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Open Peer Review on Qeios

Investigation of the properties of the composition obtained based on mixtures of polyvinyl chloride

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Funding: Azerbaijan State Oil and Industry University Baku

Potential competing interests: No potential competing interests to declare.

Abstract

The properties of mixtures and vulcanizates of polyvinyl chloride (PVC) and ethylene-propylene elastomers (SKEPT-40) with functional group polymers have been studied and it appears that the effectiveness of the application of functional group polymers (FQP) is characterized by the improvement of the complex properties of vulcanizates. As shown, among the FQP, the industrial scale production of PVC and the low cost of its use in the purchase of rubber mixtures based on Synthetic rubber ethylene propylene terpolymer (SREPT) have been developed. In this regard, new composition mixtures were obtained by replacing the main polymers in rubber mixtures with 5÷30 mass parts of PVC based on SREPT. The physical and mechanical properties of their technological and vulcanizates were studied. Experiments show that the sol-fraction and durability of vulcanizate in gasoline, gasoline-benzene (3:1) mixture, and meta xylol decrease with the increase of PVC content.

The decrease in the sol fraction of the vulcanizate can be explained by the low swelling of PVC in the above solvents. Therefore, a vulcanizate based on a PVC blend of synthetic rubber ethylene-propylene terpolymer has a higher oil and gasoline resistance than a vulcanizate based on unmodified EPDM. It became known that 10 wt. parts in SREPT. When PVC is included, the degree of swelling of the vulcanizate is reduced by 20% in gasoline, in the mixture of gasoline-benzene (3:1), M-xylene, and "Avtol" oil, compared to the vulcanizate based on SREPT 30 mass parts and when included, the degree of swelling of the vulcanizate decreases by 2.7 times in gasoline, 2.3 times in gasoline-benzene (3:1) mixture, and 3.2 times in "Avtol-10" oil.

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Keywords: Vulcanization, modification, composition, rubber, structural changes, physical-mechanical property, elasticity, fire resistance.

I. Introduction

The preparation of rubbers based on polyvinyl chloride (PVC) and ethylene-propylene elastomers (SREPT -60) is of great industrial importance today [1][2][3][4][5]. compositions based on elastomers with high unsaturation have low durability against atmospheric and ozone effects. A large amount of anti-aging agents are added to these mixtures to increase the stability of the compositions to the atmosphere and ozone[6][7][8][9]. These chemicals have a high cost and harmful effect and do not fully protect composite materials from atmospheric and ozone effects during operation[10][11][12][13]. remains [14][15][16].

II. Methodology

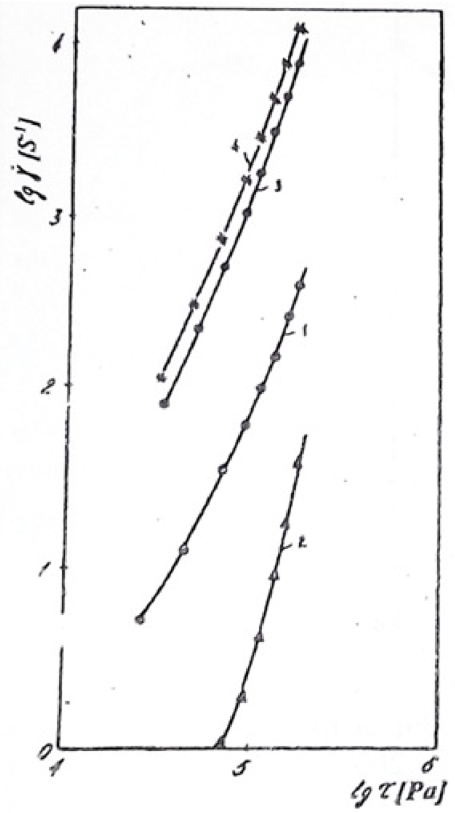
To determine the nature of the interaction of the polymer components in the SKEPT PVC mixture, the IR spectrum of the model mixture was studied. It has been shown that extracting a mechanical mixture of SREPT with PVC with dichloroethane completely washes out the PVC added to the mixture. It has been proven that. Only after the thermal effect, the connection of SREPT with PVC is established. Therefore, SREPT is subjected to temperature effects according to the vulcanization mode of the PVC model system (at 153°C for 30 and 60 minutes). This mixture is extracted with a selective solvent, dichloroethane, to determine the extent of SKEPT's interaction with PVC. At this point, PVC that is not in contact with SREPT is removed. An IR spectrum study of the kept retexture after extraction showed the following:

a. 860, 1210, 1250, 1620, 1710, 3200-3600 cm-1 absorption fields are observed;
b. 980, 1050, 1100, and m-1 absorption areas are strengthened
c. Weakening of the 720 cm-1 absorption area. The disappearance of the SREPT absorption area indicates the loss of (including) end groups in SREPT.

