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# **Inhibited Solvent for Dissolving Solid Sediments of Heat Exchangers of the Oil and Gas Industry**

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**ABSTRACT:**One of the reasons for reducing the efficiency of wells operation is the formation of inorganic salts, which are deposited in the bottomhole zone of wells and on the surface of oilfield equipment. As a rule, salt deposits are found: on the walls of the lower part of the production strings, in the receiving and working bodies of electric centrifugal and sucker rod pumps, on the inner surface of the tubing. Crystallization centers are formed there and new deposits grow on them. A layer of scale sharply worsens the thermal conductivity of the walls and reduces the cross-section of the pipes of the water supply system, is the cause of a decrease and ultimately leads to their emergency state.

**KEYWORDS:**Crystallization, scale deposition, dissolution, scale layer, formation of deposits, corrosion, thermal conductivity of walls.

## **I. INTRODUCTION**

Study of the physicochemical properties of solid scale deposits accumulating in the inner surface of pipes and heat exchangers, their dissolution, as well as the interaction and safety of reagents to the materials of the plant to be cleaned.

Hard crystalline deposits and scale from the inner surface of pipes and heat exchangers adhere firmly to the pipe walls. The new type of solvent developed by us is effective and applicable for modern equipment, obtained from local raw materials and safer for technological equipment.

One of the reasons for reducing the efficiency of wells operation is the formation of inorganic salts from the produced water, which are deposited in the bottomhole zone of wells and on the surface of oilfield equipment [1]. Formation of hardly soluble scale deposits and scale on the surface of heat exchange equipment is associated with the effect of elevated temperature on the components dissolved in water [2]. As a result of the physical and chemical processes occurring near the surface of heat exchange (in the places of the highest temperature difference), the dissolved components form compounds insoluble in water, which are deposited on the surface, where the formation of crystallization centers is most likely [3]. As a rule, salt deposits are found: on the walls of the lower part of the production strings, in the receiving and working bodies of electric centrifugal and sucker rod pumps, on the inner surface of the tubing. The usual constituents of scale are calcium and magnesium carbonates, silicon oxide, calcium sulfate, calcium and magnesium silicates, calcium, zinc and iron phosphates, and other insoluble compounds [4]. Salt deposits are the cause of a decrease or complete loss of productivity of downhole pumping units and the occurrence of emergencies at oilfield facilities. Salts drastically reduce the heat transfer coefficient and, consequently, the efficiency of the heat exchange equipment, increase the hydraulic resistance of the passage and can even lead to complete blockage of pipelines. In addition, the formation of salts provokes the corrosive destruction of the metal under its layer [5]. Before dissolving solid scale deposits, it is necessary to learn about their physicochemical properties, as well as the compatibility of the reagents with the materials of the unit to be cleaned. Salt crystallization, unfortunately, occurs mostly on the inner surface of pipes, boilers, tanks and heat exchangers. Crystallization centers are formed there and new deposits grow on them. The scale layer sharply worsens the thermal conductivity of the walls and reduces the cross-section of the pipes of the water supply system and, ultimately, leads to their emergency state. Hard crystalline deposits and scale are very firmly adhered to the walls of the pipes, and the old method of beating the walls with a sledgehammer is completely ineffective and not applicable for modern equipment [6]

## II. SIGNIFICANCE OF THE SYSTEM

The optimal conditions for the production of calcium peroxide by the conversion of calcium nitrate with hydrogen peroxide in the presence of ammonia have been determined. The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

## III. METHODOLOGY

Tests are given for solvents of the RTO-1 and RTO-2 brands, intended for dissolving scale deposits from the inner surface of pipes and heat exchangers, developed in the laboratory of chemical technology, gas and surfactant processing, IGICCh AN RUz. For comparison, we used the well-known Scale Solvent Descum 2K3511A (Russia). To determine the dissolving capacity of the RTO-1 and RTO-2 solvents, samples of solid salt deposits from heat exchangers of the Kokdumalak field were used. To determine the content of oil products in solid sediments, the method of extraction in a Soxhlet apparatus was used.

The objects of research are the solvents of the RTO-1 and RTO-2 brands developed in the laboratory of chemical technology of the Institute of National Economy and Economy of the Academy of Sciences of the Republic of Uzbekistan for testing scale samples accumulated on the surfaces of heat exchangers of the Mubarek gas processing plant, designed to dissolve scale deposits from the inner surface of pipes and heat exchangers. Research methods are PH-metry, extraction in the Soxhlet apparatus, chemical, comparative methods of analysis [5]

## IV. EXPERIMENTAL RESULTS

The action of descaling compositions is based on complete or partial removal of scale deposits and preventing the deposition of the resulting particles on the heat exchange surface. For these purposes, as a rule, inorganic or organic acids and a complexing or surface-active additive are used, as well as a metal corrosion inhibitor to prevent metal corrosion when exposed to acid [7]. Currently, the most effective are chemical methods for dissolving solid deposits. Their essence lies in the dissolution of solid deposits as a result of the chemical interaction of reagents with solid deposits [8]. Appearance: - sample 1 is solid, dense deposits, from light beige to brown; - sample 2 is a dark brown crystalline mass with the smell of oil. When circulating water in heat exchange equipment, three processes occur that lead to malfunctions: the formation of deposits, corrosion and the formation of sludge [9]. These processes take place simultaneously, so the structure of deposits on heating surfaces can be quite complex. The composition of such deposits will depend on many factors: the quality of the coolant; pipe material; temperature regime; system hydrodynamics; salt composition of water; corrosion processes (formation of sulfides and iron oxides) [10]. The composition of sediments analyzed by us is presented in Table 1. Determination of the content of oil products in sediments of samples 1a and 1b was carried out by the method of extraction in a Soxhlet apparatus. After extraction

Table 1.

