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The Researching of the Physical –Mechanical Properties of Produced Composition Based on Polyvinylchloride and Butadiene-Nitrile Rubber

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ABSTRACT

In this research, there was prepared composition material based on polyvinylchloride (PVC), butadiene-nitrile rubber (SKN-40), and dolomite and researched the physical-mechanical properties of produced composition. There was determined optimal amount of ingredients which are used in composition. There was determined that, obtained composition answers the given standards and demands of the exploitation condition. Polyvinylchloride (PVC) was modified with butadiene-nitrile rubber (SKN-40) in different ratio at 125-135^{0}C temperatures for 3-4 minutes. the rheological properties were studied. The purpose of research work is learning the effect of SKN-18 rubber on rheological properties of modified binary polymer alloy composition based on PVC. For this purpose, there was used PVC-E62 mark polymer. The modification process of PVC undergoes by using these ingredients which are given below.

For this purpose, there was suggested that produced composition material should be used as packing of plastic window, also, linoleum production.

Keywords: *Polyvinylchloride (PVC), butadiene-nitrile rubber (SKN-40), dolomite, composition, flow index of alloy , modification, plasticizer, filler, physical-mechanical properties.*

INTRODUCTION

One of the basic modification methods of the polymer is changing the mechanical properties by plasticizer. For learning properties and effects of plasticizers, must be researched different properties of modified polymers with plasticizer.

Each plasticizer effects on the plastic properties of polymer. Plasticizers were used for increasing flowing ability of cellulose industry. Also, appropriateness of plasticizer with vinylalcohol causes the passing of polymer from solid state into flow state. Adding plasticizer to the mixture causes changing of temperature which is basic factor [1-5].

By using different plasticizers, it must be used various amount of plasticizer for changing the properties of the same polymer at the same direction. By using this method, it is possible to learn the effects of different plasticizers on the same polymer [6-9].

Based on analysis, is determined that, there are plasticizers that decrease the temperature and increase the elasticity of product in all materials based on PVC. The most appropriate synthetic plasticizers for PVC are dibutyl phthalate (DBP) and dioctyphthalate (DOP). adding of plasticizers to the composition which is prepared based on PVC, causes the decreasing burning durability, it was used different fillers and antiprenes[10-21].

Based on effect mechanism, there are two types of fillers: active fillers and inert filllers. In the past, there were thought that, one group of inert fillers is mineral fillers and there was no effect

of mineral fillers for turning ability of materials based on polymer. The main purpose for adding this filler, is to facilitate the manufacture of PVC and reduce the original capital of the obtained product. According to the result of the research, some minerals such as diopsid, mekalite, floqopite, vermikulite effect the burning process of products based on polymer. It is determined that, adding fillers more than optimal amount, cause the forming of mixture and the mechanical-chemical properties became worse [21-31].

EXPERIMENT

Ecological clean diatomite is used as filler. Diatomite is sediment source clean matter that is used to filter drinks. Recipe is like below:

PVC-65 m.p.;

Plastticizer-2 m.p.;

Stabilizer-5 m.p.

Dolomite is binary salt of Ca and Mg carbonates, pure mineral and there are more than 95% dolomite in geode.

There was used cadmium-barium stearate as stabilizer.

There are plasticizer and filler in composition prepared based on polyvinylchloride. In research work, these components which are given below, are used.

Polymer:Polyvinylchloride (PVC E-32)

Filler: Dolomite

Plasticizer: Dioxyphthalate (DOP).

There were used 18 rubbers as plasticizer in research.

RESULTS

Modification of Emulsion Type PVC E22 with SKN-18 Rubber

For increasing physical-mechanical properties of PVC E 62 mark polymer, these ingredients were used.

- butadiene – nitrile (SKN-18);
- dolomite as filler ($CaMg(CO3)_2$);
- dioxyphthalate as plasticizer (DOP).

Composition mixture was prepared in laboratory mixing apparatus at 90^0C temperature for 12 minutes.

Determination of Flow Index of Polymer Alloy

The indicator of the melting index of polymers is characterized by the flow rate of the molten thermoplastics in the standard capillary at pressure and temperature.

The flowing index of alloy is expressed in grams of the polymer extrcted from the capillary during the standard time. When the flowing index of polymer alloy is high, viscosity is less. During the determining flowing index of polymer alloy, rules of doing tests, preparing condition of sample to the test, appointment of indicators must comply with the norms. By using this formula, it can be calculated consumed volume of alloy.

$$Q = \frac{S}{t} \cdot \frac{\pi D_s}{4}$$

There: Q – consumed volume of alloy, cm^3/sec;

We have learnt rheological properties of PVC/SKN-18 mixture for determinig variation during the manufacture and mechnaical mixing of PVC/SKN-18.

