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PREPARATION AND STUDY OF RUBBER MIXTURE BASED ON BUTADIENE-NITRILE RUBBER SKN-40M AND MODIFIED SPENT POLYETHYLENE

***Abstract**: Mechanochemical modification of waste low-density polyethylene (LDPE) with a modified thiourea phenol-formaldehyde oligomer (TFFO) was carried out under the conditions of traditional polymer processing. Rubber compounds based on SKN-40M nitrile butadiene rubber and waste low-density polyethylene (LDPE) modified with a modified thiourea phenol-formaldehyde oligomer (TPPO) have been developed, and the complex of properties of their vulcanizates has been investigated. It was found that the obtained rubbers, along with the preservation of the physical, mechanical and operational properties at the standard level, have improved tensile strength, petrol resistance and strength of attachment to metal. In addition, the possibility of recycling polyethylene waste and solving the associated environmental problems is shown.*

***Key words**: rubber compound, nitrile-butadiene rubber, ethylene-propylene rubber, polyvinyl chloride, waste low-density polyethylene, thiourea-modified phenol-formaldehyde oligomer, mechanochemical modification, compatibility.*

***Language**: English*

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Introduction

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The development of modern industries is associated with the creation of polymer materials with desired properties. Large-scale polymers and composite materials based on them, currently produced in the industry, in some cases do not meet the increased requirements of consumers.

At present, in the field of creating polymeric materials that meet the increased requirements of consumers, various modification methods that allow changing the properties of polymers in a predetermined direction and improving their physical, mechanical and operational characteristics take a leading place, since open up prospects for the creation of valuable composite materials on their basis.

The need to create composite materials with improved physicomechanical and operational properties based on industrial large-scale polymers, including elastomers and their mixtures, as well as the emerging need to save polymer materials and rational use of natural organic raw materials - oil, led to the search for practically effective ways to modify polymers.

Recently, the ways of polymer modification under the conditions of traditional processing, i.e. in milder conditions to preserve their original and individual properties.

One of the most accessible and promising methods for producing composite materials based on industrial large-scale polymers is the mechanochemical modification of polymers during their processing using traditionally used processes and technological equipment and modifying additives containing reactive functional groups. The practicality, simplicity and low cost of this method for modifying polymers makes it possible to obtain on their basis composite materials with improved physical, mechanical and operational characteristics, to expand the scope of application of individual industrial polymers.

The widespread composite materials primarily include rubbers for various purposes.

The modern rubber industry produces a wide range of products, which, depending on the purpose of the products and the conditions of their operation, have different requirements. This necessitates the development and study of a variety of rubber formulations, differing in technological and operational properties.

Known rubber mixture for the production of seals for oilfield equipment of the oil industry and other rubber-technical products based on butadiene-nitrile rubber SKN-40M, triple ethylene-propylene rubber (SKEPT-60) and polyvinyl chloride (PVC) SKN-40M + SKEPT-60 + PVC = 70 + 20 + 10 [7, p. 110; 8, p. 421].

The disadvantage of this known rubber compound is the use as a base component, along with butadiene-nitrile rubber SKN-40M [1, p.130; 9, p. 273], expensive, scarce triple ethylene-propylene rubber (EPDM-60) and polyvinyl chloride (PVC), as well as low tensile strength, petrol resistance and the strength of attachment to metal.

This is due to the fact that the initial hardness of polyvinyl chloride (PVC) does not allow achieving a high degree of its dispersion and interaction between the phases of the system, as a result, compatibility in the interfacial zone deteriorates and the indicators of physical and mechanical properties of compositions containing PVC are reduced [2, p. 14; 6, p. 78].

Therefore, research is currently underway to develop new formulations using available components and in order to improve the physical, mechanical and operational properties of a rubber compound based on nitrile butadiene rubber.

It is known that the development of the production of polymer materials and the expansion of their areas of application, use in various industries and in everyday life leads to an increase in the amount of polymer waste and the emergence of environmental problems.

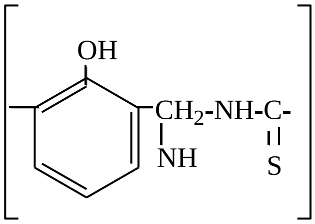
Taking into account the fact that polymer materials are not biodegradable, and their destruction leads to the loss of valuable polymer raw materials and environmental pollution, recycling is not only economically feasible, but also an environmentally preferable solution to the problem of using polymer waste.

