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Study of Compositions Based on Ethylene-Propylene Rubbers

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Abstract
The physicochemical, mechanical, and rheological properties of the rubber mixture and vulcanizate obtained based on ethylene and polyethylene copolymers in the presence of a modifier have been studied. Studies have shown that when obtaining,g wear-resistant rubbers based on copolymers of ethylene and propylene, is based on modifying them.
Most importantly, we have selected natural materials and industrial wastes based on local sources of raw materials that can be used as fillers for the preparation of various compositions based on ethylene and propylene copolymers and studied their composition and properties. The ingredients of this composition are: oligomer acrylate modifier (OAM-9), sulfur vulcanizing agent, plasticizer stearic acid, thiuram (TMTD) – tetramethyl thiuram disulfide de and captaxx accelerator, zinc oxide is used as an activator of the vulcanization process in the production of resin. mixtures and carbon blare are used as a filler.
Various rubbertetramethyl thiuramken. For compact tax, a rubber composition without a modifier (OAM-9) was also prepared. A suitable formulation of the rubber mixture was compiled and a homogeneous mixture was prepared according to the recipe in a laboratory roller (temperature 40-60 ° C, time 20-30 minutes). The optimal mode of vulcanization was determined (temperature 150°C, time 20 minutes).

Keywords: copolymer of ethylene and propylene, physical and chemical properties, mechanical and rheological properties rubber compound, vulcanizate, modifier, filler.

Introduction

The object of study: Compositions based on copolymers of ethylene and propylene, and oligomers containing -functional groups were chosen.
Objective. Investigation of ways to obtain wear-resistant rubbers with high physical and mechanical properties based on ethylene and propylene copolymers, study ddayof their changes in structural parameters during operation and selection of modifiers, modification methods and technological modes on their basis, determination of indicators and areas of use of composite materials obtained on their basis. basis. The relevance of the work [1-3]
Mechano-chemical modification of elastomers simply and effectively allows for improving their physical and mechanical performance properties and thereby expanding the scope of applications. This method does not require special complex equipment, and technical products with the required properties are obtained by traditional processing of elastomers [4-7].
A more aggressive factor for rubbers based on general-purpose rubbers is ozone. Cracks appear on rubber coatings due to exposure to ozone. Therefore, the protection of rubber from weathering is an urgent problem, and the application of protective polymer coatings on the rubber is one of the ways to solve this problem. In particular, more attention is paid to the development and research of protective coating compositions based on elastomers. From this point of view, the produced ethylene [8-11]
This rubber has several camp complex valuable parties, such as resistance to atmospheric, thermal, and chemical influences.[12-14] However, the disadvantages of ethylene-propylene rubber, such as low water resistance and low adhesion, limit the production of rubber protective coatings, and the search for ways to overcome this shortcoming awaits its solution as a major problem. In this regard, in recent years, research has been carried out in the

direction of modifying ethylene-propylene rubber with monomers and polymers containing various functional groups[15-18] The studies were carried out by chemical, physicochemical, and physicomechanical met, hods, and the most modern methods for studying compositions based on polymer[19-21]
As a result, the analysis of the scientific literature. It showed that these cost-effective and environmentally effective ways to improve the resistance of EPRT -60 rubber to ozone are its modification with an oligomer of the functional group. At work. have enough works and patents on the study of compositions based on ethylene-propyl rubber and ethylene-propyl rubber terpolymer. (EPRT)
The physicochemical, mechanical, and rheological properties of the rubber mixture and vulcanizate obtained on the based onne and polyethylene copolymers in the presence of a modifier have been studied. Studies have shown that when obtaining wear-resistant rubbers based on ethylene and propylene copolymers, it is necessary to modify them.
Most importantly, we have selected natural materials and industrial wastes based on local

1. Dıscussıon of The Obtaıned Results

The low efficiency of some compositions based on an ethylene-propylene copolymer limits their use in the production of tires and rubber products. By adding polar substances or polymers to blends of ethylene-propylene copolymers with other polymers, the co-blending and co-vulcanization of these copolymers can be improved and applications can be expanded.
When the plasticizer α, methacrylate-(bis-tri ethylene glycol phthalate) -(OAM-9) is added to the copolymer, a number of its indicators improve. Increases tear resistance, resistance to repeated stretching, increases the adhesion of the composition to the metal, chemical resistance, reduces the degree of swelling in benzene and gasoline-benzene mixture. For this, a rubber composition based on a mixture of an ethylene-propylene copolymer with oligoefaracrylate was prepared and studied.