In research work, there were determined the effects of temperature on PVC/SKN-18 mixture in İİRT – 5 device (capillary viscometer), flowing indicators of the mixture, dependency of consumed volume on amount of load, dependency of flowing velocity of system on tension, dependency of effective viscosity on tension.

Composition mixtures based on PVC were prepared according to the following recipe. Firstly, binary mixture was prepared with modification of PVC in different ratio with SKN-18 rubber (Table 1).

Table1. *Preparing process of PVC / SKN – 18 mixture*

Ingredients	Mass part						
	1	2	3	4	5	6	7
PVC	100	100	100	100	100	100	100
SKN – 18	-	10	20	40	60	80	100

At the end of the research, there was determined optimal amount. For learning the effect of filler on optimal system, there was added filler (dolomite) in different ratio and obtained mixture. (table .2).

Table2. *Preparing process of PVC/ SKN – 26/ filler-mixture*

Ingredients	Mass part				
	1	2	3	4	5
PVC	100	100	100	100	100
SKN – 26	20	20	20	20	20
Dolomite	-	10	20	40	60

After determining optimal amount of filler, there were prepared mixtures by adding plasticizer in different ratio (table 3) .

Table3. *Preparing process of PVC/ SKN – 26 filler-plasticizer mixture*

İngredients	**Mass part**				
	1	***2***	***3***	***4***	***5***
PVC	100	100	100	100	100
SKN – 26	20	20	20	20	20
Dolomite	10	10	10	10	10
DOP	-	5	10	15	20

Researching of Rheological Properties of PVC\SKN-18 Mixture

It is known that, flowing properties of alloy composition based on PVC (MFI), is one of the main indicators for determining manufacture technology of composition based on PVC [12-16].

DISCUSSION

We have learnt rheological properties of PVC/SKN-18 mixture for determinig variation during the manufacture and mechnaical mixing of PVC/SKN-18. In research work, there were determined the effects of temperature on PVC/SKN-18 mixture in İİRT – 5 device (capillary viscometer), flowing indicators of the mixture, dependency of consumed volume on amount of load, dependency of flowing velocity of system on tension, dependency of effective viscosity on tension.

Table4. *Consuming time for flowing of PVC\SKN-18 binary mixture at 170^0C temperature (S = 20mm distance)*

	Effect of load on alloy flowing,kg			
№	**13,06**	**19,12**	**24,56**	**32,08**
1	68″04‴	49″09‴	31″75‴	17″63‴
2	38″73‴	18″24‴	11″808‴	8″36‴
3	29″18‴	15″25‴	10″90‴	6″96‴
4	17″32‴	13″93‴	8″30‴	6″08‴
5	9″22‴	7″05‴	4″45‴	3″08‴
6	7″04‴	4″60‴	3″24‴	2″21‴
7	5″20‴	3″39‴	2″40‴	1″58‴

Calculate the pressure that effects on each square cantimeter of the binary mixed sample surface of the capillary viscosimetry cylinder:

$$P = \frac{G}{\frac{\pi D_S^2}{4}}$$

There: G – load on the sample (13,06 kg; 19,1kg; 24,56 kg; 32,08 kg)

Dc – diameter of cylinder (0,954 cm).

Calculate pressure (P) on the sample according to the weight of loads:

$$P1 = \frac{13,06}{\frac{3,14 \cdot (0,954)^2}{4}} = \frac{13,06}{0,785 \cdot (0,954)^2} = \frac{13,06}{0,7144} = 18,281 \text{ kg/cm}^2$$

$$P2 = \frac{19,02}{0,7144} = 26,623 \text{ kg/cm}^2$$

$$P3 = \frac{24,56}{0,7144} = 34,378 \text{ kg/cm}^2$$

$$P4 = \frac{32,08}{0,7144} = 44,904 \text{ kg/cm}^2$$

Calculate displacement tension (τ) of the binary mixture from the end point of capilyar of device according to the calculated pressure:

$$\tau = \frac{P \cdot r}{2l}$$

There : τ – radius of capillyar (0,05cm);

l – length of capillyar (0,8 cm).