In connection with the industrial production of a limited range of polymers, among which polyethylene takes the leading place, the disposal of polyethylene waste is an urgent problem.

Taking into account the above, we investigated the possibility of using in the formulation a rubber compound based on butadiene-nitrile rubber SKN-40M, ternary ethylene-propylene rubber (EPDM-60) and polyvinyl chloride (PVC) [3, p. 13; 10, p. 737], instead of ternary ethylene-propylene rubber (EPDM-60) and polyvinyl chloride (PVC), waste low-density polyethylene (LDPE) modified with a modified thiourea phenol-formaldehyde oligomer (TFFO) [3, c. 38; 3, p. 32);.

Mechanochemical modification of waste low-density polyethylene (LDPE) with a modified thiourea phenol-formaldehyde oligomer (TPPO) under conditions of traditional polymer processing has been carried out, and rubber compounds based on SKN-40M nitrile butadiene rubber and modified waste LDPE have been developed.

To modify the waste low density polyethylene (LDPE), a thiourea-modified phenol-formaldehyde oligomer (TPFO) containing amine and hydroxyl groups was used (molecular weight-764, density-1290 kg / m3, viscosity according to VZ-1-54 sec.) [3, p 33-34] in the amount of 5-10 mass.p. per 100 mass.p waste low density polyethylene:



The excellent technological properties of this class of compounds and the presence of functional groups, good rheological characteristics determine their successful application for the modification of polymers.

Modification of waste low density polyethylene (LDPE) is carried out due to the waste LDPE formed in macromolecules during its processing into products and their operation in natural conditions -OH, -COOH and ether functional groups [4, p110-112].

The modified powdered waste low density polyethylene (LDPE) was obtained by mixing in an extruder for 2-3 minutes. at a temperature of 120-1300C of waste low density polyethylene (LDPE) with a modified thiourea phenol formaldehyde oligomer (TFFO) and subsequent grinding of the modified waste LDPE.

Rubber mixtures were prepared on laboratory rollers at 25-300C. The total mixing time of the components was 20-25 minutes. The vulcanization of rubber compounds was carried out at a temperature of 1500C for 15 minutes [5, p170-172].

The complex of properties of vulcanizates of rubber mixtures obtained on the basis of butadiene-nitrile rubber SKN-40M and waste low-density polyethylene (LDPE) modified with a modified thiourea phenol-formaldehyde oligomer (TFFO) was investigated .

The elastic-strength properties of vulcanizates were determined according to GOST 270-75, resistance to thermal aging according to GOST 9.024-74, gas resistance according to GOST 9030-74, strength of attachment to metal according to GOST 209-75.

The compositions of the rubber mixtures are presented in Table 1, and the physicomechanical parameters of the vulcanizates are presented in Table 2.

A comparison of the physical-mechanical and operational properties of vulcanizates of the developed rubber mixture and the known one is carried out.

As can be seen from the data given in Table 2, when used in the formulation of a rubber compound based on butadiene-nitrile rubber SKN-40M, ternary ethylene-propylene rubber (EPDM-60) and polyvinyl chloride (PVC), instead of ternary ethylene-propylene rubber (EPDM-60) and polyvinyl chloride (PVC), waste low-density polyethylene (LDPE) modified with a modified thiourea phenol-formaldehyde oligomer (TPFO), along with the preservation of the physical-mechanical and operational properties of the vulcanizates of the obtained rubbers at the standard level, the strength indicators are improved when tensile, petrol resistance and strength of attachment to metal.

From a theoretical point of view, the observed improvement in a number of physicomechanical indicators of rubbers obtained on the basis of the developed formulation can be explained by the improved compatibility in the SKN-40M + modified TFFO, waste LDPE system, compared with the compatibility in the SKN-40M + SKEPT-60 + PVC system.

In addition, it has shown the possibility of recycling polyethylene waste, expanding the range of raw materials for the production of rubber compounds based on nitrile butadiene rubber, and solving environmental problems associated with polyethylene waste.

