Studies of the physical and mechanical properties of the composition obtained on the basis of polyvinyl chloride, synthetic rubber ethylene propylene terpolymer, and plasticizer

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Abstract

> The properties of mixtures and vulcanizates of polyvinyl chloride (PVC) and synthetic rubber of ethylene-propylene terpolymer (SREPT) have been studied. The physical and mechanical properties of vulcanizates have been studied. Thus, a vulcanizate based on a mixture of PVC with synthetic rubber of ethylene propylene terpolymer has a higher oil and petrol resistance than a vulcanizate based on unmodified SREPT. It became known that 10 mass. spare parts in synthetic rubber ethylene-propylene terpolymer PVX are optimal for modification. synthetic rubber-based ethylene propylene terpolymer. 30 mass parts and when turned on, the degree of swelling of the vulcanizate decreases in gasoline by 2.7 times, in a mixture of gasoline-benzene (3:1) by 2.3 times, and in Avtol-10 oil by 3.2 times

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I. Introduction

The production of rubber based on polyvinyl chloride (PVC) and synthetic rubber of ethylene-propylene terpolymer (SREPT) is of great industrial importance today [1][2][3][4][5]. compositions based on elastomers with high unsaturation have a low resistance to atmospheric and ozone influences. A large amount of anti-aging agents are added to these mixtures to improve the resistance of the compositions to the atmosphere and ozone [6][7][8][9]. These chemicals are expensive and harmful and do not provide complete protection of composite materials from atmospheric and ozone exposure during operation [10][11][12][13]. left [14][15][16] One of the main modification methods of polymers is to take a composition based on them and change their mechanical properties by plasticizing. In order to fully study the properties and effects of plasticizers, it is necessary to study various indicators of polymer substances modified with plasticizers.

Each plasticizer affects the plastic properties of polymer materials in a different way. Plasticizers are used in the production of cellulose to improve its flowability. Also, when combining vinyl polymers with plasticizers, the plasticizers cause the polymer to change from a horn-like or solid state to a more fluid state. Similar to in systems, adding a plasticizer to the mixture causes a significant change in a key factor such as temperature. [1][2][3][4][5]

In order to change the properties of the same polymers in the same direction by using different plasticizers, it is necessary to take different amounts of plasticizers. In this way, it is possible to study the effect of different plasticizers on the same polymer substances in a comparative way. [6][7][8][9]

As a result of the analysis, it was determined that all products and materials based on PVC and SREPT contain plasticizers that reduce the processing temperature of the product and increase its flexibility, and the most suitable synthetic plasticizers for PVC are dibutyl phthalate (DBF) and dioctyl phthalate (DOF). the addition of plasticizers causes a decrease in the fire resistance of that material. Fillers and flame retardants of various origins are used to increase fire resistance. [10][11][12][13][14]

SREP provides materials on the study of PVC in relation to the reduction of oxidative degradation in composites and its use in injection-molded polymer composites. [15][16]

Therefore, below are materials on the study of PVC, associated with a decrease in oxidative degradation and its use in injection molded polymer compositions.

The selection of the optimal ratio of components and the study of the properties of the composition based on PVC, UCPE, and a polymer plasticizer were carried out by the methods of physical and mechanical tests, thermomechanical studies, the gel fraction was determined in a Soxhlet apparatus with tetrahydrofuran (THF) for 6 hours. The time of 6 hours was taken based on the fact that the original PVC completely dissolves in tetrahydrofuran after 6 hours. In order to determine the thermal stability of the system and predict its behavior at high temperatures, the PVC composition was subjected to differential thermal analysis (DTA). A petroleum antioxidant heavy pyrolysis resin was used as a stabilizing additive. [17][18][19][20]

Thermal analysis of the PVC composition was carried out on a MOM-type derivatograph with a gas combination, which made it possible to purge the heating chamber with atmospheric air. The rate of temperature rise is 5^0C / min. The weighed portion of the tested polymer was 1-1.3 g. The NA stabilizer was introduced at the required concentration into the PVC solution, after which the solvent was evaporated at room temperature, followed by drying the samples to a constant weight in a vacuum oven at a temperature of 60°C. material on the RMI-250 tensile machine at a lower clamp speed of 50 mm/s. [21][22]

