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MATHEMATICAL DESCRIPTION OF RHEOLOGICAL PROPERTIES OF COMPOSITIONS BY PREDICTION OF THEIR THICKNESS

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Abstract
The rheological properties of compositions are mathematically described by predicting their thickness. The rheology of heterocomposite mixtures has been studied to ensure the uniformity of the thickness and properties of coatings on the surface of large-sized and complex configuration technological equipment. It is proposed that for anti-friction coatings on working surfaces for complex configuration technological equipment, it is advisable to use the compositions GKTZ-1, GKTZ-2, GKTZ-3 and GKSZ-1, GKSZ-2, GKZS-3, GKTL-1, GKTL are recommended for coatings of sheet materials GKSZ-2, GKTL-3 whose fluidity is better due to the comparatively low viscosity, depending on the type and composition of the components.

Keywords : interpolation, Lagrange, mathematical model, regression equation, GKTZ, GKSZ, GKTL, rheology, gossypol resin,

Introduction

In the sectors of the economy of the Republic of Uzbekistan, the processing and use of local raw materials is important, since the transition to an intensive development path, the creation of technology for the production of export-oriented products, import-substituting raw materials and materials, the rational and efficient use of raw materials and production waste are one of the main directions in need of technical and technological modernization.

Particular attention is paid to nanocomposites . Due to a number of their functionally important properties, they are widely used in various sectors of the world economy.
In the numerous range of components used in materials science and technology of composite materials for functional coatings, a special role is played by nanodispersed fillers and modifiers obtained from various semi-finished products, including natural ones. The relative availability of mineral raw materials, which is often a technological waste from the production of building products, metal structures, mineral fertilizers, etc., along with the effective modifying effect of finely dispersed rock particles, determines its extensive use in practical materials science.
However, the existing traditional grinding and purification technologies do not fully provide the possibility of obtaining finely dispersed high-quality mineral fillers in the development of multifunctional composite materials. In this regard, the mathematical description of the rheological properties of compositions for predicting their thickness, the development of an effective technology for obtaining new composite materials based on the study of rheological, mechanical, operational properties to obtain high-quality competitive multifunctional composite materials based on local raw materials is relevant..

Methods

It is known that the results of experiments in specific areas of research are accepted on the basis of mathematical processing. When processing the results of experimental data on the basis of a certain plan and interpolation approach, the reliability of the research is substantiated. The areas of application of interpolation are the discovery and refinement of the laws of nature, forecasting, planning and processing of experimental data, modeling, control of various objects, etc. The theory of interpolation, together with the theory of similarity and dimensions, is the scientific basis for modeling, which is very useful, and in many cases simply necessary. Interpolation can serve as a tool for verifying the truth of a law obtained theoretically. There are various formulas that allow you to get an interpolation polynomial, one of these is Newton's interpolation formula using the Lagrange method.
Based on our research and the experimental data obtained, we applied Newton's formula, which has the following form:

$$P_n(x)=y_0+\frac{\Delta y_0}{1!h}(x-x_0)+\frac{\Delta^2 y_0}{2!h^2}(x-x_0)(x-x_1)+\ldots+\frac{\Delta^n y}{n!h^n}(x-x_0)(x-x_1)\cdots(x-x_{n-1}) \quad (1)$$

We use this formula as one of the possible forms of writing an interpolation polynomial of the second degree and get

$$P_2(x)=y_0+\frac{\Delta y_0}{1!h_0}(x-x_0)+\frac{\Delta^2 y_0}{2!h_1^2}(x-x_0)(x-x_1) \quad (2)$$

Based on the results of experimental studies for all compositions (Table 1), the following regression equation was obtained:

$$P_{i,(i=1\div 10)})=0.625x^4-17.06x^3+152.1x^2-397.7x+805 \quad (3).$$

The spatial change in the expiration time of the compositions is shown in Fig. 1. It can be noted that with an increase in the HS content, the process of structure formation becomes more complicated due to an increase in the viscosity of heterocomposite mixtures.

