 hours to 2.35 cm, after 24 hours to 2.35 cm, after 48 hours and 72 hours to 2.1 cm.

M-9 At first, the diameter of the OL on the water surface decreased to 1.5 cm, after 6 hours to 1.75 cm and after 24, 48 and 72 hours, the diameter of the OL remained stable at 1.75 cm.

M-10 At first, the diameter of the OL on the water decreased to 1.5 cm and after 6, 24, 48, 72 hours it was stable at 1.75 cm.

M-11 At first, the diameter of OL on the water surface decreased to 1.5 cm, after 6 hours - 1.75 cm, after 24 and 48 hours - 1.8 cm, after 72 hours - 1.85 cm.

M-12 At first, the diameter of OL on the water surface decreased to 1.5 cm, after 6 hours it was 2 cm, after 24 hours it was 2.35 cm, after 48 and 72 hours it was 2.6 cm.

M-13 At first, the diameter of the OL on the water surface decreased to 2.0 cm, after 6 hours it was 2.35 cm and after 24 hours the OL began to spread again on the water surface.

M-14 At first, the OL diameter on the water surface decreased to 2 cm, 1.5 cm after 6 hours, 1.75 cm after 24 hours, 2 cm after 48 hours and 2.15 cm after 72 hours.

M-15 At first, the diameter of OL on the water surface decreased to 1.6 cm and after 6 hours it was 2.65 cm. After 24 hours, OL began to spread again on the water surface.

M-16 At first, the diameter of the OL on the water surface was reduced to 2 cm, after 6 hours it was 2.6 cm and after 24 hours the OL spread again on the water surface.

When using GO, the best results were obtained with solutions numbers 1.5, 8, 9, 10 and 11.

During experiments with Naphthalene oil (NO), solutions 3, 6, and 10 showed better oil-collecting properties. NO is heavy oil and

GO is light oil.

Only solution number 10 allows both heavy and light oils to accumulate on the surface, reducing the surface layer by 87.75%.

The effect of ethylene glycol (EG) on the oil storage properties of the ingredients was also studied. For this purpose, a 50% solution of EG in water was prepared and solutions were prepared by mixing 10% solutions in a 5:1 mass ratio. The activities of collecting GO and NO oils from the water surface of these solutions were studied;

1) A mixture of 10% solution of Na salt in IPA and 50% solution of EG in water in a ratio of 5:1 by weight of amide sulfation product obtained with SO and OA in a ratio of 1:2 mol.

2) A mixture of 10% solution of K salt of amide sulfation product obtained in a ratio of 1:1 mol with SO and MEA in a 90% solution of IPA in water and a 5:1 mass ratio of 50% solution of EG in water.

3) A mixture of 10% solution of Na salt of amide sulfation product obtained in a ratio of 1:1 mol with SO and OA in a 90% solution of IPA in water and a 5:1 mass ratio of 50% solution of EG in water.

4) A mixture of amidine sulfation product obtained with SO and DEA in a ratio of 1:3 mol with 10% solution of DEA complex in IPA and 5:1 mass ratio of 50% solution of EG in water.

5) A mixture of amide of 1:1 mol with SO and OA in a ratio of 5:1 mass ratio of a 10.0% solution of IPA in 90% aqueous solution with 50% solution of EG in water.

6) A mixture of 10% solution of TEA complex in 70% aqueous solution of IPA of TEA complex of amidine sulfation product obtained in a ratio of 1:2 mol with SO and OA and a 5:1 mass ratio of 50% solution of EG in water.

7) A mixture of 10% solution of amidine sulfation product of OA complex obtained in a ratio of 1:3 mol with SO and OA in 60% aqueous solution of IPA and a 5:1 mass ratio of 50.0% solution of EG in water.

8) A mixture of amidine sulfation product obtained in a ratio of 1:2 mol with SO and OA in a ratio of 5:1 by weight of a 10% solution of OA complex in 70% aqueous solution of IPA with a 50%

solution of EG in water.

9) A mixture of amidine sulfation product obtained in a ratio of 1:1 mol with SO and MEA in a ratio of 5:1 by weight of a 15% solution of OA complex in 90% solution in IPA with 50% solution of EG in water.

10) A mixture of triethanol amine complex of amidine sulfation product obtained in a ratio of 1:1 mol with SO and OA in a ratio of 5:1 by weight of 10% solution of IPA in 70% aqueous solution with 50.0% solution of EG in water.

