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DURABILITY INCREASE OF POLYSTYRENE PAINTS WITH INTRODUCTION OF ORGANIC MINERAL ADDITIVE INTO THEIR COMPOSITION

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ABSTRACT

Provides information on the use of additives in the formulation organomineralnoj polystyrene paints. Shows the effect of additives on organomineralnoj viscosity change colors, the critical pigment volume concentration, change in the rheological and technological properties of paints and performance properties of coatings on their basis. The increase of elastic deformations film samples prepared using organoclays. Set to reduce the time of grinding paint when administered ornomineralnoy supplements, a significant decrease paint consumption per square meter of finished surface.

KEYWORDS: Organoclay, Polystyrene Paint Viscosity, Time of Grinding, Elastic Properties, Resistance

INTRODUCTION

The practice of finishing work knows the use of polystyrene paints, for example, polymeric enamel (ТУ У 6-05761614/028-2000), enamel НП-182 (ТУ 2313-196-56271024-2003), paint "Solventol" (ТУ 2313-206-56241024-2004). To regulate reological, technological properties of paints and maintenance features of coatings on the basis of these paints various structural additives are introduced into composition of paints. Thus in practice we use organobenthonite, which is a thickener of oil paints and it increases their viscosity and coverings durability [1]. We have developed organomineral additive on the basis of Penza region clay, which can be used as dispersed and structural additive while developing polystyrene paints composition. As an organic component we've used additives ОП-4 and ОП-11, and we've determined their concentration according to the change of plastification solution surface strain. We have found out that clay adsorbs 1.9% of additive ОП-4 and 0.9% of ОП-11.

To research the influence of organomineral additive on the properties of polystyrene paints we've produced films (5,0×1,0 sm) on the basis of 10% polystyrene lacquer. To get this lacquer we've used strike-proof polystyrene УПМ-0508-08 (ГОСТ 28250-89) as a solvent we've used coal solvent Б (ГОСТ 1928-79).

As pigments we used titanium dioxide TiO_2 (ТУ 6-10-1650-78) and ochre – iron aluminium silicate (ТУ У – 00204607-005-2000) and as a filler we used microdolomite brand MD-10and a filler omyacarb brand 5VA.

Reological properties were evaluated by indicator of relative viscosity, determined by viscosimeter ВЗ – 4.

In figures 1-2 we can see the results of experimental research determinance of varnish colours composition viscosity from pigment TiO_2 and ochre concentration.

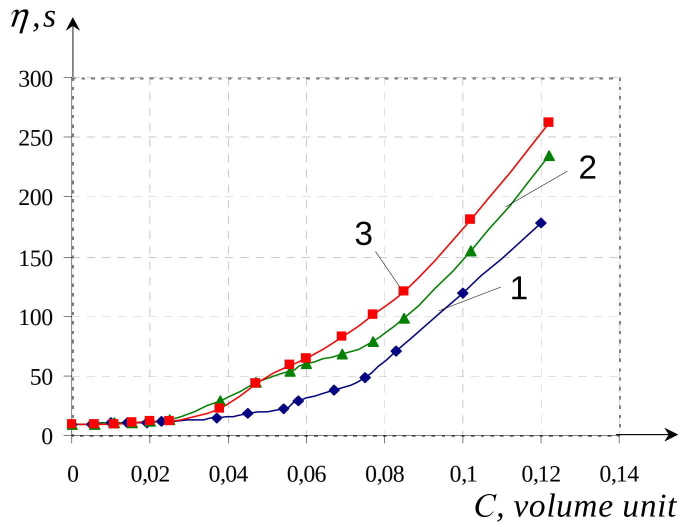

Figure 1: Determinance of Varnish Colour Composites Relative Viscosity from Volume Consentration of TiO_2 Pigment: 1 – Controle (without Additives); 2 – with Organic Clay Modified by Оп-4; 3 – with Organic Clay, Modified by Оп-11

