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V. A. Sedykh, PhD, assistant professor (VSUET);
A. Yu. Vorotyagin, technical director (JSC "Toy Factory", Voronezh);
E. S. Kuznetsova, master's degree student (VSUET);
E. P. Uss, PhD (Engineering), assistant professor (BSTU)

PROPERTIES OF FILLED COMPOSITIONS BASED ON EMULSION PVC

Set influence of chalk on the technological and technical properties of plastisol and compounds of PVC emulsion used in the manufacture of children's toys. Studied rheology filled with chalk plastisol and compounds. We studied the stability filled with chalk plastisols. Given the elastic-strength properties filled with plasticized PVC.

Introduction. Currently, flexible toys are made by rotational molding plastisol based emulsion PVC, plasticized dop (DOP).

To reduce costs and decrease mist DOP, on the surface of domestic toys, compared with toys made in China, there was the need for a filler − chalk different manufacturers (Belgorod Russia and deposits made in Turkey), differing particle size.

The aim of the study was to assess the impact of stability plastisols containing chalk in an amount of 5−20 wt % on the technological properties of PVC, while maintaining physical-mechanical FIR indicators derived compound.

Main part. *Study rheology chalk filled plastisol.* The rheological characteristics of plastisol, without chalk and with chalk increasing content, were studied using the Brookfield viscometer DV-E.

Assessed the type of colloidal dispersion viscosity change at different spindle speeds S63 (1,5−12,0 rev./min). Assessing the impact of rotational speed (n, rev./min) spindle viscometer and content Cretaceous plastisol viscosity (η, mPa · s) performed largest fold change in viscosity index (A, mPa · sec/rev./min) of the linear regression equation $\eta = A \cdot n + B$ in the speed of rotation of the spindle viscometer (Table 1).

For freshly plastisol containing no chalk and 10 wt % chalk viscosity was almost independent of the speed of rotation of the spindle (A minimal and ranged from 10 to 43 MPa · sec/rev./min), that is characterized by the properties of the plastisol ideal fluid.

Found that with increasing duration of storage plastisol within 0–48 hours or more regardless of the content of chalk in the range of 5–20 wt % a figure increased from 10 to 17,440 mPa·sec/rev./min.

A dependence of the content of the chalk in the storage process is more complicated. For freshly plastisol (0 h exposure) contains about 15 wt % of chalk, the greatest absolute value of A is equal to 1,310 mPa·sec/rev./min, and after 48 h A = 17,440 mPa·sec/rev./min.

After 24 h storage of the plastisol to 5 wt % a most chalk characterized reaching 21,600 mPa·sec/rev./min, and after 48 h − 17,440 mPa · sec/rev./min.

The obtained values of the multiplicity show that increasing the content of chalk 15 to 20 wt % when introduced into a PVC plastisol freshly properties led to a pseudoplastic liquid.

It was found that the aged for 24 hours or more, regardless of the content of the plastisol characterized chalk pseudoplastic fluid properties, since the growth speed of rotation (from 1.5 to 12.0 rev./min) reduced viscosity (1,034–7,239 reaching A mPa·sec/rev./min).

It is shown that the effect of the chalk content in the range from 10 to 20 wt % on the multiple changes in viscosity has a slightly different character. Image chalk content from 10 to 15 wt % increased the pseudoplastic properties of plastisols in 24 hours, and more exposure. So, after 24 h exposure plastisol 15 wt % a chalk figure was 7,239 against 3,451 mPa · sec/rev./min for plastisol with 10 wt % chalk with increasing spindle speed. Consequently, when a 1.5-fold increase in the content of chalk 2-fold increased A.

Table 1

Influence of spindle rotation speed of viscometer, exposure duration of plastisol and content of exposure of chalk in multiplicity indicator A changes its viscosity from the linear regression equation $\eta = A \cdot n + B$

Time, h	*A*, mPa · c/ vol. / min					*B*, mPa · c				
	no chalk	5 mas. %	10 mas. %	15 mas. %	20 mas. %	no chalk	5 mas. %	10 mas. %	15 mas. %	20 mas. %
0	–43	–43	–10	–1310	–1,177	1,356	1,356	2,824	13,070	18,713
24	–5,287	–21,600*	–3,451	–7,239	–1,034	469,450	96,230	34,096	56,756	20,966
48	**	**	–9,362	–17,440	–2,427	**	**	65,910	86,230	31,726

* Rough measurements.
** Higher limit of measurement.