11) A mixture of 10% solution of amide sulfation product obtained in a ratio of 1:3 mol with SO and OA in a 70% solution of MEA complex in IPA and a 5:1 mass ratio of 50% solution of EG in water.

12) A mixture of amidine sulfation product obtained with SO and DEA in a ratio of 1:3 mol with a 10% solution of Na salt in IPA and 50% solution of EG in water in a ratio of 5:1 by weight.

13) A mixture of amidine sulfation product obtained with SO and DEA in a ratio of 1:1 with a 10% solution of MEA complex in 90% aqueous solution of IPA and a 5:1 mass ratio of 50% solution of EG in water.

14) A mixture of amidine sulfation product obtained with SO and DEA in a ratio of 1:1 mol with a 10% solution of DEA complex in 80% aqueous solution of IPA and 5:1 mass ratio of 50% solution of EG in water.

15) A mixture of 12.5% solution of amidine sulfation product in IPA with SO and DEA in the ratio of 1:3 mol with 5:1 mass ratio of 50% solution of EG in water.

16) A mixture of amidine sulfation product obtained in a ratio of 1:3 mol with SO and OA with a 10% solution in 90% aqueous solution of IPA with 5:1 mass ratio of 50% solution of EG in water.

The prepared solutions were used to collect the oil layer formed by the GO from the seawater surface.

Immediately after the solutions 1, 3-9, 11-15 were added to the water containing OL, the diameter of the collected OL was the same and amounted to 2.35 cm. When the mixture number 10 and 16 was given, the diameter of the oil layer was 2.5 cm. For the test, 40 grams



of sea water, 2 grams of GO were given to the Petri dish and 0.04 grams of the mixture was added to the water. When mixture number 2 was added, the diameter was up to 2.2.

6 hours after adding the mixtures to the surface of the water, the oil layer was 5 cm in the case of mixtures numbered 1-12. The oil-free area of the water surface increased slightly from 75% to 79.75% in diameter and was 2.5 cm. When using mixtures 13 and 14, the diameter of the OL was further reduced to 2 cm. In the case of the 15<sup>th</sup> mixture, the diameter of the OL was 2.5 cm after 6 hours and in the case of the 16<sup>th</sup> mixture, it was 2.6 cm. A number of anomalies were observed in the formation of the OL after 24, 48 and 56 hours after the administration of reagents 1-12. 24 hours after the mixtures were applied to the surface, in the case of mixtures numbered 1-12, the OL re-spread to the surface and regained its previous state. When mixtures 2, 4, 7, 8, 9, 12, 15 and 16 were used, the spread was also observed during 48 and 56 hours of storage. When the 1<sup>st</sup> mixture is used, OL is collected again on the surface of the water and has a diameter of 2 cm, the cleaned surface of the water was 87%. After 56 hours, the oil spread again on the surface. This was also observed when using mixtures 3, 6 and 10.

6, 24, 48 and 56 hours after the addition of mixtures 13 and 14 in fact, the diameter of the OL on the surface was stable between 2.0 and 2.1 cm.

The mixtures were tested to collect the NO layer from the seawater surface. In this case, the results differ from the results obtained when checking the GO.

Immediately after giving (IAG) of solution I, the diameter of the OL was reduced to 1.8 cm and the cleaned surface of the water was 87.04%. After six hours, the diameter of the OL was 2 cm and after 24, 48 and 56 hours it remained unchanged at 2.08 cm.

Immediately after giving (IAG) of mixture II, the diameter of OL was 1.75 cm, 2 cm after 6 hours and after 24, 48 and 56 hours of storage, the oil was redistributed on the water surface.

Immediately after giving (IAG) of mixture III, the diameter of OL was reduced to 1.8 cm, 2 cm after 6 hours, 2 cm after 24 hours and 2.2 cm after 48 and 56 hours.

The surface water purified from the OL was 87.04%, 84%, 84%, 80.64% and 80.64% of the total surface.

Immediately after giving (IAG) of IV mixture, the diameter of OL decreased to 1.75 cm, after 6 hours to 2.1 cm and after 24 hours OL spread to the surface again.

Immediately after giving (IAG) of V mixture, the diameter of OL decreased to 1.75 cm, after 6 and 24 hours it was 1.8 cm in both cases and after 48 and 56 hours it was 1.9 cm in both cases.