1.1. Rubber Compoundformula

Physical, mechanical, and performance indicators (technical properties) of rubber mainly depend on the composition of the rubber mixture.
When studying the process of modifying resins based on ethylene-propylene copolymers filled with oligoephiacrylate, the composition of the resin mixture was determined first of all. For the production of rubber products, a rubber compound formulation is compiled. When developing a rubber compound formulation
The names of all ingredients and their mass ratio are also shown.
When formulating a rubber compound, the role of each ingredient in the rubber compound, as well as its mechanism of action and economic efficiency, should be taken into account. That is, the resulting mixture should be cost-effective.
In the recipe, you need to look for the spelling of the ingredient in a certain sequence. First, rubber is written, then accelerators, activators, softeners, fillers, and other components.
The composition of the investigated rubber mixture includes the following components:
Ethylene propylene rubber terpolymer EPRT -60
OAM-9- Sulfur
Stearic acid
Thiuram
Captax
ZnO
Technical carbon (P-234)

Table 1: Composition of compositions based on modified and unmodified ethylene-propylene copolymer.

Name of components	Content per 100 mass parts of rubber mass. pa.					
	I	II	III	IV	V	VI
EPRT -60	100	100	100	100	100	100
Stearic acid	1,0	1,0	1,0	1,0	1,0	1,0
thiuram	1,5	1,5	1,5	1,5	1,5	1,5
Kaptax	0,5	0,5	0,5	0,5	0,5	0,5
ZnO	5,0	5,0	5,0	5,0	5,0	5,0
Technical carbon (P-234)	50,0	50,0	50,0	50,0	50,0	50,0
Sulfur	2,0	2,0	2,0	2,0	2,0	2,0
OAM-9	–	0,5	1,0	1.5	2.0	2,5

1.2. Preparation of rubber compounds

The preparation of rubber compounds is one of the main technological processes in the production of rubber products. Powdered, solid, and liquid ingredients must be mixed with the rubber, ensuring that these ingredients are evenly distributed throughout the rubber. Therefore, the resulting rubber mixture must be homogeneous in composition.
The quality of the tested composition mainly depends on the properties of the rubber and the wetted ingredients of the rubber.
Preparation of a mixture based on rubber and ingredients, accurate dosing of components, consistent addition of ingredients to rubber, and mixing temperature affect the properties of the resulting mixture.
Under laboratory conditions, the preparation of the rubber mixture was carried out on a laboratory scale.
The mixing mode is determined by the type of mixing device, its volume, the speed of rotation of the rotor or shafts, and the composition of the rubber mixture.
The roller must be started by setting the distance between the shafts at least 0.2-0.3 mm using the adjusting screw.
The mixing process was carried out in a rolling mill at a temperature of 40-60°C for 25 minutes.
When mixed, the ingredients are added to the rubber in the following order: softeners, vulcanization accelerators, accelerator activators, filler, special purpose ingredient (OAM-9), and vulcanizing agent.
As soon as you start the mixing process, the mode clock starts. The rubber is gradually loaded into the gap between the shafts from the side of the large disk wheel, in the form of separate parts, and this operation is repeated 5-6 times.

Then the distance is increased by 1-2 mm and the rubber on the front axle is plasticized, at the same time, other ingredients are added.

The ingredients are slowly distributed throughout the rubber mass along the length of the front shaft and mixed at the right time.

In the process of preparing the mixture, the shaft temperature is checked 2-3 times with a beam thermocouple.

