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STUDYING THE PHYSICAL AND CHEMICAL PROPERTIES OF AMINE AND AMIDE CONTAINING ORGANIC INHIBITORS

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ABSTRACT

In this work, new inhibitors of metal corrosion in sulfuric acid environments are studied depending on the duration of the process, inhibitor concentration and temperature. The main parameters for the synthesis of new metal corrosion inhibitors St.3 and St.12 grades using amine and amide containing organic substances are determined and methods for obtaining these inhibitors are described. The physicochemical properties of amine and amide containing organic inhibitors of corrosion and scaling in acidic process environments have been studied.

KEYWORDS

Amine, amide containing inhibitors, corrosion, scaling, corrosion rate, degree of inhibition, inhibition efficiency.

INTRODUCTION

Natural and other process gases of the Shurtan gas and chemical complex (SHGCC) contain harmful acidic impurities, such as carbon dioxide and sulfur compounds (hydrogen sulfide, mercaptan disulfides). These compounds cause corrosion of pipes and equipment in natural gas separation plants. On the other hand, sulfur impurities and their combustion

products pollute the environment and have a harmful effect on the human body [1-2].

Based on the above, large-scale activities are currently being carried out in our republic to synthesize and study the physicochemical properties of new inhibitors of metal corrosion and mineral salt deposition for the chemical and oil and gas industries [3]. Particularly

important in this regard is the solution of these problems for water supply systems of energy- and water-intensive chemical production. Numerous inhibitors of corrosion and mineral deposits have been proposed. The republic's demand for such inhibitors now amounts to more than 5 thousand tons per year. Therefore, due to the lack of production of these products in the Republic, the latter are imported from foreign countries for foreign currency.

In order to develop new import-substituting and export-oriented inhibitors of corrosion and mineral salt deposits based on locally available raw materials and secondary materials, we conducted targeted research.

Objects and methods of research. The materials for the study were samples in the form of plastic, made of steel grades St.3 and St.12. In work [4,5], salts Na_2S and NaCl were used. A 5-3 mol/l solution of H_2SO_4 (background) was used as a model corrosive environment, and tests were also carried out in a 1-3% aqueous solution of NaCl , NaOH and a 1-3% solution of Na_2S . The electrodes made from steel grade St.3 had the following composition: $\text{Fe} = 98.36$; $\text{C} = 0.20$; $\text{Mn} = 0.50$; $\text{Si} = 0.15$; $\text{P} = 0.04$; $\text{S} = 0.05$; $\text{Cr} = 0.30$; $\text{Ni} = 0.20$; $\text{Cu} = 0.20$.

Pre-treatment of steel samples included cleaning and polishing their surface with sanding paper, followed by

chemical degreasing in an alkaline solution. The objects of the study were synthesized new amine and amide containing inhibitors conventionally designated ATKP, IR-1 at various concentrations, temperatures and media. The effect of a salt environment and inhibitors on the corrosion behavior of steel samples (grade C T.3, St.12.) was determined by polarization curve methods and gravimetric methods based on the loss of sample mass after corrosion tests. Inhibitors were also studied using the electrochemical method on a corroded steel surface.

Polarization curves of a steel electrode in acidic and neutral media in the presence of amine and amide containing ATKP and IR-1 inhibitors at various concentrations and temperatures were recorded on a PI-50.1.1 potentiostat, with a PR-8 programmer and a PDA-1 potentiometer. During the experiments, the area of the working electrode was selected based on the capabilities of the potentiostat and the maximum currents (i) in the region of active dissolution of steel.

Results and discussion. Results of the corrosion-electrochemical behavior of electrodes made of steel grade St.3. and St.12 in a 3% solution of H_2SO_4 at a temperature of 25 °C and 70 °C without additives and with the addition of ATKP and IR-1 inhibitors are shown in Table 1, as well as in Fig. 1.

Table 1.