Immediately after giving (IAG) of mixture VI, the diameter of OL was reduced to 1.75 cm, unchanged after 6 hours to 1.75 cm, after 24 hours to 2 cm, after 48 hours to 2.35 cm and after 56 hours to 2.6 cm.

Immediately after giving (IAG) the mixture VII, the diameter of the OL decreased to 2.35 cm, 2.5 cm after 6 hours, spread after 24 and 48 hours and after 56 hours the OL re-assembled on the surface and became 2.35 cm in diameter.

Immediately after giving (IAG) the mixture VIII, the diameter of the OL was reduced to 2.5 cm, after 6 hours the diameter was 2.6 cm, after 24 hours the OL re-spread to the surface and remained within 48 hours, re-assembly occurred after 56 hours and the diameter was 2.25 cm.

Immediately after giving (IAG) the IX mixture, the diameter of the OL decreased to 1.75 cm, after 6 hours to 2.1 cm and after 24 hours there was a spread.

Immediately after giving (IAG) the X mixture, the diameter of the OL was reduced to 1.75 cm, unchanged at 6 hours and 24 hours, 1.8 cm after 48 hours and 1.75 cm after 56 hours.

Immediately after giving (IAG) the XI mixture, the diameter of OL decreased to 1.9 cm, after 6 hours the diameter was 2 cm, after 24 hours it was 2.35 cm, after 48 hours it was 2.35 cm and after 56 hours it was 2.6 cm.

Immediately after giving (IAG) the XII mixture, the diameter of the OL was 1.75 cm, 2 cm after 6 hours and after 24 hours the layer was re-spread on the water surface.

Immediately after giving (IAG) the XIII and XIV mixtures, the diameter of the OL was 1.75 cm in both cases, 2 cm after 6 hours and

after 24 hours in both cases there was a spread.

Immediately after giving (IAG) the XV the diameter of the OL was 1.75 cm, after 6 hours it was 2.05 cm and after 24 hours it spread.

Immediately after giving (IAG) the XVI the diameter of the OL was 2 cm and in both cases it was stable at 2.35 cm after 6 and 24 hours and spread after 48 hours.

Mixtures 13 and 14 show good results when GO is used and mixtures 1, 5 and 11 show good results when NO is used.

**5. Influence of solutions of complexes of sulfation products of amides of vegetable oils on the life activity of sulfate-reducing bacteria.** Detection of SRB: after the percentage solution of the reagents is added to the test tubes together with the posgate solution, the test tubes are placed in a thermostat at 30-35°C and stored here for 15 days.

There are no sulfate-reducing bacteria (SRB) in the Control-1 environment and the amount of H<sub>2</sub>S is 24 mg/l.

Control-2 medium contains SRB and the amount of H<sub>2</sub>S is 375 mg/l.

The Control-3 medium is a nutrient medium and the number of bacteria is 108 cells/ml.

The analysis shows that due to the bactericidal effect, the solutions are arranged in the following descending order.

M.14 (100) = M.15 (100 %) = M.16 (100 %) > M.9 (97 %) > M.12 (95,1 %) > M.5 (94,4 %) > M.6 (94,4 %) > M. 7 (94,3 %) > M.4 (94%) = M.6 (94 %) = M.11 (94 %) > M.3 (92 %) = M.8 (92 %) > M.13 (89%) > M.2 (82 %) > M.1 (81 %) > M. 10 (74 %)

Note that, as mentioned in the previous sections, the protection of solution №12, 13 and 14 from CO<sub>2</sub> corrosion was 98.7%, 99.3% and 98.7%, respectively.

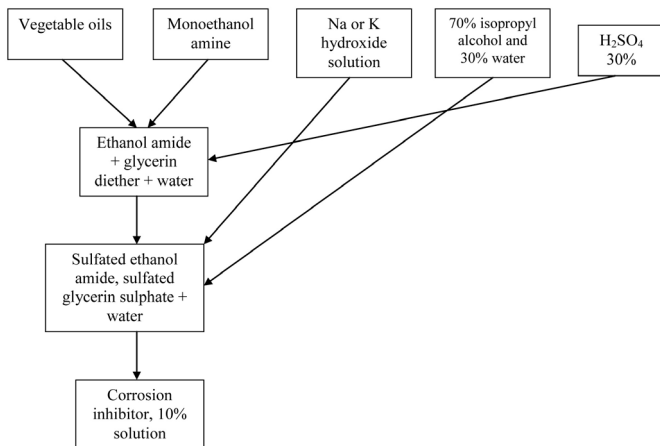
Solution 12 and solution 14 also have high bactericidal properties. Studies show that these compounds can be used as a corrosion inhibitor-bactericide.

