METHODS OF OBTAINING NEW TYPE MODIFIERS FOR METAL CONSTRUCTION EQUIPMENT RUST REMOVER

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Abstract. *The problem of improving the reliable and long-term service efficiency of all equipment in metallurgical industry systems, strengthening the resistance of metal structures to various environments is always one of the most important tasks. To date, the effects of corrosion in metals are often felt long before the service life specified in the project. At the moment, the performance and durability of these structures is determined only by the effectiveness of corrosion protection. Despite the fact that a lot of scientific research is being carried out on the prevention of metal corrosion in various sectors of the economy of rapidly developing countries, this issue is one of the issues that have not been fully resolved.*

Keywords: *Corrosion, modifier, metal, sulfuric acid, IK - spectroscopy, protection efficiency.*

INTRODUCTION

Currently, as a result of the corrosion of metals, industrial enterprises suffer a large amount of economic damage. Therefore, in order to prevent these damages, it is one of the important tasks of today to study the environment that causes the consequences of corrosion and to create the scientific basis of protection against it.

Due to the fact that metal corrosion causes billions of dollars in industrial losses every year, large investments are being made by the government in companies that produce anti-corrosion agents. The damage caused by corrosion is not only the loss of a large amount of metal, but also the failure of the plasticity, elasticity, heat and current conductivity of equipment and structures, and the impact on the quality of the manufactured product, as a result of the rapid wear of equipment, production failures and a decrease in production productivity.

It is known that a lot of scientific work has been carried out on the creation of new types of compounds that remove rust residues from the surface of metal structures. Most of them are synthesized on the basis of phosphoric acid. As a result of the reaction of phosphoric acid with metals, a film of iron phosphate derivatives soluble in aqueous medium is formed on its surface. Due to the easy oxidation of phosphates in the Iron(II) phosphate film, they do not have a high protective capacity [1; 310 p.].

METHODS

Experiments are based on modern methods of physico-chemical research, including IR-spectroscopic and electron microscopy studies, as well as standard physico-mechanical analysis.

RESULTS AND DISCUSSION

Nowadays, metal materials are an important material in the chemical industry, agro-industrial equipment, oil and gas plants, medical services, metallurgy and automobile industries. Corrosion of metals used in industry over time leads to the loss of the natural state of metal materials, pollution of the environment [2;37 p.].

In addition, the gases released as a result of corrosion affect the human body, the atmosphere, and drinking water pollution, and in turn, damage liquid metals, liquid salts, inorganic solutions, bases, acids and salts in various chemical processes in industry. Corrosion reduces the service life of industrial equipment for a long time and leads to various dangerous events. The problem of corrosion causes a large amount of economic damage and has a negative impact on the economy of any country [3; 47-52 p.].

Scientists such as F. Bentiss, M. Traisnel, L. Gengembre and M. Lagrenee have proposed several methods of solving corrosion problems, that is, they have focused on the development of economically effective, environmentally friendly and safe inhibitors [4 ; 194-201 pp.].

Today, scientists from all over the world suggest the use of inhibitors as anti-corrosion agents, because this method is recognized by the world community as the most effective method. In the scientific works of M. Bouayed, H. Rabaa and A. Shiri, they studied the anti-corrosion processes taking place in the anode and cathode, as well as the properties of adsorption of inhibitors on the metal surface. Chemical inhibitors reduce corrosion processes. Corrosion inhibitors are chemical substances, they are added to the corrosion medium in low concentration, bind to metal ion and adsorb. In this work, it was also reported that the inhibitor reduces the rate of corrosion [5; 501-509 pp.].

Based on the information of F.K. Kurbanov, anion-type inorganic, inorganic substances are always used as inhibitors for a neutral environment. In acid corrosion, organic substances are used, that is, organic substances containing nitrogen and oxygen in the form of amino, carboxyl and carbonyl are used. But until now,effective inhibitors for alkaline environment haven't been found [6;21p].

