THE DEVELOPMENT OF ANTI-CORROSION HETEROCOMPOSITE COATINGS FOR MACHINE PARTS BY USING LOCAL RAW MATERIALS

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Abstract. *The mechanisms of the formation of composite materials by the technology of high-energy sputtering of a mechanical mixture of components are investigated. This technology makes it possible to form single-layer or multi-layer composite materials with various combinations of polymer, metal, mineral components, including multilayer coatings on machine parts and mechanisms. This will make it possible to develop modern high-tech compositions of composite materials based on using local raw materials and resource-saving technologies for their production and processing into products.*

Keywords: *heterocomposite polymer materials (HCPM), roughness, glass transition temperature, plasticizer, filler, epoxy composition.*

Introduction

Nowadays, silicate-containing modifiers and mineral particles subjected to functional modification are widely used in modern composite materials science. At the same time, it is necessary to carry out systemic studies of physicochemical mechanisms, their influence on the structure and properties of matrices, both in the process of obtaining PCMs and in creating products from them. Of particular interest are the studies of the formation mechanisms of composite materials using the technology of high-energy sputtering of a mechanical mixture of components. This technology makes it possible to form single-layer or multi-layer composite materials with various combinations of polymer, metal, mineral components, including multilayer coatings on machine parts and mechanisms. Thermophysical processes in the coolant medium, which determine the kinetics of heating, melting of components, thermolysis, thermooxidative destruction, and the formation of a homogeneous composite layer on a solid substrate, require a systematic study. This will allow developing modern high-tech compositions of composite materials based on various combinations of components and resource-saving technologies for their production and processing into products[1-4].

Research methods.

The protective ability of anticorrosive compositions was assessed by comparing the densities of corrosion currents obtained during the polarization of the investigated electrode recommended in the work[2].

Compositions (№1, №2, №3, №4 of Table 1) applied to metal plates were investigated as an anticorrosive coating. It was found that the most promising is composition No. 4, the proof of which was the comparison of the protective ability of the films, which was carried out in accordance with GOST-380-71 on metal plates made of steel grade St-3 (width 70 mm, length 150 mm, thickness 0.8-0.9 mm) under the same conditions and methods of maintaining the test modes.

Table 1

The compositions of use for corrosion tests.

Composition №1	Composition №2	Composition №3	Composition №4
According to the technological regulations of production	ЭД–20 –100 wt.h.; ДБФ+ГС–20 wt.h; ПЭПА–10 wt.h; АКС–30–30 wt.h.	ЭД-20 -100 wt.h.; ДБФ+ГС–20 wt.h; ПЭПА–10 wt.h.; АКF–78–30 wt.h.	ЭД–20 –100 wt.h; ДБФ+ГС–20 wt.h; ПЭПА–10 wt.h; АКТ–10-30 wt.h.

To conduct a comparative analysis, we carried out comparative experiments (Table 2).

When comparing the obtained values with a standard film produced according to the technological regulations of production, it was revealed that:

- anticorrosive coating of composition No. 4 is not inferior in its performance to the standard film according to GOST.

- significant reserves and low cost of raw materials - determine the economic efficiency of production when using composite materials.

The results of experimental studies and their discussion.

Tables 2, 3 show the anticorrosive properties of composite polymer materials in different environments and in tables 4-6 the effect of polarization resistance in different environments over time.

Table 2

Anticorrosive properties of composite polymer materials and coatings made of them, depending on the type of kaolin grades in a saline medium of 3% NaCl

Coating	$E_{см}$,B Stationary potential	I, мА corrosion rate	γ, braking ratio	Z %, Degree of protection
Without cover	0,78	893	–	–
KPM without filling	0,65	45,3	2,19	84,00
KPM + kaolin	0,50	16,59	53,82	89,00
KPM + AKT-10	0,44	3,89	22,90	99,00
KPM + AKS-30	0,45	13,98	224,30	93,00
KPM + AKF-78	0,48	15,40	5,63	81,00

