Technical science and innovation

Volume 2019 | Issue 4 Article 5

12-12-2019

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Recommended Citation

Turabdzhanov, S. M.; Lee, M. S.; Ziyamukhamedova, U. A.; and Miradullaeva, G. B. (2019) "THE CORROSION STABILITY INCREASE OF ADHERING COATING UNDER THE PROCESS OF ELECTROCHEMICAL MECHANISM," *Technical science and innovation*: Vol. 2019: Iss. 4, Article 5.
DOI: https://doi.org/10.51346/tstu-01.19.4.-77-0042
Available at: https://btstu.researchcommons.org/journal/vol2019/iss4/5

UDC 628.358 (043): 66.067

THE CORROSION STABILITY INCREASE OF ADHERING COATING UNDER THE PROCESS OF ELECTROCHEMICAL MECHANISM

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Abstract

The article discusses the development of organomineral materials for the protection of metal parts of technological machines and structures operating mainly under the influence of an electrochemical environment. A technology has been developed for producing modified organomineral materials for anticorrosive coatings using micro- and nanosized particles of layered silicates (mineral fillers). The mechanism of the formation of nanocomposites using layered silicates and organic materials for anti-corrosion coatings formed by the activation-heliotechnological method is investigated. Using thermomechanical, physical and physico-chemical methods for studying the structure and properties of the materials obtained. Among these methods are: IR spectral analysis, scanning electron microscopy, thermogravimetry, as well as methods for determining the electrophysical and mechanical properties. And the improvement of the properties of organomineral protective coatings due to the formation of nanocomplex compounds in the interfacial layers of the binder-filler is proved.

Key words: *activation-heliotechnological method, mechanical activation, adhesion, electrochemical medium, epoxy resin, kaolin, filler, corrosion.*

Recently, special attention has been paid to the creation of new nanomaterials using silicates [1-5], which is the basis of organomineral materials [6-10]. The republic's industrial complex of the economy uses widely technological and auxiliary equipment operated under the influence of pronounced adverse factors, such as a highly aggressive corrosive environment, temperature differences, ultraviolet radiation, etc. In some cases, these unfavorable factors act simultaneously, leading to a reduction in the operational resources of technological machines, mechanisms, equipment and special metal structures, tanks and technological equipment of chemical and other industries [11-14].

To ensure the safety of these objects and increase their durability during operation, the range of applied adhering coatings based on organic and inorganic materials and coatings based on them and their formation technologies is constantly expanding, which provides a reasonable choice for specialists in the field of mechanical engineering, chemical industry and the construction industry. For example, inorganic nonmetallic coatings, such as silicate, cement, oxide, phosphate, chromate, and others — are used either alone or in combination with paints and other coatings [4-8].

It has been revealed that despite a rather high level of scientific, methodological and technical solutions in the economic sectors of the Republic of Uzbekistan, in particular the machine-building industry, insufficient attention is paid to the adhering coatings of large-sized surfaces [15-18], while at the same time it is difficult to configure the details of technological equipment. Analyzing the work in this area, some gaps were found on the application of the activation-heliotechnological method for obtaining corrosion-resistant adhering coatings with the rational use of local minerals, in particular various brands of local kaolin, having industrial production of modified structure-forming agent, which was used gossypol resin (GR) – waste of fat and oil industry. On the other hand, as a result of the production of kaolins of brand as AKF-78, AKC-30, AKT-10, the volume of tailings from kaolin production-AKO has been growing every year. An important issue is its disposal.

The search for new facilities for its rational use is considered to be the one of the appropriate ways of further use of AKO.

In this regard, we have chosen the methods and means for determining the properties of organomineral composite materials to protect large-sized, complex metal structures from the effects of corrosive environment. In the process of studying the types of corrosion damage, we found that the most common type of corrosion in relation to the operating conditions of technological equipment is the electrochemical mechanism.

The figure 1 [19] shows the classification of electrical and electrochemical methods of corrosion tests.

