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DEVELOPMENT OF A COMPOUNDING OF ELASTOMERIC COMPOSITION FOR PRODUCTION HOSES

The compounding of elastomeric compositions increased hardness for the production of hoses coiling constructions is worked out.

The studies found, that the introduction of technical carbon P 803 in the amount of 105 parts by weight at 100 parts by weight of rubber leads to a slight increase in the viscosity of the rubber composition, hardness and tensile strength, a slight decrease in elongation at break. Introduction of technical carbon P 803 in the amount of 110 parts by weight at 100 parts by weight of rubber results in an increase in the viscosity of the rubber composition, hardness and tensile strength of conventional on 4%, reduction in elongation at break on 4%. Introduction of technical carbon P 803 in the amount of 115 parts by weight at 100 parts by weight of rubber results in the increase in the viscosity of rubber mixture on 6%, the hardness on 13%, decline of tensile strength and elongation at break on 6%. Reducing the value of the conditional indicator tensile strength and a significant increase in hardness indicates an excess of carbon content in the rubber composition, the content of carbon technical P 803 therefore optimal 110 parts by weight at 100 parts by weight of rubber. Decline of maintenance of dibutyl phthalate to 8 parts by weight rendered unsatisfactory technological behavior of mixture at roll-forming, that hampered dispergating of ingredients at mixing.

Thus we have found that the optimum content of the plasticizer in the rubber mixture of dibutyl phthalate – 10 parts by weight softener and bitumen – 5 parts by weight at 100 parts by weight of rubber.

Key words: hoses coiling constructions, rubber, elastomeric composition, the Mooney viscosity, cure speed, the optimal time, physical and mechanical properties.

Introduction. The rubber industry producing hoses faces a number of the tasks to be solved. The most important of them are the development and production of new types of high-quality items, efficient in a wide temperature interval, pressure, and aggressive media. In spite of the fact that the production yield and the range of hose products increases from year to year, the requirements for these products increase because of cars, tractors production increase, and due to development of the coal and mining industry [1]. It is possible to eliminate deficit of hoses not only by yield increase, but also by improvement of their design, quality, and their working capacity, respectively.

Production of hoses occupies one of the leading places in rubber industry. Hoses serve for transfer of gases, liquids and bulk solids in various conditions: from vacuum up to the pressure of 70 MPa in the temperature range of 60–250°C. Hoses meet great requirements [2, 3]. In case of long operation they must keep hermeticity, durability and flexibility; they must resist to impact of the environment and the transported materials, resist to external mechanical loadings, and keep a permanency of the geometrical sizes. The design of hose products allows their quick and reliable fitting on the corresponding unions, nozzles, pipes and other types of mechanisms. Hoses unite quickly into the single line.

A long-length method of hose production is the most promising one. The main advantage of this method is a considerable length of a hose that allows increasing labor productivity, but production of hoses of big diameters by this method is difficult.

Thus, development of a rubber compound mixture to produce inside layer of the hoses made by a long-length method is urgent.

Main part. An objective of this research is the development of elastomeric composition of a compound of increased hardness to produce hoses of a coiling design by a long-length method.

Compounds of pilot rubber mixtures on the basis of nitrile butadiene rubber BNKS-18AMN and BNKS-28AMN (samples 1–3) combinations which are used for hoses production by a long-legnth method are presented in Table 1. These rubbers provide the technical properties, such as frost resistance and resistance to air and inert gases exposure indispensable to a hose inside layer. BNKS-18 AMN rubber is a special rubber that provides the increased frost resistance of vulcanizates; BNKS-28AM provides a good resistance to agressive environment.

The vulcanizing system is applied to cure rubber mixture; sulfur is the vulcanizing agent, curing activators are zinc whitewash and stearin acid.

Filler of rubber mixture is technical carbon P 803, it is a low-active and low-structural agent which gives to rubber mixtures the best technological properties, such as: millability, extrudability, low shrinkage and elastic recovery, and good structure [2].

Table 1

The compounds of rubber mixture to produce an inside layer of hoses

Names of rubbers and ingredients	Mass parts per 100 wt % of rubber			
	Samples			
	Initial sample	Sample 1	Sample 2	Sample 3
BNKS-18AMN	50.0	50.0	50.0	50.0
BNKS-28AMN	50.0	50.0	50.0	50.0
Ground Sulfur	1.2	1.2	1.2	1.2
Sulfenamid C	2.0	2.0	2.0	2.0
Whitewash zinc	5.0	5.0	5.0	5.0
Aceton anil N	2.0	2.0	2.0	2.0
Diafen FP	1.0	1.0	1.0	1.0
Technical Carbon P 803	100.0	105.0	110.0	115.0
Softener dibutylphthalate (DBF)	12.0	12.0	12.0	12.0
Acid stearin	2.0	2.0	2.0	2.0
Rosin pine	2.0	2.0	2.0	2.0
Duslin P	0.5	0.5	0.5	0.5