After the extraction, it shows that the amount of groups in the mixture decreases, and the number of groups increases. PVC alloy has a very high ehighlytive coating and considers le activation energy of flow (figures 1 and 2). The effective viscosity of PVC is an order of magnitude higher than that of SKEPT alloy. When PVC is added to the mixture in the form of plastic, the viscosity of the SKEPT-PVC mixture decreases by one order of magnitude according to the viscosity of SKEPT, and two orders of magnitude according to the viscosity of PVC (figures 3 and 4).

The incorporation of PVC plastic into SREPT significantly improves the rheological properties of these blends, indicating improved miscibility of SREPT with PVC, which is generally based on blends.

leads to the improvement of the physical and mechanical properties of the compositions. The activation energy KC/mol of the viscous flow of the above-mentioned mixtures can be taken into account: for PVC-204; SREPT-40; SREPT: PVC (70:30)-55.6; For SREPT:PVX: DBF (60:26:14) it is equal to 66.



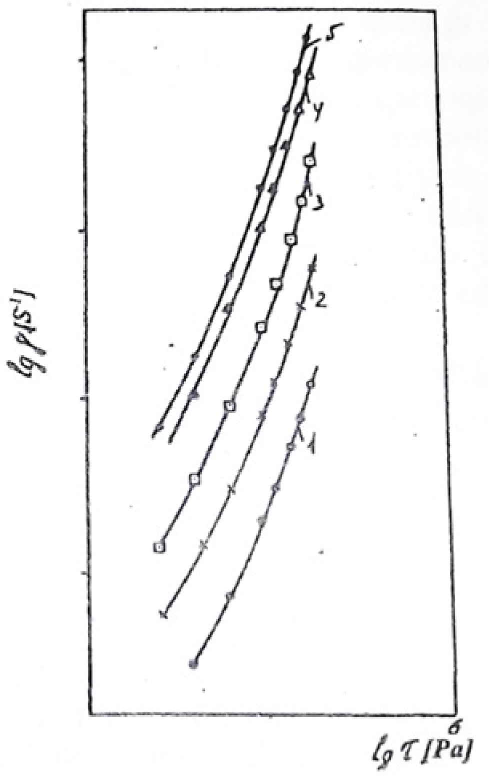


Figure 1 (on the left). Flow curves: 1- SREP; 2-PVC; 3- SKEP-PVX-DBF (60:26:14) joint; 4-SKEP-PVC-DBF (58:25:17). Temperature, 180°C.

Figure 2 (on the right). Flow curves of SREP-PVX-DBF (60:26:14 wt%) mixture. Temperature °C. 1-100; 2-130; 3-150; 4-180; 5-200.

Based on SREPT, compositions are resistant to oil, gasoline, etc. to improve its properties, 40% by mass of PVC plastic (PVX-65, DBF-35% by mass) is added to SREPT.

Oligo Tetra acrylate 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, therefore, they provide more uniform distribution in the elastomeric phase of the mixture.

Multi-component SREPT, a mixture of technical carbon and PVC, was developed at a temperature range of 100÷170°C. The decrease in the durability indicators of the compositions prepared at 100°C is explained by the agglomeration of the PVC particles in the mixture, due to the different softening temperatures of SREPT and PVC.

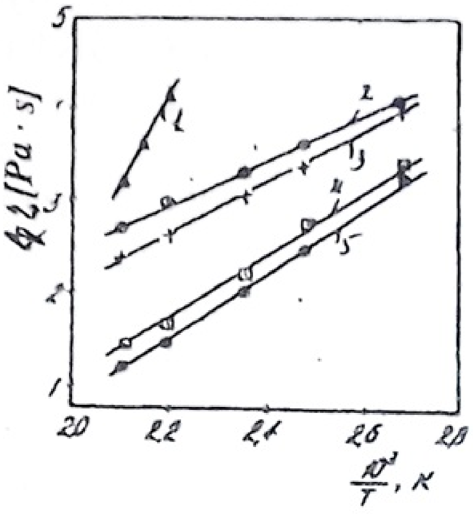


Figure 3 (on the left). Temperature dependence of the effective viscosity of alloy alloys:1 - PVC; 2 - SREPT; 3 - SKEPT-PVC (70:30); 4 - SKEPT-PVC-DBF (60:26:14); 5 - SKEPT-PVX-DBF (58:25:17).