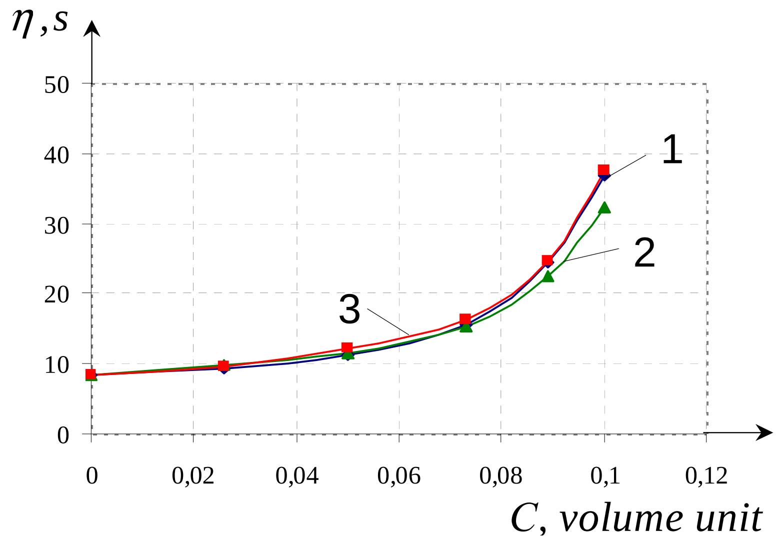

Figure 2: Determinance of Varnish Colour Composites Relative Viscosity from Volume Consentration of Ochre Pigment: 1 – Controle (without Additives); 2 – with Organic Clay Modified by Оп-4; 3 – with Organic Clay, Modified by Оп-11

Data analysis (Figure 1&2) shows that while titanium dioxide filling in intervals $0<\varphi<0.07$ (for controle composition), $0<\varphi<0.04$ (for composition with organic clays) and ochre $0<\varphi<0.06$ (for controle), $0<\varphi<0{,}05$ (for compositions with organic clays) – viscosity increase is negligible. It is obvious, that polymeric matrix just partly turns into filmy condition. While the following filling we can watch sharp viscosity increase of varnish colour composition. At reaching CVCP (Critical Volume Concentration of Pigment) structural-phasic matrix transition from volume into film condition take place and at this time structural net of pigment-pigment type is formed.

Figure 3-4 show viscosity dependence on volume pigment share in coordinate lgη-C (where C – pigment concentration in the system). This dependence is shown as two straight lines crossing each other. The point of intersection projected on abscess axis is a CVCP.

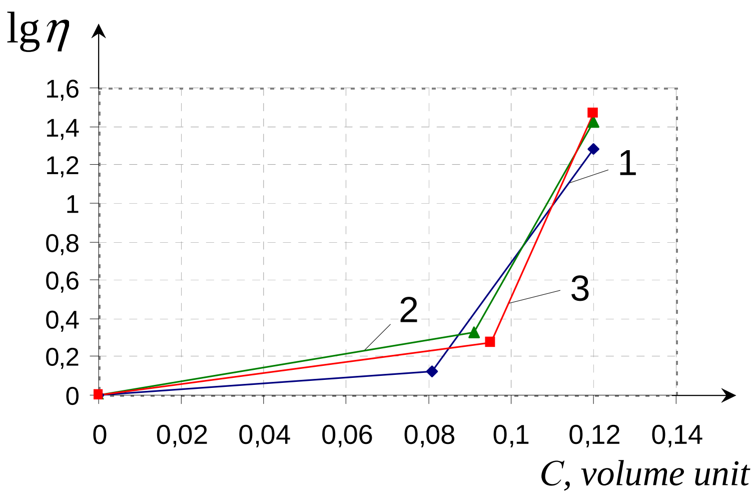

Figure 3: Dependence of the System Logarithm Viscosity from Volume Pigment (Titanium Dioxide) Concentration: 1 – Controle (without Additives); 2 – with Organic Clay Modified by Oп-4; 3 – with Organic Clay, Modified by Oп-11

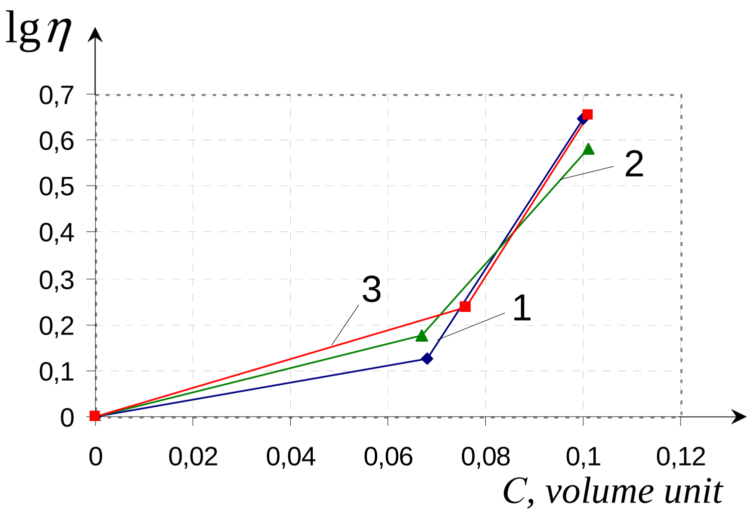

Figure 4: Dependence of the System Logarithm Viscosity from Volume Pigment (Ochre) Concentration: 1 – Controle (without Additives); 2 – with Organic Clay Modified by ОП-4; 3 – with Organic Clay, Modified by ОП-11

The results that determine critical volume concentration of the pigment are shown in Table 1.