B.B. Damaskin and O.A. Petri's scientific studies used more zinc for metal protective coatings. They are mainly used to protect ferrous metals from atmospheric corrosion. The normal electrode potential for zinc is -0.76, and it is slightly negative compared to the electrode potential of iron (-0.44). Therefore, when zinc is in contact with iron or steel in water or in the atmosphere, a galvanic couple is formed, in which no corrosion occurs, even if the iron serves as a cathode. The melting of the metal at the anode and the reduction of the oxidizer at the cathode, due to the long-term exposure of the metal to an aggressive environment, the corrosion process stabilizes at the cathode and a stationary state begins. In this case, the speeds of the anode and cathode reactions are equal ($I_a=I_k$). To reduce the rate of melting of metal in stationary conditions, 2 electrodes are achieved by reducing the rate of at least one of the reactions [7; 288 p.].

G.N. Amelina, I.I. Dzherin and S.N. The Lojkomoevs studied the results of research on the corrosion resistance of metals and alloys in the presence of liquid trifluoride bromine-BrF_3 in the presence of liquid trifluoride bromine-BrF_3 using common gravimetric and electrochemical methods. They provided necessary information and conducted test experiments to prevent corrosion [8; 1285-1291 p.].

H. Rachev and Stefanova studied the possibility of reducing the corrosion rate by the method of liquefaction. In this case, the metal creates high protective properties on its surface. Ligating components increase the protective properties of the surface layer. In this case, structural steels are alloyed with molybdenum, zinc and aluminum [9; 520-p.].

In the research works of A.I. Alsibeyva, corrosion retarders or inhibitors are added to the electrolyte to slow down the corrosion of metals. He commented that the introduction of inhibitors in the amount of no more than 1% into the corrosion environment leads to a decrease in the rate of corrosion of metals. In his scientific research, he justified the fact that inhibitors protect the desired metal in various environments: from air, aggressive gases, sea and underground water, coolants, acids and alkalis [10; 262 p.].

I.A. Rosenfeld and F.I. According to the Rubinsteins, cathodic protection is widely used now. This protection is mainly used in cases where the structure (underground pipeline, ship hull) containing sea water and underground water in the electrolyte environment is protected. The essence of such protection is that the structure is connected to a metal that is more active than the metal of the protective-protected structure. Magnesium, aluminum, zinc and their alloys are usually used as protectors in the protection of steel products. In the process of corrosion, the protector serves as an anode and is eroded. This protects the structure from decay. As the protector wears out, they are replaced with a new one. This is a shortcoming of cathodic protection, which can cause economic damage. The universal method of protecting metals from corrosion is covering the surface of metals with metallic and non-metallic coatings [11; 200 p; 12; 640 p.].

In the research work of S.Shamshiev, V.P.Guro, P.Yu. Shtirlov, local raw materials necessary for the synthesis of effective corrosion inhibitors were selected and test results were conducted. According to the test results, Na_2SiO_3-10.00 highly inhibits the corrosion of carbon steel and some non-ferrous metals; sodium polyphosphate-1:00; content No. 1-1.00; composition No. 2-0.010; No. 3- content up to 1.00 was selected [13; 60-65 pp.].

Calcium and magnesium carbonates reduce the amount of cathodic products on the metal surface, increase the pH value of the alkaline environment and form a thin coating on the metal surface. These inhibitors are used as separating inhibitors, because they separate corrosion products from the metal surface that provide cathodic processes on the metal surface [14; 50-58 pp.].

In this article, the scientific research work on the preparation of rust removers based on phosphoric acid and organic and inorganic salts that meet the standard requirements is studied. It is known that when the ratio of H_3PO_4 is below 20%, the level of rust removal decreases. When an acid with a concentration of more than 22% is used in agar, it will also absorb rust and metal. Based on this, we decided to use 20-22% acid in research. Phosphoric and citric acids were selected as the main raw materials for the production of modifiers protecting industrial construction equipment from corrosion. It is known that a high concentration of phosphate and citric acids is widely used in cleaning metals from corrosion. In order to achieve high protection efficiency at a low concentration, organic and inorganic substances were added to them.

Experimental studies were carried out to study the effectiveness of different acids in removing rust. The experiments were conducted on a 50x50x5 mm rusty steel plate at a temperature of 25˚C for 5-15 minutes at concentrations of 5-30%. The obtained research results are shown in the table below (Table 1).