Figure 4 (on the right). Dependence of the effective viscosity of the SREPT-PVC (70:30) mixture on the amount of DBF. 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 vulcanization temperature of forest compositions is also very important. During vulcanization at temperatures higher than 153°C, the release of hydrogen chloride is observed, the porosity of products made 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 mass, i.e. by 6 times, the amount of chlorine combined with the elastomer increases by 2 times. Therefore, it is suggested that the amount of PVC in SREPT-PVC mixtures should be 5-10% by mass.

III. Results and discussion

The structural changes of PVC macromolecules during processing, the formation of the absorption area at 860 cm-1, and the strengthening of the area at 3030 cm-1 indicate the formation of a connection between PVC and SREPT. The physical and mechanical properties of SREPT/PVC mixtures were also studied and the obtained results are given in Table 1.

Table 1. Physico-mechanical properties of SREPT/PVC blends

SREPT	SKEPTA section of the mixture, mass part.							
	100	95	95	95	90	90	90	70
PVC	-	5	5	5	10	10	10	30
MQF-9 modifier	-	-	0,5	-	-	1,0	-	-
Dibutyl phthalate	-	-	-	1,0	-	-	2	-
1	2	3	4	5	6	7	8	9
Breaking strength limit, MPa	20,0	20,6	20,4	20,2	19,9	19,4	19,3	15,1
Conditional stress at 100% elongation, MPa	3,1	3,6	3,4	3,5	3,7	3,3	3,2	-
Conditional stress at 300% elongation, MPa	12,9	13,6	13,2	13,5	14,0	13,4	13,3	-
Relative elongation,%	410	420	430	410	390	410	405	140
Relative residual 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
Conditional 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	1,570	2,980	2,520	1,250	2,020	1,920	-
=250 cycles/min **=20°C), thousand cycles**	0,80	0,85	0,86	0,85	0,85	0,83	0,84	0,78
	0,42	0,41	0,40	0,40	0,42	0,40	0,40	0,31
Resistance to burning, sec.	280	340	355	350	360	365	360	30

The onset temperature of decomposition of SREPT PVC (80:20) mixtures is -380°C, and that of SKEPT alone is -360°C. The half-decomposition temperatures are -440°C and 425°C, respectively. The non-combustible residue of the SKEPT PVC (80:20) mixture at 500°C is (10-12)% by mass.

Experiments show that as the amount of chlorine associated with SREPT increases, so does the amount of unburned residue. At this time, the thermal stability of the mixtures increases, and the rate of mass loss in these mixtures decreases (table 1).

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

As shown above, since PVC has a higher viscosity and molecular weight than rubbers, the vulcanizates of mixtures where it is used more than 5 c.h. are hard, generate more heat, and have less flexibility than rubber vulcanizates.

Plastisol was obtained by pre-swelling polyvinyl chloride in a plasticizer - di-butyl phthalate (DBF) for 1-2 hours. 100 c.h. PVC has been shown to dissolve in 20-50 parts by mass of DBF.

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

Research has shown that at 200°C, the structuring process begins in PVC. At 180°C, the structuring process does not occur and constant consumption rates are observed in the capillary viscometer. The effective viscosity of 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 was studied.

It has been shown that because PVC is in the form of a separate dispersed phase in the SREPT PVC mixture, these mixtures are observed to be in a state of flow viscosity 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 even at 150°C.

IV. Conclusions

The study of the physical and mechanical properties of vulcanizates of SREPT:PVX: DBF mixtures showed that their resistance to oil and gasoline is higher than the resistance of vulcanizates based on STEPT. The swelling of vulcanizates of the studied mixtures is 2.7 times lower in gasoline, 2.3 times lower in a gasoline-benzene mixture (3:1), and 3.2 times lower in "Avtol-10" oil.

One of the properties limiting the use of rubbers based on ethylene-propylene rubbers is related to their improved resistance to oil and gasoline.

Thus, it is shown that the improvement of the joint placement in the SREPT: PVC system also leads to the improvement of the basic properties of the mixture. The results obtained from the studies are shown in the flow curves with the dependence of the speed of friction on the tension of friction. For comparison, the same characteristic indicators were obtained for PVC and SREPT at 100-150 C.

Experience shows that when polyvinyl chloride plastisol is used, the viscosity of the SREPT PVC mixture is reduced by one time compared to the viscosity of SREPT, and 2 times compared to the viscosity of PVC.

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