After the mixture is removed in the form of a sheet between the shafts of the roller, it is cooled in chalk or kaolin slurry in a bath.

Vulcanization of rubber compounds

Rubber compounds should be vulcanized to obtain hard and highly elastic vulcanizates with high strength and friction resistance.

It is known that during vulcanization at a certain temperature, complex physicochemical processes occur due to the presence of vulcanizing agents in the mixture, that is, a process of mechanochemical modification occurs. As a result, products with desired properties are obtained.

The vulcanization process was carried out in the prepared rubber mixtures at a temperature of 155°C and for various periods (10-40 minutes).

The physical-mechanical and operational characteristics of vulcanizates have been studied (80). The kinetics of the vulcanization process of an ethylene-propylene copolymer and an ethylene-propylene + OAM-9 mixture have been studied.

vulcanizates obtained at different temperatures were tested in the laboratory for tensile strength in a PM-60 crusher, conditional stress at 100% and 300% elongation, tear resistance, hardness according to TM-2, and other indicators were studied. The optimal mode of the vulcanization process was determined at a temperature of 153±2 °C and a time of 25 minutes.

The time dependence of the consumption of compositions based on EPRT-60 and OAM-9 - in a capillary rheometer at a temperature of 153 ± 2 °C was studied. Every 30 seconds take and weigh the flow rate of the composition flowing through the capillary. Based on the results obtained, a graph of the dependence of the amount of consumption on time was constructed.

charts

The goal was to determine the soil fractions of the vulcanizate samples shown in Table 1. To do this, the amount of plasticizer (OAM-9) used in the chemical process was determined. Therefore, the vulcanizates were extracted with OAM-9 solvent (benzene) for 26 hours and then dried to constant weight.

The result obtained shows that 1 mass. pa. In the presence of OAM-9, the sol fraction is zero, and with a subsequent increase in the amount of OAM-9, the sol fraction increases. This once again allows us to say that the amount of OAM-9in the mixture is 1 mass. pa. chemical contact is possible both with the polymer and in the mixture. During subsequent growth, the part that does not enter into chemical contact and does not participate in polymerization is washed out. Therefore, the amount of OAM-9 in further studies is 1 thousand hours. considered appropriate to accept it. The analysis of the obtained results shows that the process of vulcanization of the composition EPRT-60 + OAM-9 (1.0 mass.p.) at these temperatures ends after 14 minutes, and the vulcanization time of the composition is based on after 18 minutes. . These results once again prove that - OAM-99 with ester group and double bonds is used as a modifier in the composite system and can be polymerized at a given temperature. And thus, it can be argued that during the vulcanization process it forms an additional vulcanization mesh. The obtained data shown in figures 1 and 2 confirm that OAM9 is involved in the vulcanization process.