As can be seen from the results of the table, it was found that the reduction of corrosion in 5-30% sulfuric acid is from 6 points to 8 points, that is, the corrosion resistance is not stable (Table 1, experiment No. 1). It was proved that the corrosion resistance of phosphoric acid is relatively stable in the range of concentration from 5 to 7 points (Table 1, experiment No. 3). In 5-30% citric acid, the reduction of corrosion was found to increase from 5 to 9 points (Table 1, experiment No. 6). As the concentration of citric acid increases, the aggregate state of citric acid changes, in which, as the dissociation of the acid decreases, its acidity also decreases, the washing levels decrease, that is, the citric acid turns into a crystalline state, the sphere of influence on the metal decreases. Low concentrations of citric acid have been found to have superior rust removal capabilities compared to acetic acid, making it a cost-effective and localized cleaning agent.

Table 1

RESEARCH RESULTS OF STUDYING THE RUST CLEANING EFFECT OF CITRIC ACID WITH DIFFERENT CONCENTRATIONS

№	Name of the tested acids	Concentration of tested acids, %	The initial mass of the sample, gr	Mass reduction of the sample at a temperature of 25°C, gr								
				Processing times, min								
				5 minutes			10 minutes			15 minutes		
				Mass after processing, gr	Mass reduction difference gr	Ball	Mass after processing, gr	Mass reduction difference gr	Ball	Mass after processing, gr	Mass reduction difference gr	Ball
1	Sulfuric acid	5	25,7163	25,5267	0,1896	6	25,2627	0,4536	6	24,7301	0,9862	7
		10	21,9071	21,5446	0,3625	6	21,3207	0,5864	7	20,9446	1,2145	8
		15	19,3327	18,7963	0,5364	7	18,0566	0,8261	7	17,8765	1,4562	8
		20	22,6781	21,892	0,7861	7	21,5455	1,1326	8	20,7516	1,9265	8
		25	25,3643	24,4495	0,9148	7	24,0076	1,3567	8	23,2184	2,1459	8
		30	21,8824	20,7566	1,1258	7	20,3562	1,5262	8	19,5176	2,3648	8
2	Hydrochloric acid	5	23,4135	23,1173	0,2962	6	23,0171	0,3964	6	22,734	0,6795	7
		10	22,5667	22,2099	0,3568	6	21,9706	0,5961	7	21,6703	0,8964	7
		15	21,1281	20,6014	0,5267	7	20,365	0,7631	7	19,807	1,3211	8
		20	24,4256	23,707	0,7186	7	23,5259	0,8997	7	23,012	1,4136	8
		25	22,8762	21,9531	0,9231	7	21,5521	1,3241	8	21,1303	1,7459	8
		30	23,6871	22,5626	1,1245	8	22,0089	1,6782	8	21,7182	1,9689	8
3	Phosphoric acid	5	24,5267	24,4755	0,0512	5	24,4725	0,0542	5	24,4033	0,1234	6
		10	21,6781	21,6066	0,0715	5	21,5896	0,0885	5	21,5244	0,1537	6
		15	25,1218	25,0227	0,0991	5	25,0176	0,1042	6	24,8451	0,2767	6
		20	23,0967	22,8044	0,2923	6	22,7474	0,3493	6	22,6646	0,4321	6
		25	24,5643	24,2129	0,3514	6	24,0768	0,4875	6	23,9051	0,6592	7
		30	22,8113	22,2788	0,5325	6	22,1327	0,6786	6	21,9168	0,8945	7
4	Nitric acid	5	24,1266	20,9808	3,1458	8	17,3854	6,7412	9	14,2302	9,8964	9
		10	25,7612	20,3029	5,4583	9	16,7953	8,9659	9	13,1938	12,5674	10
		15	23,7142	16,1881	7,5261	9	14,0559	9,6583	9	10,1493	13,5649	10
		20	24,6213	15,6559	8,9654	9	13,232	11,3893	10	0	0	0
		25	24,3241	14,1985	10,1256	10	11,9779	12,3462	10	0	0	0
		30	23,6781	11,3213	12,3568	10	9,5528	14,1253	10	0	0	0
5	Acetic acid	5	25,5863	24,3739	1,2124	8	24,1225	1,4638	8	23,8501	1,7362	8
		10	24,0741	22,5374	1,5367	8	22,283	1,7911	8	22,2476	1,8265	8
		15	24,6879	23,06	1,6279	8	22,8898	1,7981	8	22,8208	1,8671	8
		20	27,9018	26,1053	1,7965	8	25,9254	1,9764	8	25,7654	2,1364	8
		25	24,7132	22,7269	1,9863	8	22,3656	2,3476	8	22,1341	2,5791	8
		30	23,9613	21,3822	2,5791	8	21,1248	2,8365	8	21,0176	2,9437	8
6	Citric acid	5	22,3117	22,2568	0,0549	5	22,235	0,0767	5	22,212	0,0997	5
		10	22,2944	21,9558	0,3386	6	21,718	0,5764	6	21,4113	0,8831	7
		15	20,5643	18,8851	1,6792	8	18,6279	1,9364	8	17,0967	3,4676	8
		20	23,2268	20,1019	3,1249	8	17,981	5,2458	8	16,3134	6,9134	9
		25	26,7382	20,6003	6,1379	9	18,0929	8,6453	9	17,4591	9,2791	9
		30	25,8819	18,9088	6,9731	9	17,9104	7,9715	9	16,7473	9,1346	9