Sediment composition		
Indicators	Sample 1a	Sample 1b
Appearance	Solid, dense, brown-gray beige hard destructible mass	Solid, dry crystal, black brown hard destructible mass
Mass fraction organic part,%	-	3.98
Mass fraction inorganic part,%	99.08	95.11
Mass fraction inorganic part water soluble,%	2.30	3.00
Mass fraction inorganic part, insoluble in water,%	96.78	92.11
Mass fraction of water,%	0.92	0.91
total	100.00	100.00

hexane was distilled off and the remaining hexane was blown off in a fume hood. Determination of the content of petroleum products showed that there were no petroleum products in sample 1a, and in sample 1b they were 3.98%. It can be seen from the data in the table that sediment samples 1a and 1b are a mixture of organic and inorganic compounds, the main share of which is inorganic compounds and is 99.08% and 95.11%, respectively. As is known, reagents based on organic acids are the most effective solvents for the destruction of solid scale deposits [11]. The study to determine the efficiency of dissolution of deposits with RTO-1 solvents was carried out at temperatures of 250C and 800C. Descum 2K 3511A (Mirrico, Russia) was used for a comparative analysis of the determination of the dissolving ability. The results of studies of the efficiency of RTO-1 samples in comparison with Descum 2K 3511A solvent (Mirrico, Russia) are presented in Tables 2 and 3 on sample 1a.

**Table 2**  
**Results of investigations of the efficiency of RTO-1 at temperatures of 25 ° C and 80 ° C on sample 1a.**

№	Reagent concentration, %	Hitch,	Duration ness of experience, hour		Dissolution efficiency, %	
			at a temperature 25° C	at a temperature 80°C	Effective dissolution rate,%	Duration ness of experience, %
1	I	2.10	4	3.77	4	2.77
2	5	2.10	4	4.76	4	6.98
3	10	2.70	4	14.28	4	11.07
4	100	2.03	4	39.62	4	56.03
5	100Descum 2K 3511A (Mirrico)		4	4.11	4	46.30

As can be seen from Table 2, the dissolving ability of the analyzed sample PTO-1 is 1.2 times more effective on average, compared to 100 Descum 2K 3511A (Mirrico). A direct regularity of the dissolution efficiency on the reaction time and temperature is observed: the higher the temperature and concentration of the solution, the higher the efficiency of the reagent [12]. Table 3 shows the results of studies of the efficiency of the RTO-1 sample at temperatures of 25 and 800C on solid deposits 1b.

**Table 3**  
**Results of studies of the efficiency of the RTO-I sample at temperatures of 25 ° C and 80 ° C on solid deposits 1b**

№	Concentration reagent.	Hinge, g	Duration ness experience, hour		Efficiency dissolution, %	
			at a temperature 25° C	at a temperature 80°C	Duration experience, hour	Efficiency dissolution, %
1	1	2.10	4	4.70	4	6.10
2	5	2.10	4	7.57	4	8.80
3	10	2.70	4	14.40	4	17.50
4	100	2.03	4	44.40	4	57.40
5	100 Descum 2K 3511A (Mirrico)		4	21.60	4	32.20

As can be seen from Table 3, with an experiment duration of 4 hours, the analyzed sample RTO-1 has an average efficiency of 1.8 times as compared to 100 Descum 2K 3511A (Mirrico). Thus, it has been established that the solvent RTO-1 has a greater dissolving power, regardless of the types of solid deposits 1a and 1b. To further study the solubility of solid deposits 1a and 1b, we selected the RTO-1 solvent. Table 4 shows the results of the dissolving power of RTO-1 at a temperature of 80 ° C for 24 hours on solid deposits 1a and 1b.

**Table 4**  
**The results of studies of the efficiency of the RTO-1 sample at a temperature of 80 ° C on solid deposits 1a and 1b and the effect of the reagent during the day**

№ experience	Try	Hinge, g	Duration of experience, hour	Dissolution efficiency, %
			at a temperature 80°C	
1	1a	3.1	24	90.3
2	1б	2.3	24	93.7
3	100 Descum 2K 3511A (Mirriko)		24	93.0

As can be seen from table 4, the dissolving capacity of solid deposits of the RTO-1 solvent within 24 hours reaches 93.7%. A test of the synthesized corrosion inhibitors (table 5) of carbon steel by the gravimetric method was carried out, in accordance with the requirements of the standards, under the following conditions: test material - specimens of steel grade St3, disk-shaped, 50 mm in diameter; with a surface area of 0,002 m<sup>2</sup> each; the ratio of the volume of the test solution to the sample area: ~ 0.1 m<sup>3</sup>/m<sup>2</sup>; solution temperature 220C, test time 2 h.

**Table 5**  
**Composition of solutions and test results**

№	Corrosive environment composition	Inhibitor	g/m <sup>2</sup> .hour	Degree of protection, %
1	RTO -1	0.4% IGICH-F1	3.6	97
2	RTO -1	1.2% IGICH-F2	9.4	95
3	RTO -1	1.2% IGICH-F3	11.4	95
4	RTO -1	No inhibitor	~200.0	-

According to the results of corrosion tests, the inhibitor IGICH-F1, taken at a concentration of 0.4%, showed the best protective properties against carbon steel of grade P.3 in an environment of 7% hydrochloric acid, which provided 97% protection of steel against corrosion.

## V. CONCLUSION AND FUTURE WORK

According to the results of corrosion tests, the inhibitor IGICH-F1, taken at a concentration of 0.4%, showed the best protective properties against carbon steel of grade St.3 in an environment of 7% hydrochloric acid, which provided 97% protection of steel against corrosion.

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