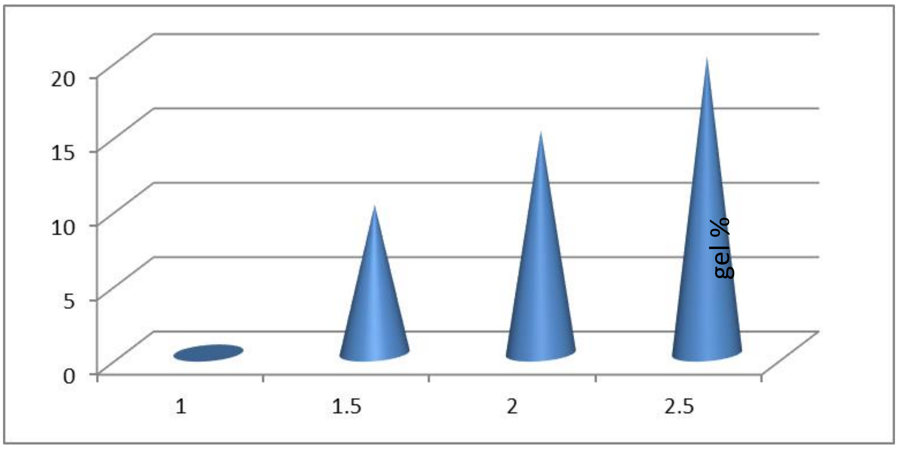
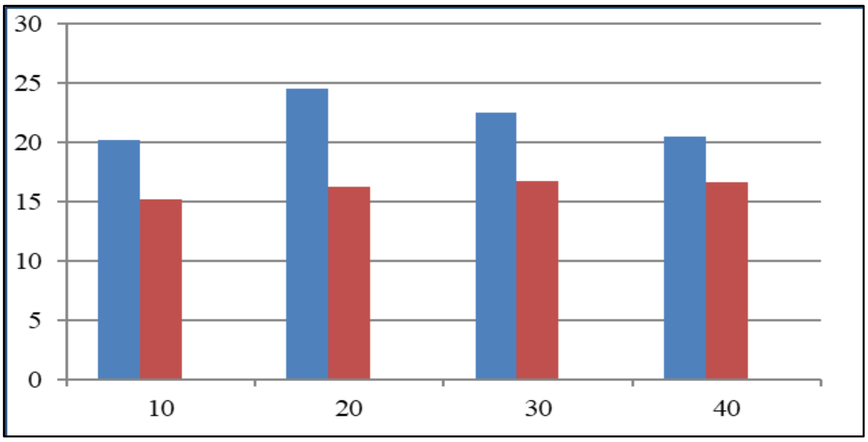


Fig. 1: Content of OAM-9in composition: 1; 1.5; 2.0; 2.5 (mass.p.) temperature can

These figures confirm the results of the vulcanization kinetics according to the dependence of the tensile strength on time (Figure. 2).

As can be seen from the figure, the time of their vulcanization is (20.0-22.2) minutes. After this period, the equilibrium state persists for up to 45 minutes, and finally, after 45 minutes, reversion begins. When comparing the tensile strength of the compositions EPRT-60 and EPRT-60 + OAM-9, it can be seen that the tensile strength of the sample modified with OAM-9 reaches (20.7-24.6) MPa. Therefore, it is assumed that the functional group OAM-9can also be polymerized at 153 °C.

Introduction to the mixture of low molecular weight additives - oligoephraacrylate- OAM-9leads toto a decrease in the viscosity of the mixture. Improved physical and mechanical properties of compositions based on a mixture of EPT: OEA)



Fiq. . 2: basic composition based on EPRT-60 --
II - composition of EPRT-60 + OAM-9.

These mixtures are used in the production of tires and rubber products. Compositions based on these mixtures have higher adhesion to metal than compositions based on EPRT-60 alone, and a lower degree of swelling in –the gasoline mixture.

Table 2: Based on an ethylene/propylene copolymer, unfilled and filled with oligoefaracrylate. physical and mechanical properties of rubber compounds.

№	Indicators	Rubber compound					
		I	II	III	IV	V	VI
1.	Tensile Strength, MPa	20,7	21,1	24,6	21,5	18,5	17,3
2.	10 Nominal stress at 100% elongation, MPa	3,6	3,8	4,1	3.7	3,4	2,8
3.	Nominal stress at 300% elongation MPa	13,6	13,9	14,2	13,5	12,9	12,1
4.	Relative extension, %	380	395	410	430	450	480
5.	Relative permanent deformation, %	14	14	14,1	14,6	14,8	15,0
6.	tear resistance, kN/m Vulcanization time, min	32,9	33	35,8	33,6	33,1	32,7
7.	rebound elasticity	40	40	40	39	37,5	36,
8.	Hardness according to TM-2, conditional unit.	70	70	69	68,5	68	67,5
9.	Bond strength to metal	1,40	1,50	1,65	1,54	1,52	1,40
10.	Fatigue endurance at repeated stress (edin.=200%, v=250 cycles/min.)	1,25	1,50	1,92	1.98	2,0	2,1
11.	Heat aging coefficient at 100 for 140 hours: f_p ε_p	0,76 0,41	0,76 0,42	0,75 0,43	0,73 0,44	0,69 0,48	0,67 0,50
12.	The swelling rate at 26C for 48 hours (in gasoline)	130,5	11,50	90,8	110,7	115,2	120,5

A small amount of plasticizer OAM-9. Make sales it possible to obtain cable rubbers with improved properties based on mixtures of EPRT-60 and styrene-butadiene-styrene rubber. In industry, for a long time, the service life of cable rubbers and gaskets with other rubberdoesdo does not have durability, and, as a result, the f operationdoesdo not withstand the conditions and fails. To eliminate such problems, the formulation of the following composition was prepared (Table 3).