Table 2

CHANGES IN THE EFFECTIVENESS OF REMOVING METALS WHEN CITRIC ACID IS ADDED TO A 20-22% CONCENTRATION SOLUTION OF H_3PO_4

№	H_3PO_4 concentration,%	Temperature, °C	$C_6H_8O_7$,%	Corrosion resistance of the cleaned surface			
				Rusty metal mass, g	Mass after processing, g	Corrosion rate, gr/m^2	According to the requirements of GOST 9.402- 2004, levels of cleaning, points
1	20	25	2	25,6479	25,5679	0,08	5
			4	23,6472	23,5572	0,09	5
			5	25,6427	25,5427	0,1	5
2	22	25	2	24,6973	24,6773	0,02	4
			4	22,8617	22,8217	0,04	4
			5	23,4572	23,3872	0,07	5
3	25	25	2	24,1375	24,0975	0,04	4
			4	22,4173	22,3873	0,03	4
			5	22,3491	22,2991	0,05	5

As can be seen from the results of the above table, the cleaning efficiency in the pilot study in which 2% citric acids were added to 20% phosphoric acid was 5 points (Table 1, No. 1: Experiment 1). It has been scientifically proven that the cleaning efficiency is 4 points, i.e. it is resistant to high corrosion (Table 2, experiment No. 2:4). From these indicators, it was found that the efficiency of rust removal is high even at low concentrations of known acids.

In experimental studies, anti-corrosion properties were studied using a mixture of substances listed in Table 3. When a joint mixture of substances is used against corrosion, their inhibitory power is several times higher than when each inhibitor is used separately. The inhibitory power of the mixture of potassium bichromate and zinc sulfate is greater than the sum of the effects of each of them at the highest concentration, stopping the corrosion of steel, and the power of the chromate inhibitor increases dramatically. According to the results of Table 3, it was determined that the mixtures of phosphoric acid with 22.0%, citric acid with 2.0%, potassium bichromate with 1.0%, and zinc sulfate with 1.5% are the most optimal composition.

Table 3

DEGREE OF METALS CORROSION PROTECTION WHEN OPTIMUM COMPOSITION OF POTASSIUM BICHROMATE AND ZINC SULFATE IS INCLUDED

№	H_3PO_4, %	$C_6H_8O_7$ %	$K_2Cr_2O_7$ %	$ZnSO_4$ %	Tempe-rature ˚C	Rusty metal mass, g	Mass of metal after processing, g	Corrosion rate,g/m²	Degree of protecti-on, %
1	20	2	0,5	1,0	25	53.4651	53,4571	0,008	92.2
		4			25	50.0635	50,0585	0,005	94.3
		5			25	55.3417	55,3387	0,003	96.6
2	22	2			25	53.2543	53,2493	0,005	94.8
		4			25	52.1969	52,1929	0,004	95.3
		5			25	51.3941	51,3921	0,002	97.08
3	20	2	1,0	1,5	25	52.1408	52,1378	0,003	96.3
		4			25	52.0235	52,0215	0,002	97.06
		5			25	54.3782	54,3762	0,002	97.5
4	22	2			25	52.1937	52,1927	0,001	98.05
		4			25	52.5611	52,5601	0,001	98.15
		5			25	51.6347	51,6337	0,001	98.36
5	20	2	1,5	2,0	25	53.2925	53,2855	0,007	93.32
		4			25	51.2364	51,2324	0,004	95,9
		5			25	52.4218	52,4198	0,002	97.6
6	22	2			25	56.8142	56,7642	0,05	90.4
		4			25	52.3436	52,3386	0,005	94.5
		5			25	53.2094	53,2054	0,004	95,0