Table 3

The degree of protection and the coefficient of inhibition of compositions based on kaolins in an acidic medium 3% H2SO4

Coating	$E_{см}$,B Stationary potential	I, мА corrosion rate	γ, braking ratio	Z %, Degree of protection
Without cover	0,28	1584	–	–
Compound without filling	0,35	876,3	21,19	80,00
KPM + kaolin	0,32	616,59	5,82	83,00
KPM + AKT-10	0,29	36,89	2,90	95,00
KPM + AKS-30	0,31	130,98	4,30	91,00

KPM + AKF-78	0,34	155,40	5,63	86,00

Table 4

Time dependence of the polarization resistance of compositions filled with kaolins in a 3% NaCl solution.

Coating	Time in days				
	5 days	25 days	55 days	75 days	100 days
	R, Om				
Without cover	157	125	125	110	110
KPM + AKT-10	158	167	168	170	171
KPM + AKS-30	157	161	161	160	160
KPM + AKF-78	159	165	165	166	166

Table 5

Time dependence of the polarization resistance of compositions filled with kaolin in a solution of 3% H2SO4.

Coating	Time in days				
	5days	25 days	55 days	75 days	100 days
	R, Om				
Without cover	110	45	40	30	30
KPM + AKT-10	137	161	160	160	156
KPM + AKS-30	161	154	139	138	137
KPM + AKF-78	140	149	154	154	152

Table 6

Time dependence of the polarization resistance of compositions based on kaolin in an aqueous medium.

Coating	Time in days				
	5 days	10 days	15 days	20 days	25 days
	R, Om				
Without cover	1310	710	130	69	68
KPM + AKT-10	1410	1270	220	135	134
KPM + AKS-30	1370	1290	300	272	270
KPM + AKF-78	1370	980	400	320	318

The dependence of the polarization resistance on time was studied in saline, acidic and aqueous media in the presence of a two-component coating (Tables 4-6, Figs.1-3) based on an epoxy binder filled with kaolin AKF-78, AKS-30, AKT-10.

It can be seen that the polarization resistance of the steel probe in an uncoated aqueous medium based on gossypol resin compositions is more than an order of magnitude higher than in acidic and saline media. In an aqueous medium, the polarization resistance in the presence of a coating changes insignificantly after 10 days, which indicates its effectiveness. When the probe is kept for up to 15 days and further, the polarization resistance decreases, but the presence of the coating in this case also has a noticeable effect. This effect is especially noticeable in acidic and saline environments, that is, after even 25 days, the values of the polarization resistance remain almost unchanged.

Recently, much attention has been paid to the production and use of combined coatings. Gossypol resin [5-10] waste of fat and oil production is of great interest for use in anticorrosive technology.