**6. Principled technological scheme of obtaining hydrogen sulfide and CO<sub>2</sub> corrosion inhibitors based on vegetable oils.** It has been found that more effective inhibitory ingredients are derived from sunflower and corn oils. Cotton and palm oils can also be used if needed.

Taking vegetable oil and MEA in a ratio of 1:1 mol, first add vegetable oil to the reactor, heat to 120°C and add the appropriate amount of MEA in proportion to the mole ratio and mix at the same temperature for 3 hours. The reaction product is then cooled to 60°C, then a calculated amount of 30% sulfuric acid is added to the reaction product and the sulfation takes place at that temperature for 12-16 hours. Salts and complexes are then obtained in the presence of solvents.

As can be seen from the schematic diagram, no by-products that pollute the environment are obtained during the process (scheme 1). The use of renewable raw materials as raw materials ensures the reliability of inhibitor production.

Depending on the supply capacity and the aggressiveness of the expected environment, raw materials can be easily replaced and different inhibitory ingredients can be prepared.



**Scheme 1. Schematic diagram of the production of H<sub>2</sub>S and CO<sub>2</sub> corrosion inhibitors based on vegetable oils.**

More suitable vegetable oil is selected as the raw material used. The selected vegetable oil is loaded into the reactor in a certain amount and a 50% solution of MEA in water is taken in the ratio of 1:1 mole of MEA to the oil. A portion of the MEA solution is added to 30% of the stoichiometric amount of oil and the mixture is heated to 100°C by stirring. The rest of the MEA solution is then gradually fed to the reactor. The temperature is maintained between 100-120°C and the process continues for 3 hours. As a result, a mixture of ethanol amide and glycerin of vegetable oil acids is obtained. 30% sulfuric acid is added to the mixture and sulfation is continued at 60°C. The sulfation product is neutralized with sodium hydroxide or potassium hydroxide to form a 10% solution. It should be noted that a mixture of 70% IPA and 30% water is used as a solvent.

## CONCLUSION

1. The possibility of creating H<sub>2</sub>S and CO<sub>2</sub> corrosion inhibitors based on corn, sunflower, cotton, palm oils has been studied and highly effective inhibitor formulations have been developed. For this purpose, one-stage amidation of the vegetable oils with ethanolamines and alkylamines, and the sulfation of the obtained amides have been carried out. The structures of the products formed at each stage of the synthesis of salts and complexes of sulfates have been determined by spectral analysis and their physical-chemical properties have been studied.

2. It was found that after amidation of sunflower oil with MEA, the sulfation product was neutralized with sodium hydroxide, potassium hydroxide, ammonium hydroxide, MEA and DEA in a 10% solution in a solvent consisting of 70% isopropyl alcohol and 30% water:paraffin 9:1 by weight and hydrogen sulfide in a dissolved environment to protect against corrosion to varying effectiveness. Na, K, NH<sub>4</sub><sup>+</sup>, MEA and DEA complexes at a concentration of 100 mg/l have a corrosion protection effect of 44.4%, 68.3%; 59.6%; 88.1% and 92.1%, respectively. Na, K and NH<sub>4</sub><sup>+</sup> salts at a concentration of 200 mg/l provide 64.3% corrosion

protection, 92.1% and 81.4%, respectively. When using MEA complex 150 mg/l, and DEA complex solution 100 mg/l, steel-3 sample is 100.0% protected from corrosion. Due to the protective effect, the ingredients are arranged in the following order:

Na salt (44,4%) < NH<sub>4</sub><sup>+</sup> salt (59,6%) < K salt (68,3%) < MEA complex (88,1%) < DEA complex (100%).

3. A 10% solution of corn oil-based complexes was used as an inhibitor of H<sub>2</sub>S corrosion. It was found that Na, K, NH<sub>4</sub><sup>+</sup> salts and solutions of MEA and DEA complexes are used at a concentration of 100 mg/l, the protection against hydrogen sulfide corrosion was 90%, 72%; 62.7%, 90% and 100% respectively. The sequence was as follows in terms of effectiveness:

NH<sub>4</sub><sup>+</sup> salt (62,7%) < K salt (72%) < Na salt (90%) = MEA complex (90) < DEA complex (100%).