After 48 h exposure plastisol the trend growth rate of order k remained and amounted to 17,400 against 9,362 mPa·sec/rev./min, respectively.

Further increase of chalk in the plastisol up to 20 wt % led to a decrease of A with increasing rotational speed of the spindle viscometer. Thus, after 24 hours exposure and the bottom to 1,034, and after 48 h of exposure − to 2,427 mPa·sec/rev./min.

This was due to the high level of the estimated initial viscosity (n = 0 rev./min) filled plastisol characterized indicator B, equal to 56,756 and 86,230 mPa · sec to increased sorption plasticizer surface chalk and as a consequence, the lack of plasticizer on the surface of PVC. Thus, studies found that the rate of rotation of the spindle viscometer and dosage chalk affect the change in viscosity of the plastisol.

Stability study chalk filled plastisols. Chalk content significantly affects the stability of aging (viability) plastisol filled with chalk. To assess the stability of colloidal dispersions (plastisol filled with chalk) after 24 hours storage plastisol selected sample from the top and a depth of 7 cm to define the ash. By scatter resulting ash content was estimated scatter chalk content (Table 2) and, indirectly, the degree of separation of the colloidal dispersion. It was established that the chalk content in the range 5–15 wt % of the spread, and therefore the lowest dispersion stability of the plastisol.

Table 2

Effect of the content of chalk in dispersion of the plastisol on its viscosity and delamination on the sol (in a layer of height of 7 cm)

Contents of chalk, mass. % PVC	Content of ash, mass. % (Up / down)	Viscosity (n = 1.5 vol. / min), mPa · c	
		actual at 0 h / 24 h	estimated at 0 h *
5	0.9/0.8	1,600/63,830	1,526
10	2.9/1.9	9,170/31,260	18,276
15	3.1/2.3	11,600/46,390	27,462
20	3.8/3.9	19,840/29,670	25,873

* According to the regression equation

Thus, for greatest stability identified plastisols containing 20 wt belgorod chalk% PVC.

Study rheology chalk filled plastic. Practical interest are the rheological properties of the resulting flexible PVC plastisol. For this purpose, the molten PVC toys milled at 180^{0}C extruded through calibrated nozzle SmartRheo-1000 rheometer software «CeastVIEW 5,94-4D» with increasing shear rate (υ) from 0 to 1.6 s^{-1}.

According to the coefficients of the regression equation $\lg\eta_{pl} = C_{pl} \cdot \lg\upsilon + D_{pl}$ (Table 3), the melt viscosity of flexible PVC decreased regardless of the content of chalk with increasing shear rate and shear stress level increased with increasing content of chalk in flexible PVC with 5 to 20 wt %. Therefore, the melt PVC compounds, as well as plastisol was pseudoplastic fluid.

Table 3

Effect of the content of chalk and shear rate of melt plasticate by fold change to measure multiplicity of changes in viscosity η_{pl} [Pa · s] plasticate C_{pl}

Contents of chalk in the plastisol, mass. % PVC	The coefficients of the regression equation $\lg\eta_{pl} = C_{pl}\lg\upsilon + D_{pl}$	
	C_{pl}	D_{pl}
5	–1.1	3.5
10	–1.0	3.7
15	–0.9	3.8
20	–1.0	3.9

Effect of chalk in the range of from 5 to 20 wt % on the outside multiplicity reduce viscosity versus shear rate C_{pl} = 0.9−1.1 substantially not detected.

With increasing content of chalk in plastic its estimated maximum viscosity increased proportionally D_{pl} ratio from 3.5 to 3.9.

Thus, the character of pseudoplastic melt flow-plasticity is not altered by the introduction of chalk.

Stress-strain properties of filled PVC. Rebound resilience flexible PVC containing from 5 to 20 wt % belgorod chalk, was 11−18% (Table 4). Applied to the pilot samples increase in Belgorod chalk toys from 15 to 20 wt % reduced the impact elasticity to 11−13%. With the growth in flexible PVC content of 5 to 20 wt % belgorod chalk revealed a slight increase in hardness (from 49 to 58 s.u. against 45 s.u.) plastic without chalk.

Table 4

Influence of the content Belgorod chalk on the hardness and rebound resilience plasticates subjected to compression

Recipe number	Contents of chalk mass. % PVC	Hardness, Shore A units	Rebound elasticity, %
1	0	45	17
2	5	50	16
3	10	49	17
4	15	58	18
5	20	54	18
6	10	–	18
7	15	57	11
8	20	56	13
9	20	44	18

Note. For the preparation of formulations used No. 1–8 Belgorod chalk, and number 9 − hydrophobizated chalk Turkish production. Recipes No. 1–5 − laboratory and No. 6–9 − pilot samples ZAO “Toy Factory”.