Table 1: Value of CVCP

№ п/п	Compositions	CVCP	
		TiO_2	Ochre
1	controle	0,081	0,068
2	with organic clay modified by ОП-4	0,091	0,067
3	with organic clay, modified by ОП-11	0,095	0,076

We've estimated that CVCP value rises with introduction of organic mineral addition.

Optimal filling degree of polymer composites was calculated by two methods. In the first case components expenditure for making a unit of polymer composite is calculated by formula [2]

$$V_{filler} = \frac{1}{\alpha} \quad (1)$$

$$V_{film} = 1 - \frac{\rho_{bulk}}{\alpha \cdot \rho_{filler}} \quad (2)$$

$$V_{mon} + V_{film} = 1 \quad (3)$$

$$V_{mon} = V_{filler} - V_{filler} \cdot V_{Efiller} \quad (4)$$

where V_{filler} – volume of filler particles, volume unit;

V_{film} – volume of filmmaking solution, volume unit;

α – coefficient of filler particles parting;

ρ_{bulk} − filler bulk density kg/m^3

ρ_{filler} – filler density, kg/m^2

V_{mon} – volume of monolite filler particles,

$V_{Efiller}$ – volume of filler interparticle emptiness, volume unit.

Whereas

$$V_{Efiller} = 1 - \frac{\rho_{bulk}}{\rho_{filler}} \quad (5)$$

Coefficient of filler particles partition is determined by

$$\alpha = \left(\frac{d_{aver} + h}{d_{aver}} \right)^3 \quad (6)$$

where d_{aver} – average size of filler particles, m;

h – average thickness film layer, m, was equal to 1,4 mcm.

The second method of calculation is the following:

$$\varphi = \rho_{bulk} / \left[\rho_f \left(\frac{h_o S_u \rho_f}{6} + 1 \right)^3 \right] \quad (7)$$

where φ – volume filler content;

ρ_{bulk} – bulk filler density, kg/m^2;

ρ_f – filler density, kg/m^2;

h_o – average thickness of film layer, 1,4 mcm (1,4×10^{-6} m);

S_u – specific filler surface, m^2/kg.

Pigment expenditure was the same in both cases. The data are given in table 2.

Table 2: Theoretical Calculations of Pigment Expenditure

Pigment	S_u, m^2/kg	$d_{aver} \cdot 10^{-6}$, m	ρ_{bulk}, kg/m^2	ρ_{fill}, kg/m^2	V_{filler}, Volume Unit	V_{mon}, Volume Unit	V_{film}, Volume Unit
TiO_2	467,92	3,2	650	4000	0,34	0,054	0,946
ochre	1128,83	1,83	730	2900	0,182	0,046	0,954
red lead	750,53	2,04	1072	3900	0,209	0,057	0,943
chrome oxide	1012,64	1,13	882	5210	0,089	0,015	0,985

The received results of pigment volume concentration (PVC) for different pigments were used while making compositions of paints with a number of designed-properties.

We’ve researched the influence of the offered organic mineral additive and organicbentonite on the time of paint milling. According to ТУ У В. 2.7-05761614.028-2000 the degree of polysterine paints milling should be no more than 50 mcm. The degree of paints milling was determined by instrument “Klin” ГОСТ 6589-57 “Research methods. Determinance of paints milling degree by “Klin” method”. It is known that controle composition (without organic clay) gets the degree of milling 52 mcm in 20 minutes of milling, while organic clay addition shortens the time of milling up to 5-7 minutes with the same degree of milling. Another time of milling process considerably influences the consumption of energy and hence influences the decrease of cost price of paints. Introduction of native organic concrete leads to shorter time needed for pigment milling in comparison with controle composition and it makes 10 minutes (figure 5)