From the analysis of the nature of the change in the gel fraction, it was found that with an increase in the concentration of the plasticizer, other things being equal, the degree of crosslinking monotonically decreases [23][24][25]

II. Methodology

Choosing the optimal ratio of components and studying the properties of the composition based on PVC, SREPT, and polymer plasticizer was carried out by physical-mechanical tests, and thermomechamethodsresearch methods, and the gel fraction was determined in Soxhlet—apparatus with tetrahydrofuran (THF) for 6 hours. The 6 h time was taken based on the complete dissolution of the original PVC in tetrahydrofuran after 6 h. The PVC composition was subjected to differential thermal analysis (DTA) to determine the thermal stability of the system and to predict its behavior at elevated temperatures.

Environmentally friendly diatomite was used as a filler. Diatomite is a pure substance of sediment origin and is used to filter drinks (eg wine, beer, etc.). The recipe is as follows:

- PVC-65 mass parts
- Plasticizer-2 mass parts;
- Stabilizer-5 mass parts.
- Dolomite, a binary salt of Ca and Mg carbonates, is a pure mineral, and its rocks contain more than 95% dolomite.
- Cadmium-barium stearate is used as a stabilizer.

The composition structure is made on the basis of polyvinyl chloride, in addition to polyvinyl chloride, plasticizer, and filler. The following components were used in the research work:

- Polymer: Polyvinyl chloride (PVC E-32)
- Filler: Dolomite
- Plasticizer: Dactyl phthalate (DOF).
- Plasticizer chemical - 18 rubber was used in the work.

Dolomite, a binary salt of Ca and Mg carbonates, is a pure mineral, and its rocks contain more than 95% dolomite. Only after thermal exposure is the SREPT-PVC connection established. Therefore, the SREPT model is exposed to the temperature effect according to the vulcanization regime of system (30 and 60 minutes at 153°C).

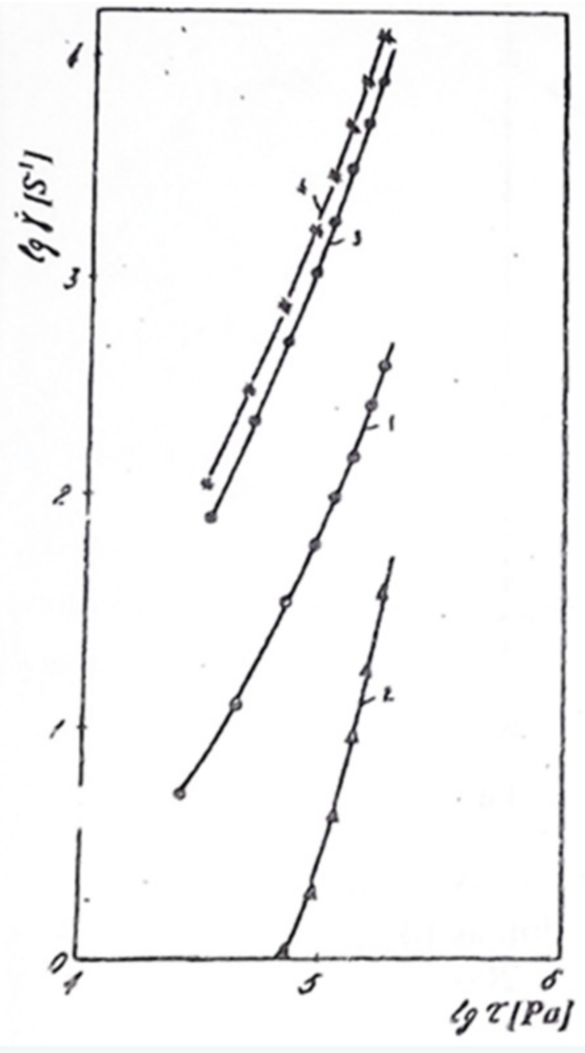
Results and Discussions

Compositions based on SREPT+PVC

And the plasticizers were made on a laboratory roll at a temperature of 130°C and for 12 minutes. After obtaining a homogeneous mixture, their activation energy and polymer melt index were determined on an IIRT-3 instrument (Figs. 1 and 2). The effective viscosity of PVC is an order of magnitude higher than that of the SREPT alloy. When PVC is added to the mixture in the form of plastic, the viscosity of the SREPT-PVC mixture decreases by one order of magnitude in the viscosity of SREPT and by two orders of magnitude in the viscosity of PVC (Figures 3 and 4).).