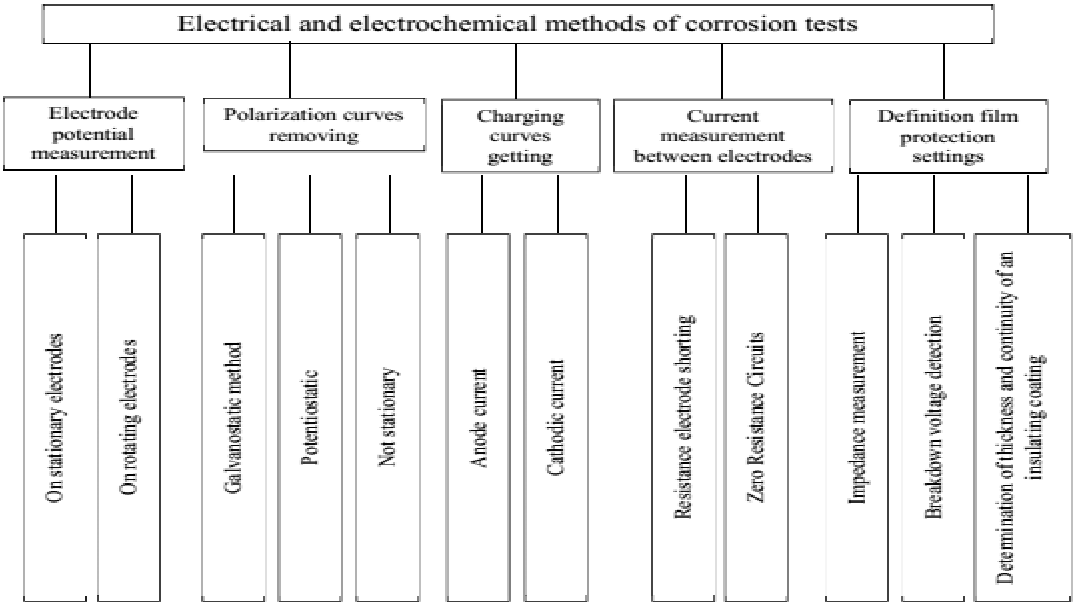

Fig 1. Corrosion test methods based on measuring electrical quantities.

The simplest and most common way to determine the protective ability of coatings is to test the immersion of coated samples in a fixed or mobile corrosive solution, which was also chosen by us.In order to establish the plasticizing and hardening effects of HC, experiments were carried out in laboratory conditions (Table 1.); curing process was within the first 12 hours in the shade (28 ± 20C), then for 10 hours under the influence of direct solar radiation (42 ± 20C) within 3 days (30 hours in the sun).When evaluating the curing process and the effect of the structure-forming agent on the properties of organomineral coatings, the microhardness (Nm) was monitored on a PMT-3 device and the impact strength σ_{imp} - on a U-2 device (Table 2).

Table. 1.

The degree of cure of the epoxy compositions (in %) depending on the exposure time of the solar treatment

№	HC contents in epoxy compound ^{1}	Shadow curing ^{2}	Subsequent solar treatment ^{3} (in hours)		
			5	10	15
1	ED-20 - 100 mass parts, HC-5 mass parts	72	78	84	92
2	ED-20 - 100 mass parts, HC-7,5 mass parts	74	82	86	94
3	ED-20 - 100 mass parts, HC-10 mass parts	75	85	89	95
4	ED-20 - 100 mass parts, HC-12,5 mass parts	78	88	94	96
5	ED-20 - 100 mass parts, HC-15 mass parts	76	91	95	96

Note: 1. Content of PEPA – 12 mass parts; 2. T = 28±2℃, t = 24 hours; 3. T = 42±2℃.

Table. 2.

The influence of the time of the heliotechnological modification method on the mechanical properties of organomineral protective coatings

Mechanical^1 properties	The duration of the heliotechnological treatment, t (hour)					Control ^{2}
Microhardness (Nm) MPa	12	36	60	84	108	224
Impact strength (σ_{imp}) kN / m	122	115	109	105	104	76

Note: 1. With optimal hardener (PEPA -12 mass parts) and structural agent (GS-10 mass parts). 2. Curing with traditional heat treatment (T = 2930K; t = 2 hours, without HC).

From an analysis of the results of the study (table 1 and table 2) to determine the degree of curing, it was found that the optimum content as a structure-forming agent can be taken 10 mass parts HC at 12 mass parts PEPA.

Table. 3.

Assessment of corrosion resistance of structural materials on a five-point scale

Corrosion rate, mm / year	**Strength rating, score.**	**Resilience Group**
At most 0,1	Very resistant	1
more 0,1 to 1,0	Persistent	2
more . 1,0 to 3,0	Minimum resistance	3
more . 3,0 to 10,0	Low resistant	4
more. 10,0	Unstable	5
Note – lower grade are characterized by more resistant metals.		