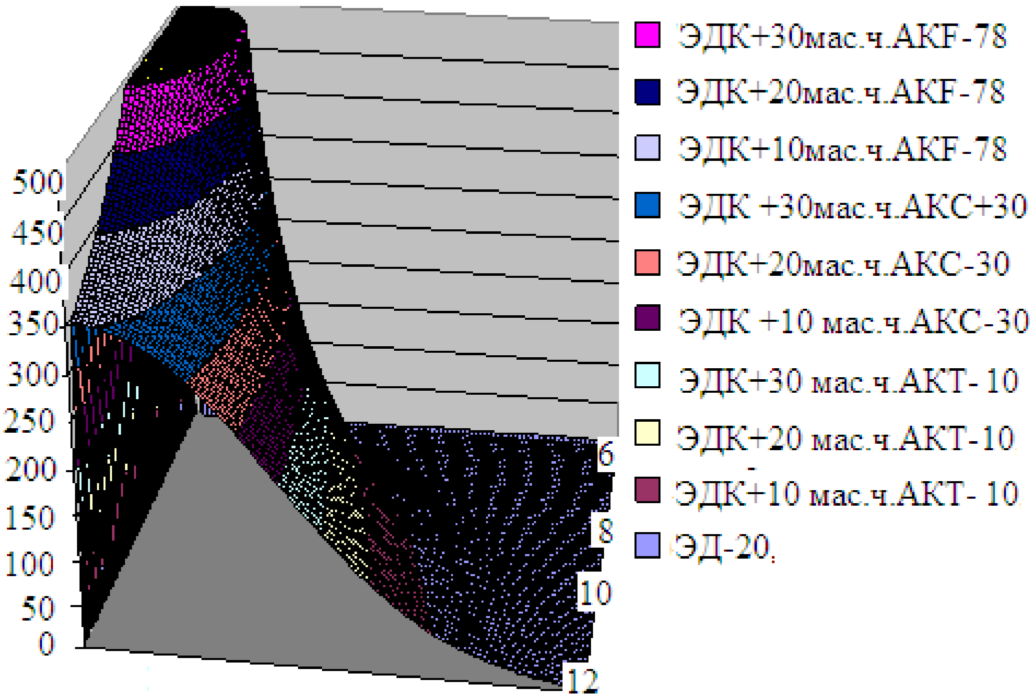

Figure 1. Spatial changes in the composition of the mixture

Based on the study of the factors affecting the rheology of coating formation, we have optimized the compositions of heterocomposite materials for antifriction coatings. (Table 1).

In table. 2 shows the results of studies of the main physical and mechanical properties of the developed compositions. It can be seen that the compositions meet the requirements for basic strength and mechanical properties. In particular, for anti-friction coatings on working surfaces for complex configuration technological equipment, it is advisable to use the GKTZ-1, GKTZ-2, GKTZ-3 and GKTZ-1, GKZZ-2, GKZS-3 compositions, GKTL-1, GKTL are recommended for coating sheet materials

GKTL -2, GKTL-3 whose fluidity is better due to the relatively low viscosity, depending on the type and composition of the components.

Table 1 Compositions of heterocomposite materials recommended for use on the working surface of large-sized and complex- configuration equipment

Compositions and components of heterocomposite materials										
Components	GKTL-1	GKTL-2	GKTL-3	GKTZ-1	GKTZ-2	GKTZ-3	GKSZ-1	GKSZ-2	GKSZ-3	GKSZ-4
ED-20	100	100	100	100	100	100	100	100	100	100
PEPA	12	12	12	12	12	12	12	12	12	12
HS	6	8	10	8	10	12	6	8	10	12
ACT-10	25	25	25	30	30	30	-	-	-	-
AKS-30	-	-	-	-	-	-	15	15	10	10
Note: GKTL-1 - heterocomposite materials with AKT-10 filler for surface coatings of sheet structural materials, GKTZ - heterocomposite materials with AKT-10 filler for casting materials of complex configuration parts; GKSZ - heterocomposite materials with filler AKS-30 for casting materials of complex configuration parts										

Table 2 Physical and mechanical properties of heterocomposite coatings formed by the activation-solar technology method