The inclusion of PVC plastic in SREPT significantly improves the rheological properties of these blends, indicating improved miscibility of SREPT with PVC, which is typically based on blends.

leads to an improvement in the physic mechanical properties of the compositions. You can take into account the activation energy KC/mole of viscous flow of the above mixtures: for PVC-204; SREPT-40; SREPT, SREPT: PVC (70:30) -55.6; For SREPT:PVX: DBF (60:26:14) it is 66.



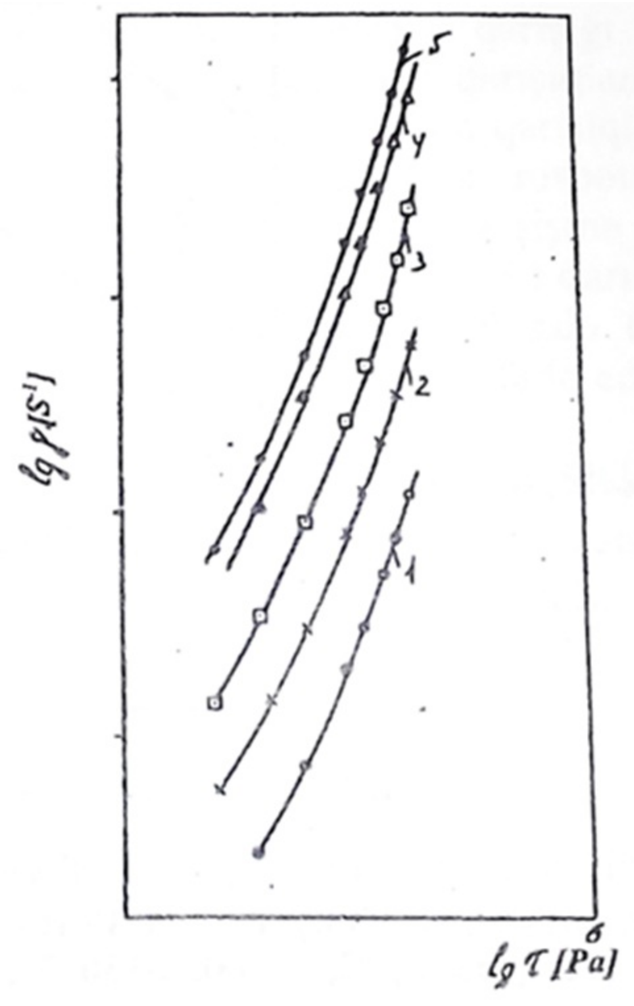


Figure 1 (left). Flow curves: 1- SREPT; 2-PVC; 3- SREPT-PVC-DBF compound (60:26:14); 4- SREPT-PVC-DBF (58:25:17). Temperature 180°C.

Figure 2 (right). Flow curves of a mixture of SREPT-PVC-DBP (60:26:14 wt.%). Temperature °C. 1-100; 2-130; 3-150; 4-180; 5-200.

Based on SREPT, oil-resistant, gasoline-resistant, etc. compounds are added to SREPT to improve its properties by adding 40% weight of PVC plastic (PVC-65, DBP-35% by weight).

Oligotetraacrylate does not mix well in these mixtures, which is explained by their chemical structure and low similarity with the polymers of the mixture. Dactyl phthalate and dactyl brutality are selective PVC plasticizers, and therefore provide a more uniform distribution in the elastomeric phase of the mixture.

Multicomponent SREPT, a mixture of carbon black and PVC, was developed in the temperature range of 100÷170°C. The decrease in the durability of compositions prepared at 100°C is explained by the agglomeration of PVC particles in the mixture due to the different softening temperatures of SREPT and PVC. Figure 1 (left). Flow curves: 1- SREPT; 2-PVC; 3-SREPT-PVC-DBF compound (60:26:14); 4- SREPT-PVC-DBF (58:25:17). Temperature 180°C.

