THE USE OF CARBON-CONTAINING MATERIALS AS REINFORCING FILLERS OF ELASTOMERS IN THE PRODUCTION OF RUBBER PRODUCTS

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Based on existing technologies for the manufacture of rubber products (RP), actively used by manufacturing companies, the reinforcing filler is carbon black (CB), which is used both to slow down aging and to increase the electrically conductive properties of products. In the composition of the rubber mixture, the content of CB reaches 60% by weight. It is necessary to strengthen the rubber compound and has an impact on the further performance characteristics of all rubber products. The raw materials for the production of CB are hydrocarbon oils of petroleum and/or coal origin and gaseous hydrocarbons [1].

The production of CB by traditional methods: burning raw materials with a shortage of air and by thermal decomposition of raw materials in furnaces is an acute environmental problem due to emissions of combustion products into the atmosphere. Due to the ever-worsening environmental problems and the increase in emissions of harmful carbon-containing substances, from 2023 the European Union introduces a carbon tax on products produced with the help of «dirty» energy, which also includes the production of CB [2].

With complex, waste-free processing of raw materials, the issue of developing alternative types of fillers (substitutes for traditional CB brands) for RP is acute. Shungite rocks are unique in composition, properties and structure of natural formations, which are waste products of the mining and metallurgical complex. The chemical composition of shungite is unstable: on average it contains 10-50% by weight of carbon and 50-90% by weight of the mineral part [3]. Today, shungite deposits are known in Russia (Karelia) and in Kazakhstan (Bakyrchik, Koksu). Therefore, the study of the possibility of using waste from the mining and metallurgical complex - shungite rocks of the Bakyrchik deposit of East Kazakhstan as a reinforcing filler of RP instead of CB, as well as solving environmental problems related to the rational use of natural resources, the involvement of man-made resources in production is an actual subject of this study.

The production of rubber mixtures was carried out on rollers by mixing the ingredients included in the formulation of the rubber mixture (rubbers, vulcanization activators, accelerators, fillers, vulcanizing agent, etc.). The finished mixture is cut from the rotating front roll of the rollers manually in the form of separate sheets measuring 0.8 × 1.0 m, 8-12 mm thick.

After the preparation of the experimental samples, tensile tests were carried out under n.c. (table 1). The tests were carried out in comparison with standard rubber 7-NO-68-1 (TU 22.19.20-111-75233153-2018, gr. III-1b-23), manufactured at JSC «Tula Rubber Technical Articles Plant», according to GOST 270-75 [4].

Table 1 – Results of tests of elastic-strength properties of samples

Name	f_p, MPa	ε_p, %	σ_p, MPa
Formulation of the rubber compound №1	1,1	140	2,3
Formulation of the rubber compound №2	4,4	595	29,0
Formulation of the rubber compound №3	0,7	114	1,5
Formulation of the rubber compound №4	1,0	177	2,8
Formulation of the rubber compound №5	3,1	240	10,1
Formulation of the rubber compound №6	1,9	215	5,7
Standard rubber 7-NO-68-1	0,7	284	2,4

Hardness tests of the obtained formulations were carried out on a type D hardness tester model TH210 according to GOST R ISO 7619-1-2009 (table 2) [5].

Table 2 – Shore hardness index of various formulations of rubber compounds

Name	Hardness index, Shore units
Formulation of the rubber compound №1	12,5
Formulation of the rubber compound №2	10,5
Formulation of the rubber compound №3	15,1
Formulation of the rubber compound №4	14,5
Formulation of the rubber compound №5	18,2
Formulation of the rubber compound №6	16,3
Standard rubber 7-NO-68-1	14,7

The research was carried out on the basis of the Center for Physico-Chemical Methods of Research and Analysis of the Al-Farabi Kazakh National University and the scientific and production company «AIM Lab» LLP.

The obtained test results of experimental rubber samples were compared with standard rubber 7-NO-68-1. According to the test results, it can be concluded that the experimentally obtained vulcanized rubber compound has the following characteristics in comparison with the standard one: the conditional strength (f_p) is 5 times higher, the elongation (e_p) is 3 times higher, the true strength (σ_p) is 10 times higher.

The obtained research results show the prospects of using a reinforcing filler – shungite as an effective replacement for the traditional filler – CB. The use of shungite made it possible to reduce the cost of rubber compounds, as well as to improve their physico-chemical and elastic strength characteristics.

References

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