Calculate displacement tension according to the pressure on the polymer alloy:

$$\tau 1 = \frac{18,281 \cdot 0,05}{2 \cdot 0,8} = \frac{0,91405}{1,6} = 0,5712 \text{ kg/cm}^2 = \underline{\boldsymbol{0,5712 \cdot 9}}$$

$P3 = \frac{24,56}{0,7144} = 34,378\ kg/cm^2$

$P4 = \frac{32,08}{0,7144} = 44,904\ kg/cm^2$

Calculate displacement tension (τ) of the binary mixture from the end point of capilyar of device according to the calculated pressure:

$$\tau = \frac{P \cdot r}{2l}$$

There : τ – radius of capillyar (0,05cm);

l – length of capillyar (0,8 cm).

Calculate displacement tension according to the pressure on the polymer alloy:

$\tau_1 = \frac{18,281 \cdot 0,05}{2 \cdot 0,8} = \frac{0,91405}{1,6} = 0,5712\ kg/cm^2 = 0,5712 \cdot 9,806 \cdot 104 = 5,6012 \cdot 104$ Pa

$\tau_2 = \frac{26,623 \cdot 0,05}{1,6} = 0,8319\ kg/cm2 = 0,8319 \cdot 9,806 = 8,1576 \cdot 104$ Pa

$\tau_3 = \frac{34,378 \cdot 0,05}{1,6} = 1,0743\ kg/cm2 = 1,0743 \cdot 9,806 = 10,5346 \cdot 104$ Pa

$\tau_4 = \frac{44,904 \cdot 0,05}{1,6} = 1,40325\ kg/cm2 = 1,40325 \cdot 9,806 = 13,7603 \cdot 104$ Pa

Calculate logarithmic of displacement tension:

$\log \tau_1 = \log (5,6012) = 4,75$ $\log \tau_3 = \log (10,5346) = 5,02$

$\log \tau_2 = \log (8,1576) = 4,91$ $\log \tau_4 = \log (13,7603) = 5,14$

Calculate volume consumption (Q) of the samples which overcome determined distance of indicator (20 mm), according to the each displacement tension at 170oC temperature:

$$Q = \frac{S}{t} \cdot \frac{\pi D_S^2}{4}$$

There: S – determined distance of sample (0,02 cm);

t – time that overcame determined distance (second). Obtained results are demonstrated Table 5 and 6.

Table5. *Dependency of amount of concumed volume of alloy on amount of load*

№	G1 (13,06 kg)	G2 (19,12 kg)	G3 (24,56kg)	G4 (32,08kg)
Q1	2,09994	3,1	4,5001	8,1043
Q2	3,6893	7,8337	12,10027	17,0909
Q3	4,89678	9,369718	13,10105	20,52873
Q4	8,249896	10,25699	17,20202	23,60

Table6. *Dependency of amount of concumed volume of alloy on amount of load*

№	G1 (13,06 kg)	G2 (19,12 kg)	G3 (24,56kg)	G4 (32,08kg)
Q1	2,09994	3,1	4,5001	8,1043
Q2	3,6893	7,8337	12,10027	17,0909
Q3	4,89678	9,369718	13,10105	20,52873
Q4	8,249896	10,25699	17,20202	23,60
Q5	15,49764	20,266	32,1078	46,3896
Q6	20,29662	31,0608	44,0987	64,6515
Q7	27,4785	42,1475	59,5333	90,4303

According to the results of the researches, there was learnt dependency of consumed volume of composition mixture on amount of SKN-18 in composition mixture. (picture 1). Consumed volume of mixture increases by increasing of amount of SKN-18. The main value of the displacement velocity during the capillary movement of the samples at 170^0C – temperature corresponding to each of the displacement tension is calculated by the following formula:

$$\dot{\gamma} = \frac{Q}{\pi r^3}$$

Obtained results were given below.

Table7. *Dependency of displacement velocity (γ̇) on displacement tension (τ)*

№	τ_1, sec-1	τ_2, sec-1	τ_3, sec-1	τ4, sec-1
$\dot{\gamma}1$	0,535	0,7898	1,1465	2,0648
$\dot{\gamma}2$	0,93995	1,9958	3,0829	4,3543
$\dot{\gamma}3$	1,2476	2,3871	3,3378	5,2302
$\dot{\gamma}4$	2,1019	2,6132	4,3826	5,9873
$\dot{\gamma}5$	3,9484	5,1634	8,1803	11,8190

$\gamma 6$ —	5,1711	7,9136	11,2353	16,4717
$\gamma 7$ —	7,0009	10,7382	15,1677	23,0395

This formula is used for calculate slipping velocity: _

$\dot{\gamma} = (3 + n)\ \dot{\gamma}$

There: n – is the angle of tangent of the curve that reflects abnormal viscosity.