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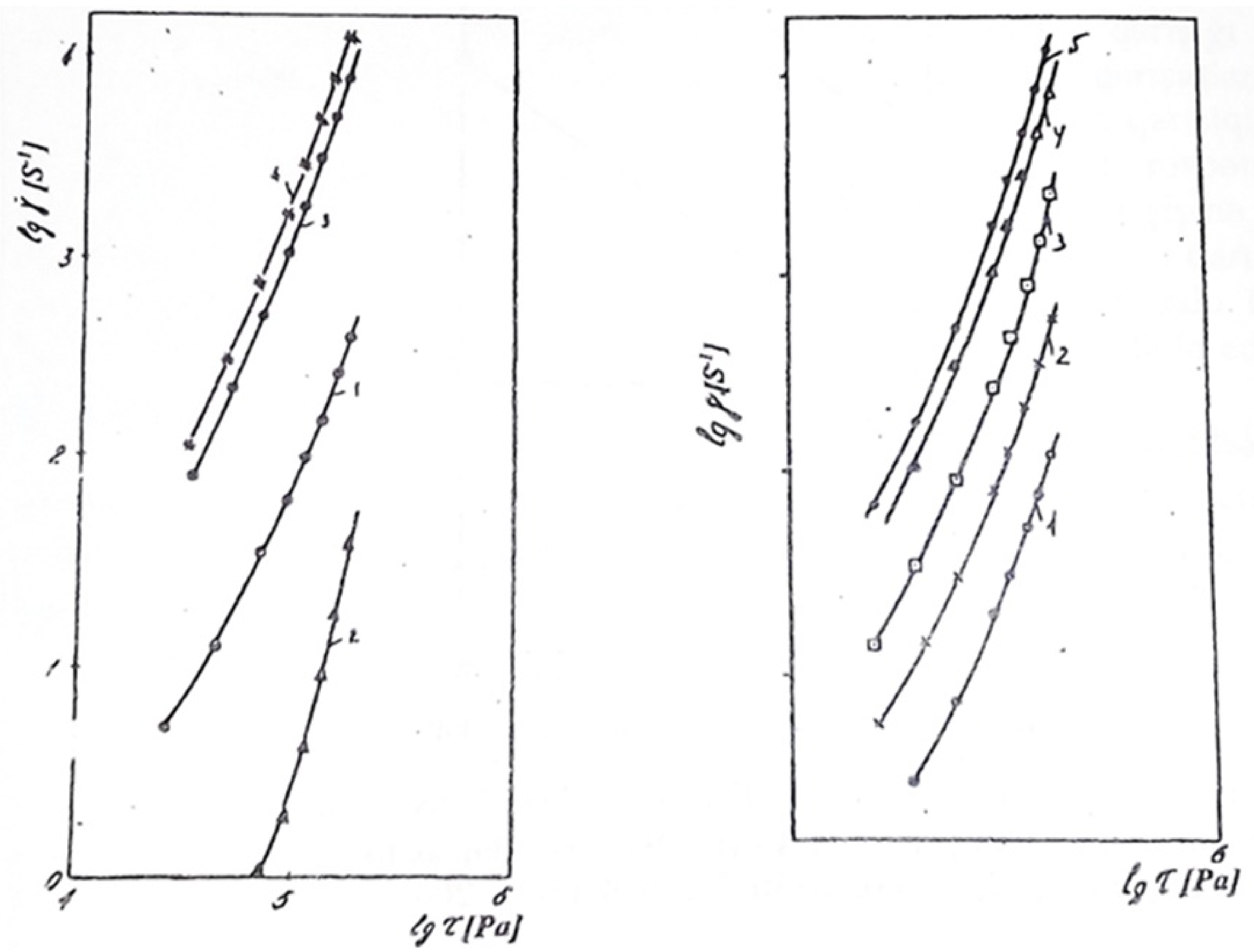

Figure 3 (left). Temperature dependence of effective viscosity of alloys: 1 - PVC; 2 - SREPT; 3 - SREPT -PVC (70:30); 4 - SREPT-PVC-DBF (60:26:14); 5 - SREPT-PVC-DBF (58:25:17).

Figure 4 (right). Dependence of the effective viscosity of the mixture SREPT-PVC (70:30) on the amount of DBP. Shear stress - τ=1.35 105 Pa, Temperature, °C: 1-373; 2-403; 3 - 423; 4-453; 5-473.