Change in corrosion rate Art.3 and Art.12. in the presence of inhibitors

inhibitor	background	Temperature, °C	$K_{\text{corr}} \cdot 10^{-3}$	$Z, \%$	$\gamma, \%$
ATKF	Without inhibitor	25	94.0	-	-
	With the addition of ATKP		4.96	94.7	5.27
	Without inhibitor		0.35	-	-

	With the addition of ATPK	70	0.011	96.8	3.17
IK-1	Without inhibitor	25	5.2	-	-
	With the addition of IK-1		0.2	96.0	3.8
	Without inhibitor	70	4.40	-	-
	With the addition of IK-1		0.11	97.5	3.2

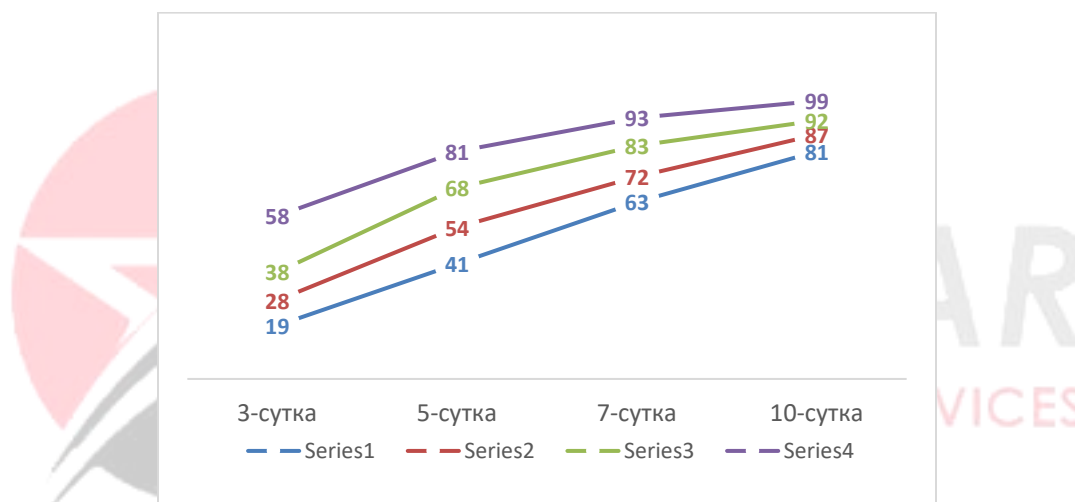


Fig.1. Dependence of the degree of inhibition of St.3 and St.12 in a sulfuric acid medium on the duration of the process at $t = 25$ °C.

From the results presented in Table 1 and Fig. 1, it was found that the IK-1 inhibitor has a more effective effect on the degree of inhibition of St.3 and St.12 in a sulfuric acid medium than the ATPK inhibitor. With the use of the inhibitor IK-1, the corrosion rate of St.3 and St.12, depending on the concentration of the inhibitor, was 84÷97.5%. Based on these experimental data obtained, a new synthesized inhibitor IK-1 is recommended to inhibit the process of corrosion and scaling of mineral salts in equipment made from steel grades St.3 and St.12.

The results of gravimetric determination of the values of corrosion rate (K_{cor}) and braking coefficient (γ) at different temperatures (25 °C) show 7-12% than imported inhibitors such as “С и 70°С Nalco” (Germany) and KW currently used in industry -2353 (Russia). The results of gravimetric studies and calculations of the corrosion rate and degree of protection (inhibition) are shown in Figures 2 and 3.

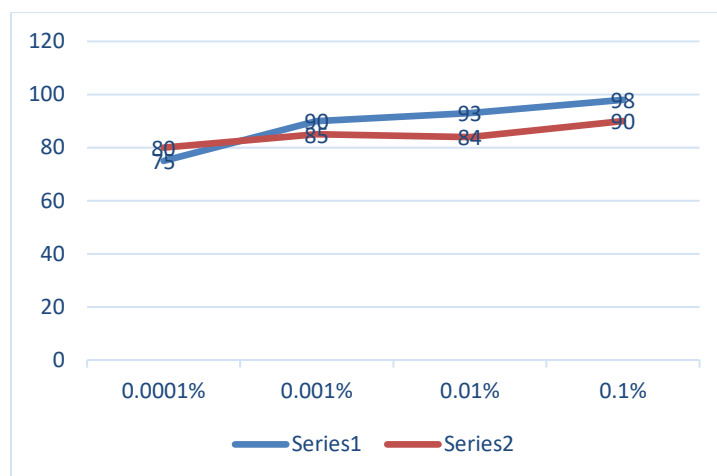


Fig.2. Dependence of the degree of inhibition of St. 3 (1) and St. 12 (2) in a sulfuric acid medium on the inhibitor concentration $T = 298 \text{ K}$,