Table .3: Based on modified ethylene-propylene and SBS composition of compositions.

Name of components	Content of mass parts		
	I	II	III
EPRT-60	100	90	85
SBS	-	10	15
Stearic acid	1,0	1,0	Ambroxol
Ambroxol SP-137	6,7	6,7	6,7
petrolatum	7	7	7
ZnO	5,0	5,0	5,0
Технический углерод (П-234)	35,0	35,0	35,0
Технический углерод (Р-514))	20,0	20,0	20,0
сера	2,0	2,0	2,0
OAM-9	–	0,5	1,0

The prepared rubber mixture is vulcanized by keeping it at room temperature for 6-8 hours. The physical and mechanical properties of the vulcanizate are shown in Table 4.

Table 4: physical and mechanical properties of rubbers based on EPRT-60, modified with MQF-9 and SBS.

№	Indicators	Rubber compound		
1	2	3	4	5
1.	Tensile Strength, MPa	10,5	11,3	12,6
2.	10 Nominal stress at 100% elongation, MPa	4,1	4,5	4,8
3.	Nominal stress t 300% elongation, MPa	7,	8,5	8,6
4.	Relative extension , %	672	640	645
5.	Relative permanent deformation, %	26,4	25,1	25,5
6.	tear resistance, kN/m	45,3	54,6	55,5
7.	rebound elasticity, %	6,5	7,1	7,1
8.	Hardness according to TM-2, conditional unit.	54	52,5	53,5
9.	Bond strength to metal, MPa	1,45	1,50	1,60
10.	Fatigue endurance at repeated stress (εedin.=200%, v=250	1,56	2,65	2,75
11.	Heat aging coefficient at 100 for 140 hours: f_p ε_p	0,59 0,46	0,62 0,59	0,63 0,58
12.	The swelling rate at 26C for 48 hours (in gasoline)	120,5	120,0	120,8

As can be seen from the table, the addition of OEA-modified EPRT-60 to the SBS-based composition improves its performance, as well as the coefficient of thermal aging.

According to the results of numerous studies, it can be determined that the plasticizer a,w-methacrylate-(bis-trimethylene glycol phthalate)-(OAM-9) reduces the curing time and improves the physical properties of EPRT-60 and its other elastomeric mixtures to improve mechanical and performance properties.

Results

Insufficient properties of compositions based on ethylene and propylene copolymers limit their use in the production of cable rubbers and rubber products. In order Ttothecompatibility and mixing of EPDM-60 with other components, the ethylene-propylene copolymer was modified with oligoephraacrylate (OAM-9).

Physical, mechanical, and operational properties of vulcanizates (ultimate tensile strength, conditional stress at 100% elongation, conditional stress at 300% elongation, relative elongation, relative residual deformation, tear resistance, elasticity, hardness TM-2, contact strength with metal, (fatigue resistance under repeated tension, coefficient of thermal aging, degree of swelling after 48 hours, resistance to aggressive media).

The introduction of a certain amoun9 into plasticizer OA9 into various mixed compositions leads to an improvement in the properties of vulcanizates, including an improvement in the mutual dispersion of components in the mixture. The inclusion of a plasticizer increases the resistance of the compositions to repeated stretching (Unit = 200%, V = 250 cycles/min) from 1.5 thousand to 1.92 thousand cycles and the adhesion strength with metal increases from 1.20 to 1.65 MPa. These indicators exceeded the corresponding indicators of cable and gasket rubbers used in the industry**.**

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