Table 1. Composition of rubber compounds

Components	Content of components, mass part		
	Known	Developed	
	1	2^{x}	3^{xx}
SKN-40M	70	90	90
SKEPT-60	20	-	-
PVC	10	-	-
Waste low-density polyethylene (LDPE) modified with a modified thiourea phenol-formaldehyde oligomer (TFFO)	-	10	10
DUEK-4 (bis-dihydrocyclopentadienyl capromate)	6	6	6
Sulfur	2	2	2
Captax	1	1	1
Altax	1	1	1
ZnO	4	4	4
Neozon "D"	2	2	2
Technical stearin	1	1	1
rosin	2	2	2
Carbon black P-803 P-234	 20 50	 20 50	 20 50

Note: 1 - the components are taken in parts by weight. per 100 m.p. mixtures SKN-40M + SKERT-60 + PVC

2.3- components are taken in parts by weight per 100 wt. including mixture SKN-40M + waste LDPE modified with TFFO.

2x -TFFO is taken in an amount of 5 parts by weight. per 100 m.p. waste low density polyethylene (LDPE):

3xx - TFFO is taken in an amount of 10 parts by weight. per 100 m.p. waste low density polyethylene (LDPE).

Table 2. Physicomechanical properties of vulcanizates of rubber compounds

№	The name of indicators	Indicators		
		Known	Developed	
		1	2	3
1	Conditional tensile strength, MPa	16,6	17,8	18,0
2	Relative extension, %	335	350	360
3	Relative residual deformation, %	12	12,4	12,8
4	Abrasion, cm 3 / kW.h	68	67,2	67,9
5	Tear resistance, k / Nm	56	57	56,5
6	Strength of attachment to metal, MPa: steel-3 brass	 5,5 3,6	 6,1 3,8	 6,8 4,2
7	Brittleness temperature, K	245	247	248
8	Hardness according to TM-2, conv. units	78	79	80
9	Swelling rate at 296K for 24 hours: in isooctane-toluene mixture (70:30) in a gasoline-benzene mixture (3: 1)	 14,5 23,5	 11,2 14,4	 11,0 14,0
10	Heat aging coefficients at 379K for 48 hours: by strength elongation	 1,03 0,88	 0,93 0,84	 0,94 0,85
11	Rebound elasticity, %	14	13,6	13.8
12	Ozone resistance at a temperature of 298K for 27 hours (deformation 20%, ozone concentration 0.015%)	Does not collapse	Does not collapse	Does not collapse

References:

1. Ibragimov, A.D., et al. (1995). Issledovanie svojstv maslobenzostojkih rezin na osnove smesej SKN-40 M, SKJePT-60, nairit, PVH dlja oborudovanija neftjanogo mashinostroenija. *Uchenye zapiski AGNA*, №2, pp.127-135.
2. Movlaev, I.G., et al. (1982). Svojstva vulkanizatov na osnove kompozicii SKJePT-60--PVH. *Kauchuk i rezina*, №4, pp.14-15.
3. (2000). *Metodicheskie ukazanija k kursu «Vysokomolekuljarnye soedinenija»*. Uchebnoe posobie / sost.: Sobanov A. A., Kuramshin A. I., Burnaeva L. M. i dr. (p.42). Kazan`: Izd-vo KazGU.
4. Cragg, P.J. (2010). Supramolecular Chem. Biol. *Inspiration to Biomedical Appl*., V.4, pp.109-156.
5. Vorob`ev, A. (2003). Jepoksidnye smoly. *Komponenty i tehnologii*, №8, pp. 170-173.
6. Horszczaruk, E., et al. (2014). Nanocomposite of Cement/Graphene Oxide - Impact on Hydration Kinetics and Young's modulus. *Construction and Building Materials.*, 78p. DOI: 10.10 16/j.conbuildmat.20 14.12.0 09.
7. Korshak, V. V. (1976). *"Tehnologija plasticheskih mass"*, Izd. 2-e, pererab. i dop. (pp.109-121). Moscow: "Himija".
8. Rjauzov, A. N., Gruzdev, V. A., & Baksheev, I. P. (1980). *"Tehnologija proizvodstva himicheskih volokon":* Uchebnik dlja tehnikumov, 3-e izd., pererab. i dop., (pp.415-422). Moscow: Himija.
9. Vorob`ev, V. A., & Andrianov, R. A. (1990). *Tehnologija polimerov*. (p.303). Moscow: Vyssh. shkola.
10. Nikolaev, A. F. (1992). *Sinteticheskie polimery i plasticheskie massy na ih osnove*. (p.768). Moscow: «Himija».