4. 100.0% solutions of salts based on palm oil provide protection of steel-3 sample from H<sub>2</sub>S corrosion at a concentration of 200 mg/l in the following order:

Na salt (46,4%) < potassium salt (50,4%) < NH<sub>4</sub><sup>+</sup> salt (76,2%). When the MEA salt is 100 mg/l, the corrosion protection is 92.1%, the DEA complex solution provides 98.0% protection at the same concentration.

5. 10% solutions of Na, K, NH<sub>4</sub><sup>+</sup> salts, MEA and DEA complexes of cotton oil monoethanol amide sulfate derivative were tested as H<sub>2</sub>S corrosion inhibitors and the following protective effects were obtained (at a concentration of 200 mg/l):

Na salt (54,3%) < K salt (64,3%) < NH<sub>4</sub> salt (78,2%). MEA complex and DEA complex solutions showed 86.1% and 100% protection effect, respectively, at a concentration of 100 mg/l.

6. Sulfate derivatives of diethanol amides of sunflower, corn, cotton and palm oils were synthesized, salts and complexes of their sulfate derivatives were obtained, 10% solutions of them were prepared, physical and chemical properties of solutions were studied. The freezing temperatures of the obtained solutions were as follows, depending on the nature of the cation:

Na salt (minus 25°C) = NH<sub>4</sub><sup>+</sup> salt (minus 25°C) < K salt (minus 33°C) < MEA complex (minus 34°C) < DEA complex (minus 45°C).

Solutions based on corn oil:

K salt (minus 34°C) < Na salt (minus 38°C) < NH<sub>4</sub><sup>+</sup> salt (minus 40°C) = DEA complex (minus 45°C).

Solutions based on cottonseed oil:

NH<sub>4</sub><sup>+</sup> salt (minus 10°C) < K salt (minus 12°C) < Na salt (minus 14°C) < MEA complex (minus 24°C) < DEA complex (minus 36°C).

Solutions based on palm oil:

Na salt minus 12°C) < NH<sub>4</sub><sup>+</sup> salt (minus 28°C) < MEA complex (minus 30°C) < K salt (minus 34°C) < DEA complex (minus 38°C).

7. 10% solutions of Na, K, NH<sub>4</sub><sup>+</sup> MEA and DEA complexes of diethanol amidine sulfate derivative based on sunflower oil provide 48%, 56%, 94% and 100% protection against H<sub>2</sub>S corrosion at a concentration of 100 mg/l, respectively.

Corn oil-based solutions at a concentration of 100 mg/l provide corrosion protection of 60%, 64%, 64%, 92% and 100%, respectively.

In cotton oil-based solutions of the same concentration, the protective effect was 33%, 42%, 40%, 86% and 98%, respectively.

Palm oil-based solutions do not provide good protection against H<sub>2</sub>S corrosion, even at a concentration of 200 mg/l, in the presence of cations Na, K and NH<sub>4</sub><sup>+</sup>. MEA complex solution at a concentration of 100 mg/l provides protection of 84.0% and DEA complex solution provides 96.0%.

8. MEA, DEA, octyl amide of sunflower oil were obtained by taking 1:1, 1:2 and 1:3 mol of ethanol amine and octyl amine of oil and their sulphate derivatives were synthesized and based on them, compounds number 1-16 were prepared. The effect of the components on the kinetics of carbon dioxide corrosion was studied. The effect of 10.0% solutions on kinetics was as follows: it was found that when samples 2-8 and 10-16 of the active substance were 50 mg/l, the carbon dioxide corrosion protection was 99,5%; 99,5%; 99,4%; 99,4%; 99,2%; 99,4%; 99,4%; 99,6%; 98,9%; 99,4%; 99,6%; 99,6%; 99,1% vа 99,3%.

Sample 1 provides 99.2% corrosion protection at 75 mg of active substance and sample 9 provides 99.4% corrosion protection

at 62.5 mg/l. From an economic point of view, a solution of ethanol amines and amide derivatives obtained in a 1:1 mole ratio of active amine to oil (example 12) is more suitable. Thus, MEA is the most produced and cheaper raw material.

**The main content of the dissertation is given in the following published scientific works:**

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