Therefore, it was proposed to prepare filled compositions based on a mixture of SREPT + PVC at temperatures above 130°C. The choice of temperature for the vulcanization of forest compositions is also of great importance. During vulcanization at temperatures above 153°C, the release of hydrogen chloride is observed, the porosity of products from these compositions increases, and their properties deteriorate. As a result of increasing the amount of PVC in the mixture from 5 to 30% by weight, i.e. 6 times, the amount of chlorine associated with the elastomer is increased by 2 times. Therefore, it is expected that the amount of PVC in SREPT-PVC blends should be 5-10% by weight

Также были исследованы физико-механические свойства смесей SREPT+ПВХ, полученные результаты приведены в таблицу1

Table 1. Physical and mechanical properties of mixtures of SREPT / PVC

SREPT	content of components (per 100 mass parts)							
	100	95	95	95	90	90	90	70
PVX	-	5	5	5	10	10	10	30
Modifier	-	-	0,5	-	-	1,0	-	-
dibutyl phthalate	-	-	-	1,0	-	-	2	-
1	2	3	4	5	6	7	8	9
Tensile strength, MPa	19,0	19,6	19,4	19,2	20,09	20,2	20,4	16,1
Nominal stress at 100% elongation, MPa	3,3	3,5	3,3	3,4	3,8	3,43	3,4	-
Nominal stress at 300% elongation, MPa	11,9	12,5	12,92	12,87	13,0	13,6	13,2	-
Relative extension, %	415	424	432	420	390	420	415	150
Relative permanent deformation, %	18,0	19,5	21,0	20,0	19,5	20,0	20,5	12,5
Tensile strength, kN/m	35,0	36,2	40,0	35,5	35,0	36,0	37,0	30,0
Elasticity, %	38,0	38,7	39,2	39,5	39,0	39,5	39,0	24,0
Conventional unit of hardness according to TM-2	66,0	66,0	64,0	65,0	66,5	65,7	65,0	78
Metal contact strength, MPa	1,10	1,48	1,55	1,50	1,65	1,60	1,58	2,3
Tensile fatigue resistance (=200%)	1,35	1570	2980	2520	1250	2020	1920	-
=250 cycles/min	0,80	0,85	0,86	0,85	0,85	0,83	0,84	0,78
=20°C), thousand cycles	0,42	0,41	0,40	0,40	0,42	0,40	0,40	0,31
Fire resistance, sec.	280	340	355	350	360	365	360	30

The temperature of the beginning of the decomposition of PVC mixtures SREPT (80:20) is -380°C, and one SREPT - -360°C. The half-life temperatures are -440°C and 425°C, respectively. The non-combustible residue of the

mixture of PVC +SREPT (80:20) at 500°C is (10-12)% by weight.

Experiments show that as the amount of chlorine associated with SREPT increases, so does the amount of unburned residue. At this time, the heat resistance of mixtures increases, and the rate of weight loss in these mixtures decreases (Table 1).

The proposal of PVC as the most suitable functional industrial polymer in polymer blends suggests that it is important to overcome several disadvantages of these blends.

As shown above, since PVC has a higher viscosity and molecular weight than rubbers, compound vulcanizates where it is used for more than 5 hours are hard, generate more heat, and have less flexibility than rubber vulcanizates.

Plastisol was obtained by preliminary swelling of polyvinyl chloride in a plasticizer - dibutyl phthalate (DBP) for 1-2 hours. It has been shown that 100 hours of PVC dissolve in 20-50 mass parts of DBP.

The viscosity properties of the mixture SREPT-PVC with the inclusion of PVC-plastisol up to 40% were studied (Fig. 1 and 2). It is shown that PVC + SREPT mixtures are characterized by non-Newtonian flow at all studied ratios.

Studies have shown that at 200°C the structuring process begins in PVC. At 180°C, the structuring process does not occur, and constant flow rates are observed in the capillary viscometer. The effective viscosity of the alloys at different temperatures was studied depending on the amount of PVC in the mixture.

The dependence of the effective viscosity on the amount of PVC in the mixture has been studied.

It is shown that since PVC is in the form of a separate dispersed phase in the SREPT + PVC mixture, these mixtures are in a state of fluidity even at 100-150°C.

However, PVC does not flow in this temperature range. In this regard, more homogeneous and technologically well-mixed SREPT PVC mixtures can be prepared already at 150°C.

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