Table. 4.

Investigation of the corrosion resistance of samples from St-3 in different aggressive environments

Type of ambient	Test time (days)				
	5	10	15	20	25
H_2O	0,002	0,004	0,008	0,009	0,01
NaOH	0,04	0,09	0,15	0,22	0,3
H_2SO_4	0,08	0/15	0,3	0.45	0.6

The results of the study showed that structural materials of technological equipment operated in aggressive environments today correspond to 4 points of resistance (low resistance) on a 5-point scale.

In this regard, on the basis of the research results, compositions of organic-mineral materials for protective coatings for technological equipment operating in highly aggressive environments are proposed (Table 5).

Table. 5.

The proposed compositions of organic mineral composite materials

Organic Mineral Components	The compositions of organic mineral materials for coatings (mass parts)		
	OMCM-1	**OMCM-2**	**OMCM-3**
ED-20	100	100	100
HC	10	10	10
AKF-78	2	2	2
AKO	20	-	-
AKT-10	-	20	-
AKC-30	-	-	20
PEPA	12	12	12

To assess the corrosion stability of the proposed adhering coatings, the dependence of the polarization resistance on time in an acid medium of 92-98% H_2SO_4 was studied. As an example, the results of studying the dependence of the polarization resistance on the time duration in a solution of 98% H_2SO_4 (Fig. 7.) are presented. It is seen that the most resistant is OMCM2.

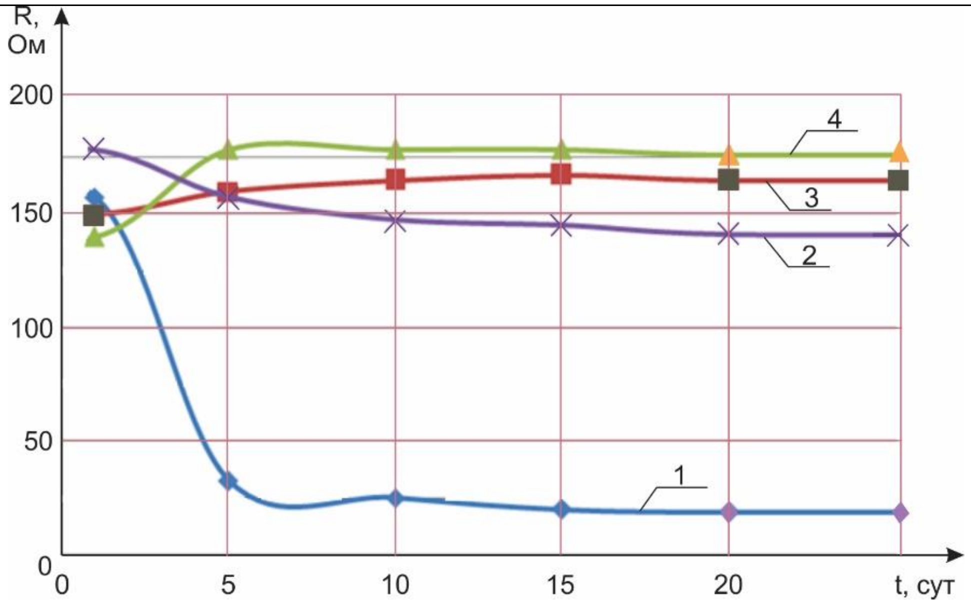

Fig. 2. The dependence of the polarization resistance from time to time in 98% H2SO4 solution 1 - uncoated; 2 - OMKM3; 3 - OMKM1; 4 –OMKM2.

The analysis of the research results compared with the assessment of the anticorrosive ability of the compositions showed that the compositions OMCM1, OMCM2, OMCM3 proposed by us (Table 5) can be used to protect metal parts operating in the most aggressive, high-temperature acidic environments, increasing the operational life of the machines.

As a result of periodic inspections, in order to determine the state of the metal surface of technological equipment and anti-corrosion coating by non-destructive testing methods (ultrasonic and magnetic), no microcracks and delamination of the coating were detected.

Production tests and implementation were carried out with an assessment of economic efficiency. The use of organic-mineral anti-corrosion coatings, approved by the implementation acts and calculations of economic efficiency, allowed to increase the service life of the two-rotor mixer by an average of 1.33 and the screw conveyor by 1.53 times, respectively, with an actual economic effect of 71.4 million sums per year only due to increase the service life of technological equipment.

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