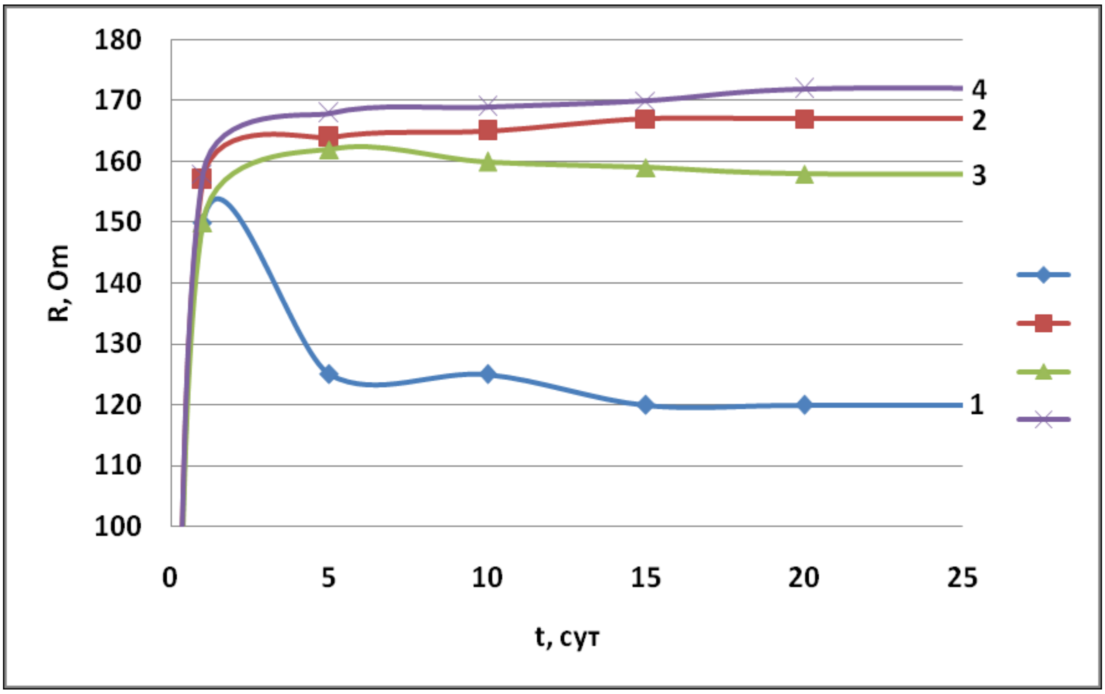

Figure: 1. Dependence of the polyarization resistance on time in 3% NaCl in the presence of a coating:

1 - uncoated; 2– composition filled with kaolin AKS-30; 3 - composition filled with AKF-78 kaolin; 4 - composition filled with AKT-10 kaolin.

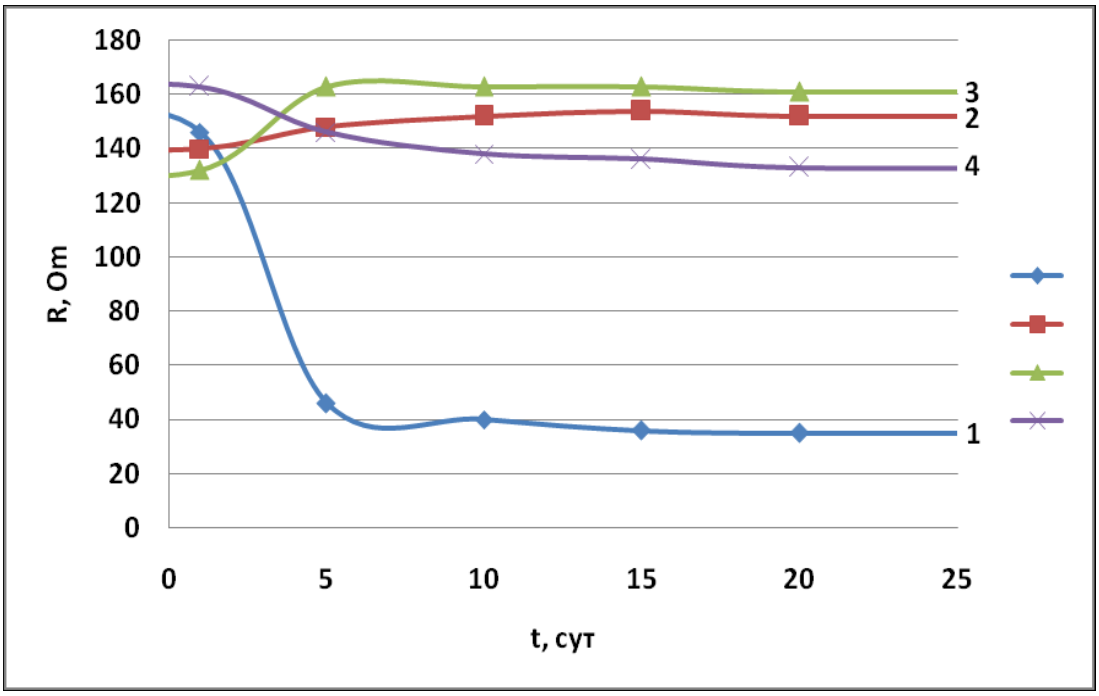

Figure: 2. Dependence of the polarization resistance on time in a 3% H2SO4 solution in the presence of a coating.