The results of IR spectroscopy are given below, and information about the position of the absorption bands in the vibrational spectrum of the groups of atoms in the obtained rust modifier was given. The IR-spectrum of the obtained composition was obtained in the range of 4000-400 cm-1 using a sample in the form of a tablet with KBr on a UR-20-spectrophotometer. Based on the results of the IR spectroscopy analysis, valence vibrations of the SO42- ion related to the ZnSO4 added to the inhibitor composition were observed in the region of 603.72 cm-1. The PO43- ionic group belonging to orthophosphate acid is located at 1147.65 cm-1; and the Cr2O72- ion contained in potassium bichromate is in the area of 1111.51 cm-1; It was found that the -C-N= bond forming the hexamethylenetetramine ligand in the urotropin substance exhibits an absorption frequency in the region of 991.41 cm-1.

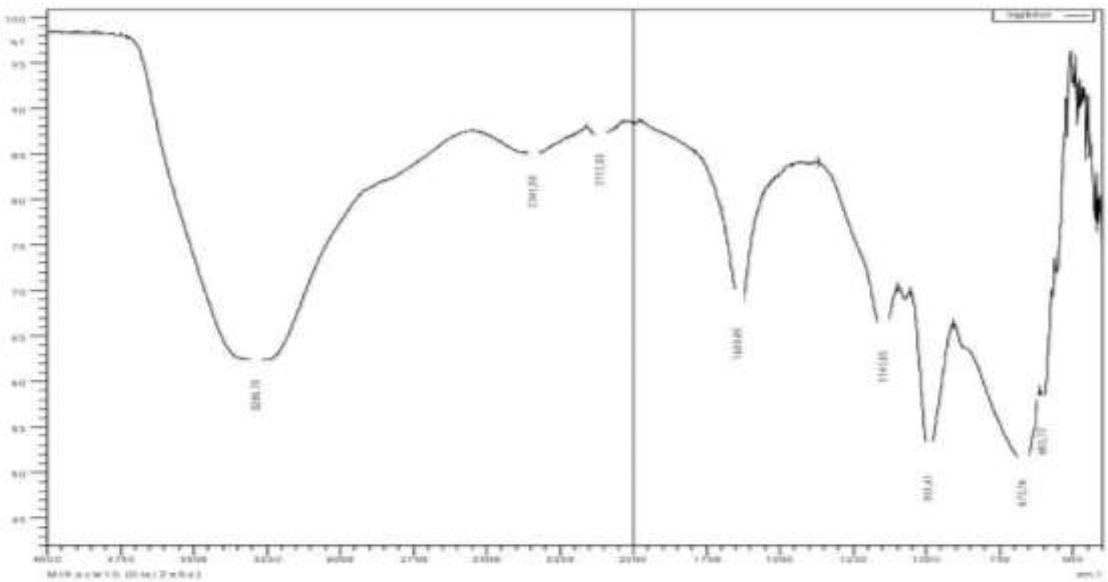
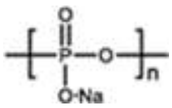


Figure 1. IR spectrum of the sample

It is the basis of sodium polyphosphate  it was observed that the monomer shows absorption characteristic of valence and deformation vibrations in the regions of 2112.05 and 2341.58 cm^{-1}. The group of C=O atoms belonging to citric acid is valence in the area of 673.16 cm^{-1}; It was found that -C-OH group of atoms exhibits absorption characteristic of valence and deformation vibrations in the areas of 3286.70 and 1639.49 cm^{-1} respectively.

Conclusions

From the above results, it can be concluded that the formed rust modifier has the ability to protect metals from acid corrosion. In accordance with the standard requirements of GOST 9.505-86, tests of this composition were conducted to evaluate the ability of acid corrosion inhibitors to protect them. The resulting composition was tested in hydrochloric and sulfuric acid solutions. The obtained results showed that this obtained composition is able to perform the function of an inhibitor with high efficiency in protecting against acid corrosion.

Based on the above, the main task of the research was to determine the optimal conditions for export of competitive rust modifiers based on local resources and industrial waste, as well as the use of urotropin as a local raw material for corrosion inhibition.

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