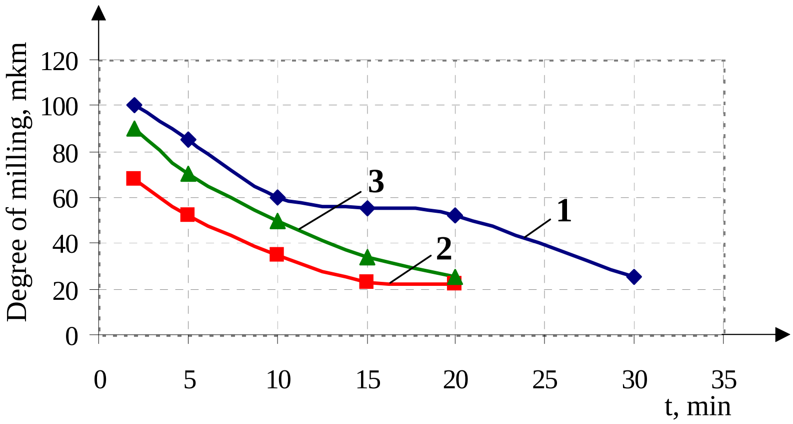

Figure 5: Dependence of Milling Degree on Time: 1 – Controle (without Additives); 2 – with Organic Clay; 3- with Organic Concrete

Introduction of organic mineral additive into polystyrene paints composition changes reological, technological paints properties and maintenance properties of coatings on their basis. It is estimated that the use of organic clay in polystyrene paints composition leads to considerable decrease of paints expenditure on a square metre (Table 3).

Table 3: Varnish Paint Spreading Capacity

№ п/п	Organicclay, %	Filler, %		Spreading Capacity
		MD-10	Omycarb	
Controle	-	-	-	160
1	2	-	5	110
2	2	-	-	112
3	2	5	-	142

Two methods of organic clay introduction into paint composition were investigated. The first method is the following. Plastyfying additive ОП-4 with concentration 1.9% from clay weight was introduced into solvent while making painting compositions. Clay (2% from polystyrene weight) was added into the mixture. Clay concentration (2%) was adopted according to recommendation [2]. Then in 15-20 minutes polystyrene was added into the solution.

In the second method of varnish making dry organic clay was introduced into polystyrene spread, which was later used for varnish making.

After hardening the films were tested on stretching by tearing instrument ИР 50-57 with traverse moving speed 35 mk/c. The results of testing are given in Table 4 and on figure 6.

Table 4: Physic-Mechanical Properties of Polystyrene Film

№	Name	Thickness, sm	Tearing Stress σ_s, kg/sm^2	Elasticity Module E_{el} kg/sm^2	Elastic Deformation ε_{el}	Plastic Deformation ε_{pl}	Relative Deformation ε_{rel}
1	Controle	0,07	52,4	$0{,}75 \cdot 10^4$	0,0056/0,14	0,0337/0,86	0,039/1
2	First method of organic clay introduction	0,07	96,2	$0{,}95 \cdot 10^4$	0,0079/0,28	0,0201/0,72	0,028/1
3	Second method of organic clay introduction	0,07	59,04	$0{,}85 \cdot 10^4$	0,0065/0,24	0,0205/0,76	0,027/1

Data analysis given in Table 4, proves that strength polysterene films with organic clay on ОП-4 basis leads to films strength increases on 30% in case of the first method of varnish making. In case of the second method films strength increases on 11%.

It is estimated that films samples produced with organic claypossess increased elastic deformation. Thus controle samples have elastic deformation ε_{el} = 0.0056 mm/mm whereas films with organic mineral additive have increased elastic deformation. During the first method of introduction ε_{el} = 0.0079 mm/mm during the second method ε_{el} = 0.0065 mm/mm. With introduction of organic mineral additive polystyrene films have higher value of elasticity module. During the first method of organic clay introduction elastic module $E_{el} = 0.95 \cdot 10^4$ kg/sm^2, during the second method of varnish making$E_{el} = 0.85 \cdot 10^4$ kg/sm^2.

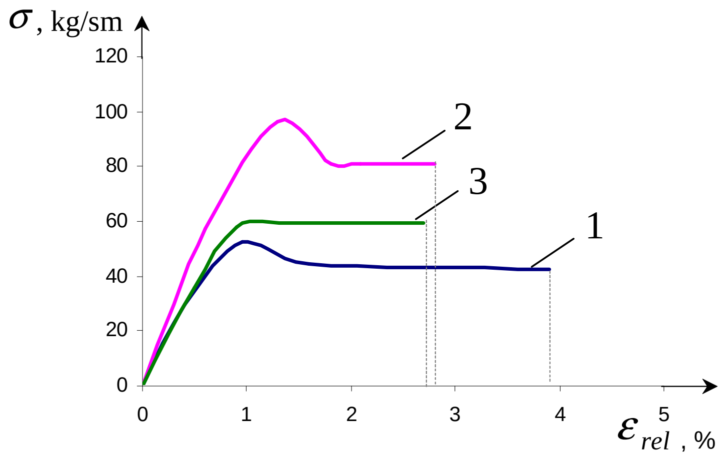

Figure 6: Diagram of Polystyrene Films Stretch: 1 – Controle Composition (without Organic Clay); 2 – with Organic Clay (1st Method of Making); 3 – with Organic Clay (2d Method of Making)