1 - uncoated; 2 - composition filled with AKS-30 kaolin; 3 - composition filled with AKF-78 kaolin; 4– composition filled with AKT-10 kaolin.

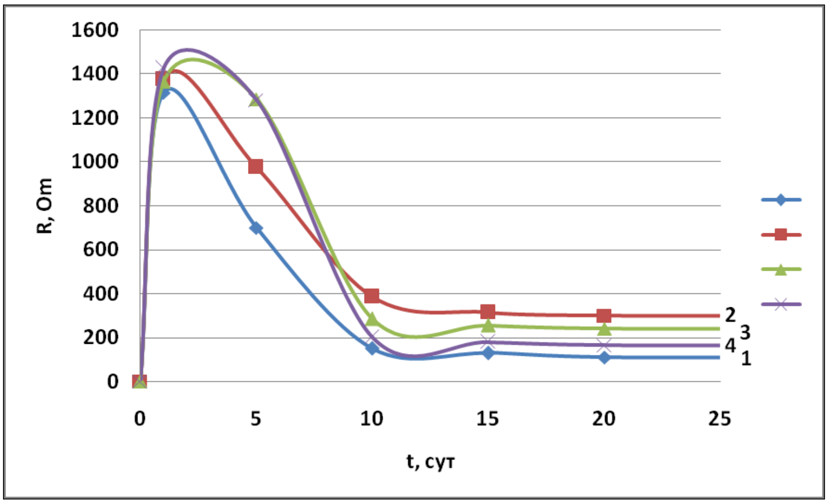

Figure: 3. Dependence of the polyarization resistance on time in an aqueous medium in the presence of a coating.

1 - uncoated; 2 - composition filled with AKS-30 kaolin; 3 - composition filled with AKF-78 kaolin; 4– composition filled with AKT-10 kaolin.

Recently, bitumen - oil waste (GOST 5.2239–77) - has been widely used as anti-corrosion paint and varnish products.

Table 7

Comparative indicators of the tested and standard paintwork compositions.

Indicators	Состав применяемой краски	
	По технологическому регламенту производства	ЭД–20 –100мас.ч; ДБФ+ГС–20 мас.ч; ПЭПА–10 мас.ч; АКТ–10–30 мас.ч
Package appearance	Цвет черный, блестит, поверхность гладкая	Цвет черный, блестит, поверхность гладкая
Viscometer elongation 20-250C	18–35	30
Mass fraction of non-volatile substances,%	39 ± 2	40
Drying time of the film to degree 3 at 20 ± 2° sec. H. no more at 100-110^{0}C min. No more (min)	20	20
Package hardness according to the pendulum device M-3 conventional units	0,20	0,20
Flexural elasticity, mm	1,0	1,0
Package resistance to static impact of water at a temperature of $20^0 \pm 2^0$ s, h, not less	48	48
Film resistance to static impact of 3% NaCl solution at a temperature of 200 20 s,h, not less (points)	3	3

Conclusion.

The analysis of the research results in comparison with the assessment of the anticorrosive ability of the compositions showed (Table 7), that the best protective properties against corrosion in a salt environment are possessed by compositions filled with AKT-10 kaolin, and in an acidic medium — compositions filled with AKF-78 kaolin. This difference in the properties of coatings filled with kaolins is explained by their chemical composition and particle size, due to the fact that in AKT-10 kaolin, as compared to AKF-78, the content of oxides is: iron oxide, more silicon dioxide, the predominance of aluminum oxide in AKF-78 gives the advantage of a coating based on it to predominate anticorrosive properties to aggressive acidic environments. The content of these elements makes it possible to assume the formation of nanocomplex compounds during mechano-chemical modification during their production, which will be devoted to further research.

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