Table 2

Influence of content of technical carbon P 803 on physical and mechanical indicators of rubbers

Names of indicators		Samples			
		Initial sample	Sample 1	Sample 2	Sample 3
Conditional durability at stretching, MPa		8.3	8.4	8.7	7.8
Relative elongation at break, %		250	245	240	235
Hardness, units, Sh A		68	70	72	77
Change of weight after media influence, %	Izoktan + Toluene (23°C × 24 h)	25	24	26	26
	SZhR-3 (125°C × 24 h)	30	31	29	30
Viscosity according to Mooney, unit of Mooney		64	67	70	78
Skorching, min	τ 5	37	36	36.5	30
	τ 35	42	40.5	40.5	27
	Δτ	5	4.5	4	3

Aceton anil N and diafen FP that are called antiagers, are used to protect from exposure to light, sunshine, atmospheric gases, and especially ozone, a component of special substances in the composition of rubber mixtures. Protective action of chemical antiagers is caused by break of a chain in case of rubber oxidation as a result of interactions of active radicals of an antiager with radicals of hydrocarbon of rubber. At the same time inactive products of reaction are formed that slows down process of oxidation [3].

Duslin P is introduced to prevent pre-vulcanization as a decelerator of pre-vulcanization [1].

The hoses made by a long-length method require use of more tough, solid rubber mixture providing structure and preventing deformation of chambers.

The following methods increase the hardness of rubber mixtures:

– increase of fillers contents;

– reduction of softeners contents.

Taking into account the above mentioned we conducted the researches aimed at increasing the hardness of rubber mixture. Influence of the fillers and softeners contents on the properties of compositions was studied.

Table 2 presents the results of our researches of influence of the fillers on the physical and mechanical indicators of vulkanizates.

It is seen from Table 2 that increase of technical carbon P 803 in rubber mixture content indicates the increase of viscosity, hardness, and relative elongation at break decreases. Conditional durability at stretching increases slightly and the technical carbon content at 115 pts. wt decreases. Possibly, it is due to the fact that this brand of technical carbon does not have a high specific surface ($16 \cdot 10^{-3}$ m^2/g), there are no active centers capable to interact with the active surface of rubber.

Reduction of conditional durability indicator at elongation and significant increase in hardness testifies the excessive content of technical carbon in rubber mixture, therefore the optimum content of technical carbon P 803 is 110 pts. wt per 100 pts. wt of rubber (Table 1).

In Fig. 1–3 dependences of indicators of hardness, relative elongation at break, and conditional durability at stretching on the content of technical carbon in rubber mixture are presented.

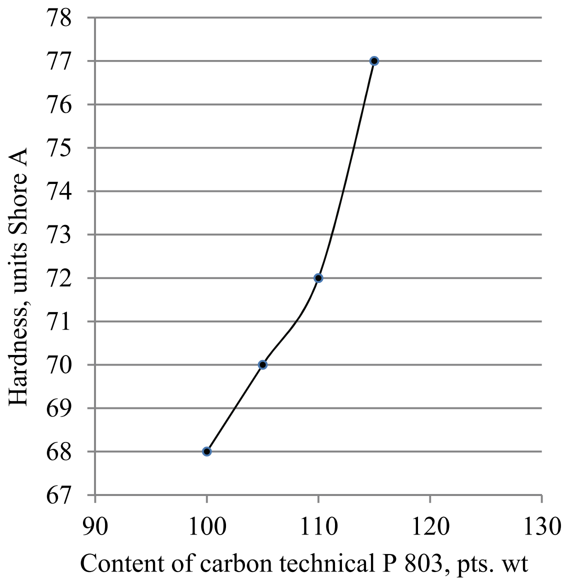

Fig. 1. Dependence of an indicator of hardness on the content of technical carbon in rubber mixture

It is seen from Fig. 1 and 2, considering an experiment error, increase of the technical carbon content P 803 results in the increase of rubber hardness by 9%, and relative elongation at break decreases by 4%. When solid fillers are introduced into elastomer, there is an essential reduction of molecular mobility of macromolecules, it leads to increase of degree unrandomization of macromolecules and density of packaging.

At increase in the technical carbon content P 803 in rubber mixtures durability at stretching passes through the maximum defining a filling optimum.

Thus, it is established that the optimum content of technical carbon P 803 is 110 pts. wt per 100 pts. wt of rubber.

To increase the hardness, structure of rubber mixture and decrease its cost we have conducted researches on reducing the content of expensive synthetic softener in mixture, dibutylphthalate. We reduced the DBF contents in composition by 17–33% and in addition we introduced a softener – bitumen oil.