In the picture 1, it has been demonstrated dependency of displacement velocity on displacement tension of PVC/SKN – 18 mixture alloy at 175^0C temperature. Minimum amount of τ (τ_1) is called Newton condition. In Newton condition, polymer alloy has maximum viscosity. Character of polymer alloy in high amount of τ (τ_2, τ_3) is non-Newton condition. This is abnormal viscosity area that is related with effective viscosity. The less Newton viscosity is observed in the highest amount of τ (τ_4).

When the amount of SKN rubber is 10-20 m.p in PVC/SKN – 18 mixture, caharacter of polymer mixture curve is in τ_1 və τ_2 Newton condition. When amount of SKN-18 is in more than 30 m.p, character of polymer alloy is in τ_3 və τ_4 non-Newton condition and this is undesirable condition. [15-16]

Researching of the physical-mechanical properties of the composition materials based on PVC/SKN. Composition based on PVC/SKN was prepared in laboratory mixer according to the recipe for 20 minutes and demonstrated at Table.3 –Prepared composition was vulcanized at 143 ± 1^0C temperature for 20 minutes. There were researched physical-mechanical properties of obtained vulcanized material and demonstrated at Fig.1

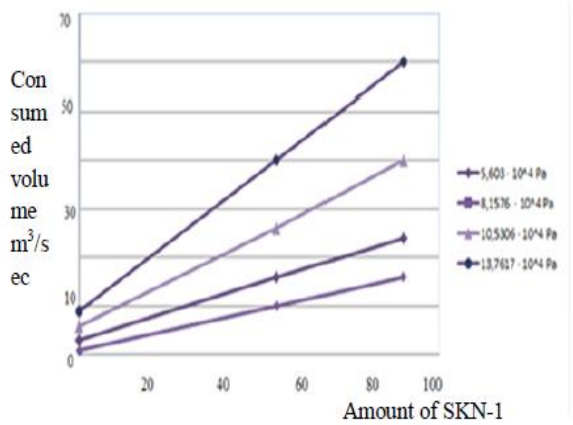

Fig1. *Dependency of consumed volume of PVC/SKN-18 composition by the by the effect*

Researching Physical-Mechanical Properties of Composition Material Based on PVC/SKN

Composition based on PVC/SKN was prepared in laboratory mixer according to the recipe for 20 minutes and demonstrated at Table .3 – Prepared composition was vulcanized at 143 $\pm1^0$C temperature for 20 minutes. There were researched physical-mechanical properties of obtained vulcanized material and demonstrated at table 7.

Table8. *Physical-mechanical properties of composition material based on PVC/SKN-18*

№	Physical-mechanical properties	Composition code					
		1	2	3	4	5	6
1.	Hardness limit in stretching,MPa	66	76,2	76,9	74,6	76,8	67,9
2.	Relative extension ,%	120	140	146	150	153	158
3.	Remain deformation,%	10,8	10,9	11,0	11,4	11,9	12,0
4.	Elasticity ,%	21	23,1	23,8	24,0	23,9	24,1
5.	Hardness for TM – 2 device	68	67,4	67	66,2	66,0	85,0
6.	During the period of 200 cycles of the device Friction resistance, gr/min	19,9	16,0	16,3	16,9	17,1	17,7

RESULT

According to the obtained results, we decide that, the properties of modified composition with DOP is better than unmodified composition. The physical-mechanical properties of composition which is prepared by using optimal amount in comparision with composition based on PVC, hardness limit in stretching is 76,8 MPa for 66MPa, relative extension is 153% for 120%, elasticity is 24% for 21%, friction resistance is 16 g for 19,9 g. So, it is clear that, adding 5-20 m.p DOP is an optimal variant and it is possible to obtain demanding composition.

- Dolomite as filler in different amount was added to the PVC/SKN-18 – 100/20 binary mixture and rheological properties were

learnt. It was determined that, optimal amount of dolomite (10 m.p).

- Composition mixture was prepared by adding dioxyphthalate to PVC/SKN-18/dolomite – 100/20/10
  mixture and rheological properties such as consumed amount of alloy, effective viscosity, dependency of displacement velocity on displacement tension at 170 – 175^0C temperatures, (5,6 – 13,76) · 104 Pa pressure. Optimal amount of DOP is 10 m.p. [14-18]
- Composition material was prepared based on PVC/SKN/dolomite/DOP – in 100/20/10/10 ratio and researched physical-mechanical properties of composition mixture. It was determined that, obtained composition answers the demanding standards and hard aplication condition. For this purpose, it was suggested that this composition material can be used in plastic window industry, lineleum production

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