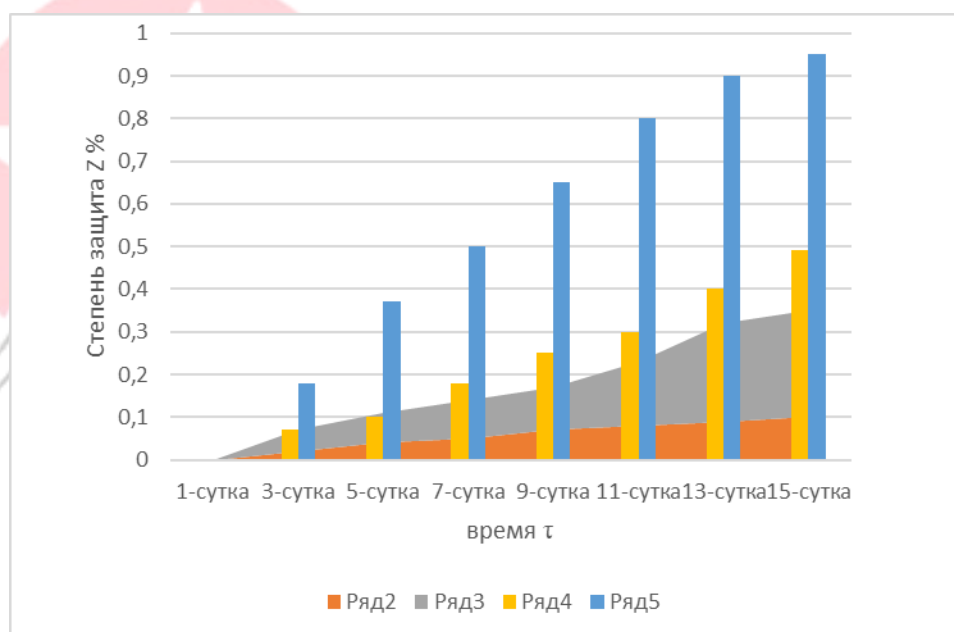


Fig.3. Dependence of corrosion rate on process duration: inhibitors ATKP (1.1 1) and IR-1 (2.2 1)

As can be seen from Fig. 2, the most significantly effective results are achieved in the presence of 0.0001 mg/l solution of the IK-1 inhibitor in sulfuric acid media. Thus, depending on the duration of corrosion tests, the value of the degree of protective actions of IK-1 varies from 75% to 89.9% (in Article 3) and from 73% to 98.0%

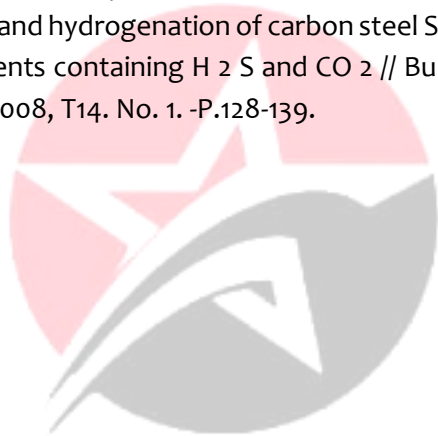
(in Article 12) . The nature of the degree of corrosion protection of carbon steel St. 3 in solutions of H_2SO_4 and others environments are approximately the same. This is due to the formation on the surface that slows down the diffusion of oxygen to the metal surface.

CONCLUSION

Comparing the results of studies on the corrosion of steel grades St.3 and St.12 in sulfuric acid solutions, high efficiency was found in the presence of an inhibitor of the IK-1 type. Increasing the temperature of the inhibition process to 70 °C does not significantly affect the degree of protection of metals (Art. 3 and Art. 12) (75÷98.0%). It should be noted that when using the Nalco brand inhibitor imported to the republics of Uzbekistan, the degree of protection at 80 °C is 87.58%.

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