Coating properties	GKTL-1	GKTL-2	GKTL-3	GKTZ-1	GKTZ-2	GKTZ-3	GKSZ-1	GKSZ-2	GKSZ-3	GKSZ-4
Microhardness , (Nm), MPa	14.0	15.1	15.5	14.4	15.5	16.1	13.1	14.5	15.1	15.5
Impact strength Nm	30.2	31.1	32.0	29.1	28.2	28.4	30.1	32.5	33.0	35.1
adhesive strength. plating/metal score	1	1	1	1	1	1	1	1	1	1
Water absorption , % (100 days)	1.45	1.48	1.56	1.55	1.55	1.72	1.83	1.84	2.01	2.12

The step of calculating the regularity of the change in the time of the expiration of mixtures from the composition of heterocomposite materials:

$$h = x_i - x_{i-1} = 360 - 350 = 10 \text{(four)}$$

Using the Newton interpolation formula, for the values of the components ED-20, PEPA, GS and AKT-10, we compile a difference table of the change in the outflow time from the composition of heterocomposite materials.

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Table 3 Difference Table

expiration time x	Components	Compositions of GKTL heterocomposite materials			
		y	Δy	$\Delta^2 y$	$\Delta^3 y$
350	ED-20	100			
			-88		
360	PEPA	12		82	
			-6		-82
370	HS	6		0	
			-6		
25	ACT-10	0			

Taking into account the dependence of the mixture flow time on the composition of heterocomposite materials, we have the regression equation (4.5) and its graphical representation (Fig. 4.2) based on the interpolation formula:

$$P_{истеч.время}(x) = -0{,}003x^4 + 3{,}3286x^3 - 883{,}318x^2 + 186030{,}3x - 4068132 \quad (5)$$

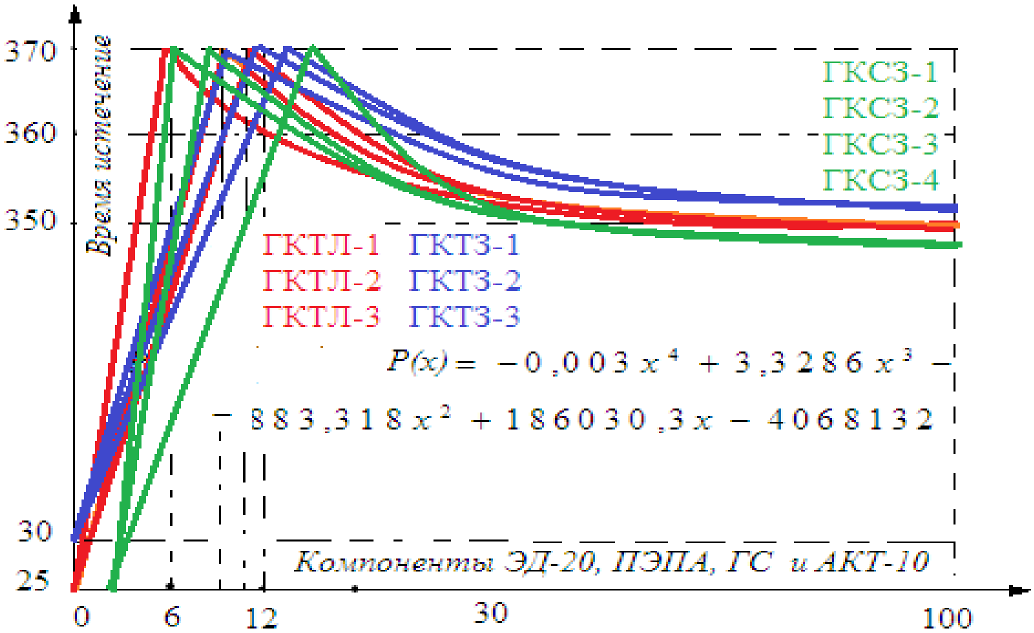

Fig.2. Change in the expiration time of mixtures from the composition of heterocomposite materials

We determine the difference changes in the properties of heterocomposite coatings (microhardness (MPa), impact strength (N□m), modulus of elasticity (GPa), water absorption (%)).

Conclusions

Mathematical processing of the results of the study of the process of structure formation of heterocomposite materials and coatings, using the Newton interpolation formula and the Lagrange method, taking into account rheological parameters, the use of heterocomposites is proposed for both large-sized and complex -configuration technological equipment, and sheet structural materials.

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