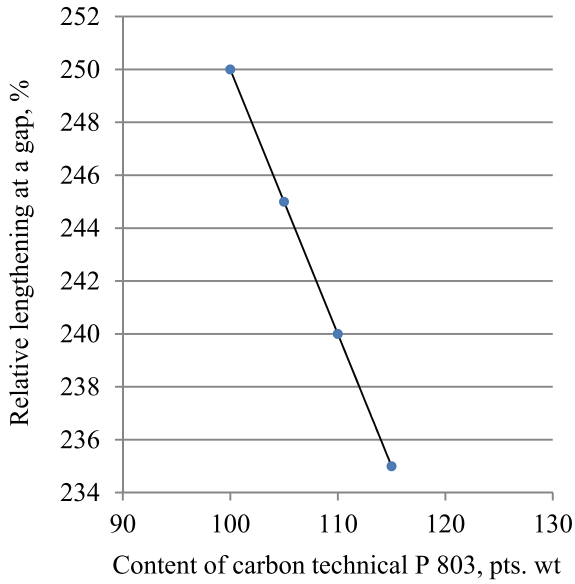

Fig. 2. Dependence of an indicator of relative elongation at break on the content of technical carbon in rubber mixture

Compounds of the testing rubber mixtures are presented in Table 3 (samples 4, 5).

Influence of the softeners contents on physical and mechanical indicators of rubbers is shown in Table 4.

When bitumen is introduced, viscosity of rubber mixtures changes slightly, but formation improves due to elastic reduction and structure increase of the mixture [4]. Possibly, there is an influence of simultaneous concentration of physical bonds and dispersals of chemical bonds at interphase border a filler – a softener.

Table 3

The compounds of rubber mixtures to produce an inside layer of hoses

The name of rubbers and ingredients	Mass parts per 100 pts. wt rubber		
	Samples		
	Initial sample	Sample 4	Sample 5
BNKS-18AMN	50.0	50.0	50.0
BNKS-28AMN	50.0	50.0	50.0
Sulfur ground	1.2	1.2	1.2
Sulfenamid of C	2.0	2.0	2.0
Whitewash zinc	5.0	5.0	5.0
Aceton anil of N	2.0	2.0	2.0
Diafen FP	1.0	1.0	1.0
Technical Carbon P 803	100.0	110.0	110.0
Softener DBF	12.0	10.0	8.0
Acid stearin	2.0	2.0	2.0
Rosin pine	2.0	2.0	2.0
Duslin P	0.5	0.5	0.5
Bitumen oil	—	5.0	5.0

Table 4

Influence of the softeners contents on physical and mechanical indicators of rubbers

Name of indicators		Samples		
		Initial sample	Sample 4	Sample 5
Conditional durability at stretching, MPa		8.3	8.2	8.2
Relative elongation at break, %		250	260	250
Hardness, units Shore A		68	72	73
Change of weight after media influence, %	Izoktan + Toluene (23°C × 24 h)	25	24	25
	SZhR-3 (125°C × 24 h)	31	28	30
Viscosity according to Mooney, unit of Mooney		64	70	71
Scorching, min	τ 5	35	34	37
	τ 35	39	37.5	42
	Δτ	4	4	5

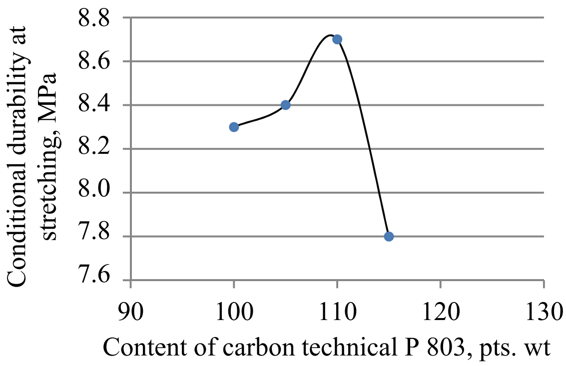

Fig. 3. Dependence of an indicator of conditional durability at stretching on the technical carbon content in rubber mixture

When rubber mixture with 8 pts. wt of DBF and 5 pts. wt of bitumen is produced, the unsatisfactory technological behavior, i.e. “shubleniye” on rollers is established that complicates dispergating of ingredients in the mixture.

As a result of the conducted researches, it is established that the optimum content of DBF softener in the rubber mixture is 10 pts. wt per 100 pts. wt of rubber and a softener of bitumen – 5 pts. wt.

Conclusion. It is shown in the work that the elastomeric composition made according to the compound sample 4 (Table 3) conforms to the requirements to the compositions to produce an inside layer of hoses by a long-length method.

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