Figure 6 shows the diagram of polystyrene films stretch. The film of the controle composition (without organic clay) teared when relative lengthening was 3.9% and tension σ_s = 42.72 kg/sm^2. The films with organic clay teared at relative lengthening 2.8% (the first method of introduction) and 2.7% (the second method of introduction). It should be mentioned that destructive stress at film stretching was much higher in the first method of organic clay introduction and it was σ_s = 96,2 kg/sm^2 and in the second case it was σ_s = 59,04 kg/sm^2.

In addition we've studied the influence of organic clay introduction on the change of the paints reological quality. The paints technological qualities were evaluated during their drying. The paint was produced on the basis of 10% polystyrene varnish. The degree of drying was evaluated on 5 marks scale according to ГОСТ 19007-73* "Varnish paint materials. Method of time and degree drying evaluation". The results are given in Table 5.

The time of coverings drying to mark scale 3 on cement-sand under layer is on average 7.6 - 10 minutes, on glass – 18.2 – 35.5 min. At minus temperature (t = -10 °C) of cement-sand under layer and plus temperature of the paint (t = 20 °C) the time of coverings drying shortens in all compositions in comparison with hardening conditions at plus temperature. The time of drying to the 3d mark scale at minus temperature of the under layer covering was 7.1 – 9.8 minutes.

Comparative properties of polystyrene paints modified with organic clay and coatings on their basis are given in Table 6. It is estimated that with introduction of organic mineral additive impact strength increases and cohesive strength of polystyrene coating with under layer increases. Polystyrene paints with organic sand cover porous surface. Coatings on the basis of modified polystyrene paints are characterized by high decorative properties. Addition of fractionated sand into a composition gives salient surface to the coatings.

Table 5: Drying Time of Varnish Paints Compositions Depending on the Kind of Underlayer and Drying Conditions

Kind of Underlayer	Drying Conditions	Drying Time, Min	Compositions				
			Controle	1	2	3	4
Glass	Air temperature t = 20C Relative humidity φ = 60	1	9	11	13	10	11
		2	15	24,7	17	34	17,5
		3	18,2	27,7	19,5	35,5	20
		5	19,8	32,7	22,5	39,5	22
Cement-sand underlayer	Air temperature t = 20C Relative humidity φ = 60	1	0,75	0,94	1,7	0,92	1,08
		2	3,3	7,8	6,1	8,2	6
		3	7,6	8,1	7,9	10	9,4
		5	10,2	11,6	10,3	12,2	10,7
	Air temperature t = -10C Paint temperature t = 20 C	1	-	-	-	-	-
		2	3	2,6	5,8	7,7	5,4
		3	7,1	7,8	6,9	9,8	8,9
		5	9,3	9,9	8,9	12	9,9
	Air temperature t = -10C Paint temperature t = -10 C	1	-	-	-	-	-
		2	24,7	28	25	21	26,5
		3	28,5	30	28,5	24,7	32
		5	34,5	35,7	35	32	36

Table 6: Maintenance Quality of Polystyrene Coatings

	Controle	With Organic Clay
Conventional viscosity ВЗ-4, s	11-14	12-16
Drying time to 3 mark at (20+2) C, min	8-10	10-12
Film impact strength У-1а, N·m	3,5	5,0
Degree of milling, mkm	50	50
Resistance $П_к$ to static interaction at (20+2) °C	48	48
Resistance to steam penetration $R_п \cdot 10^{-5}$, $m^2 \cdot h \cdot Pa/mg$	6,78	8,2
Fusion, min	9	8
Cohesion strength, MPa	1,88	2,11
Character of the upper finishing layer	Smooth	Smooth
Quality of the outer covering after 500 hours of wetting	III (loss of glance up to 50%, considerable change of colour; considerable whitishness)	V (loss of glance up to 5%, change of colour inconsiderable, lack of whitishness)

CONCLUSIONS

Found that the introduction of polystyrene paint organomineralnoj supplements based mixed-clay enhances resistance of protective and decorative coatings, reduce energy consumption during manufacturing, reduction of consumption per square meter of finished surface.

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