Introduction 20 wt % hydrophobized chalk Turkish production has not led to an increase in hardness (44 s.u.) while maintaining high flexibility. This was due to the lack of interaction between the surface of the chalk-coated water-repellent composition, PVC matrix swollen with DOP.

Hardness products from plastic, obtained by rotational molding, besides the content and quality of chalk and location influenced plane products (Table 5). Most surface hardness product as a cube with a wall thickness of 6 mm on the detected bottom plane (48−54 s.u.), the average hardness (48−52 s.u.) – in the side planes and the smallest (at 42−50 s.u.) − in the upper plane. This is due to the design of rotational molding machine, where the rate of centrifugal factor varies along the axes of the mold products.

Table 5

Influence of the content Belgorod chalk and location of the molding surface on the hardness plasticate

Location plane of the article	Hardness of Shore A (units) of surface article with content of chalk mass. % PVC		
	5	10	15
Top	42–46	48–50	42–44
Bottom	52	48–50	52–54
Laterally	50–52	48−52	50–52

Samples with varying content of chalk were tested for strength, and a relative residual elongation at break, tear strength (Table 6).

Table 6

Influence of the content Belgorod chalk on stress-strain performance plasticates

Number	Contents of chalk mass. % PVC	Tensile strength, MPa	Deformation,%		Tear resistance, kN / m
			breaking	remaining	
1	0	6.7	389	46	22.3
2	5	5.6	330	24	22.6
4	15	2.7	340	20	8.3
5	20	2.0	236	16	3.8
6	10	3.3	315	18	17.3
7	15	6.6	336	30	27.2
8	20	4.7	248	16	23.0
9	20t	1.4	204	12	4.8

Note. For the preparation of formulations used No. 1–8 Belgorod chalk, and number 9 − hydrophobizated chalk Turkish production. Recipes No. 1–5 − laboratory and No. 6–9 − pilot samples ZAO "Toy Factory".

With increasing content of Belgorod chalk strength of samples obtained under laboratory conditions, decreased. For products obtained in the pilot plant (recipe according to claim 6−9), a similar dependence is not installed.

In turn, the samples containing 20 wt % of chalk turkish origin, revealed abnormally low tensile strength of 1.4 MPa.

With increasing content of chalk from 0 to 20%, and the relative residual elongation at break for both laboratory and to pilot samples and laboratory samples tear strength decreased from 3.8 to 22.3 kN/m.

For pilot samples tear resistance dependence on the content of chalk in the range 10−20 wt % change on a curve with a maximum of 27.2 kN/m at belgorod chalk content of 15 wt % PVC. Note abnormally low tear samples filled with 20 wt % turkish hydrophobized chalk due to lack of interaction with the surface of the particles of chalk matrix surface PVC, DOP swollen.

Deterioration of elastic-strength indices of laboratory PVC containing 10 to 20 wt % belgorod chalk, as compared with the pilot associated with the inability to provide a shear laboratory conditions close to the developing in an industrial setting.

Conclusion. Thus, the effect of the content found on the chalk technological and technical properties of flexible PVC plastisol and PVC emulsion used in the manufacture of toys.

It was confirmed that during storage the viscosity of the plastisols increases. Introduction Belgorod chalk plastisol in an amount of 10–20 wt % PVC plastisol initial viscosity increased, but reduced rate of viscosity increase during storage for 48 hrs.

Found that with increasing content of chalk in the range of 5–15 wt % spread its content increased due to insufficient initial viscosity of the plastisol. The greatest stability was revealed for plastisols containing 20 wt % belgorod chalk with a higher initial viscosity.

With increasing shear rate viscosity of melts filled with chalk PVC decreased regardless of the content of chalk, which is typical of pseudoplastic fluids. For products obtained by rotational molding PVC filled with chalk, characterized by differences in hardness planes products by inappropriate design rotational molding machine.

It is shown that with increasing content of Belgorod chalk from 5 to 20 wt % strength and elongation at break of samples of toys were down. Resistance level of tear strength filled PVC depended on the rate of mixing of the masterbatch.

Replacing belgorod chalk in toys manufactured in turkey chalk led to an anomalous drop in hardness, tensile strength, tear resistance, while maintaining flexibility to rebound due to lack of surface interaction chalk and PVC.

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