УДК 678.029.46

R. M. Dolinskaya, Ph.D (Chemistry), assistant professor (BSTU);
T. D. Sviderskaya. researcher (BSTU);
Ye. I. Shcherbina, D. Sc. (Engineering), professor (BSTU);
N. P. Prokopchuk, Corresponding Member of Belarus NAS, D. Sc (Chemistry), professor, head of department;
S. N. Marusova, leading engineer (JSC "Belarusrezinotechnika")
D. V. Rusetski, Ph.D, chief technologist (JSC "Belarusrezinotechnika")

WASTE RUBBER INDUSTRIES – PERSPECTIVE MATERIAL TO MAKE NEW PRODUCTS

The article deals with the research of possibility of utilization of rubber industry wastes – rubber crumb, in elastomeric compositions. Influence of size of crumb on properties of composition material is studied. It is in process shown that dispersion of rubber crumb has influence on properties of rubber products. It is established that for making of elastomeric composition material it is expedient to use the crumb of 0.5–1.0 mm fraction , as application of crumb of more shallow fraction increases the prime price of the received wares, and the use of large particles makes the results of physical mechanical parameters. worse.

Introduction. Rubber industry refers to a group of production involved in mechanical and mechano-chemical processing of raw materials. Waste rubber products are the stocks of raw materials and semi-finished products produced in the process of production not completely lost their quality, not meeting their standards.

Use of waste rubber industry can not only organize waste-free production and solve environmental problems of general mechanical rubber goods production, but also to reduce the cost of the products for a short period of time. Recycling of waste general mechanical rubber goods (GMRG) is one of the important problems in the science of materials, economic and environmental problems of modern industry GMRG. In this regard, it was interesting to explore the possibility of creating polymer composites based on waste rubber industry.

Main part. Rubber crumb rubber is one of the processing products of secondary raw rubber (rubber waste, including old tires). The main raw material for production of rubber crumb is worn out tires, as more than half of the rubber produced in the world is used in the manufacture of tires.

Shredded tires as crumb are widely used in various fields, especially as an adequate supplement to fresh rubber compounds. The fine rubber crumb retains the elastic and the strength properties of the starting material to the maximum extent. The compositions containing crumb rubber, represent a dispersion type "polymer resin".

Rubber crumb of different fractions from 0.2 to 4.0 mm is obtained, it is produced by processing of recycled car tires and it is used in asphalt laying (to give elasticity); as a flexible filler for sports polyurethane coatings; for filling in sports coverage with artificial grass; as a filler for rubber mixtures, in the manufacture of roofing materials; in the manufacture of bituminous mastics; as sorbent materials; for manufacturing plugging wells and hydro insulation of pipes in the petroleum industry [1].

Our investigations were aimed at developing of composition formulations using waste products designed for the manufacture of various rubber products (Table 1–3).

Table 1

Recipes of elastomeric compositions using rubber crumb fractions 0.2–1.0 mm

Names of parts	Samples, the mass fractions of 100 pts. wt of rubber				
	1	2	3	4	5
Rubber CKMC-30 APKM-15	100.0	100.0	100.0	100.0	100.0
Rubber crushed (fraction 0.2–1.0 mm)	90.0	100.0	110.0	120.0	130.0
Sulfur	7.0	7.3	8.0	8.3	9.5
Thiazole	5.0	4.7	4.0	3.7	3.5
Technical carbon-P803	45.0	45.0	45.0	45.0	45.0
Stearic acid	2.0	2.0	2.0	2.0	2.0
Bitumen BN 90/10	30.0	30.0	30.0	30.0	30.0
Oil softener Mon-6SH	35.0	35.0	35.0	35.0	35.0
Phthalic anhydride	1.5	1.5	1.5	1.5	1.5

Names of parts	Samples, the mass fractions of 100 pts. wt of rubber				
	1	2	3	4	5
Physical and mechanical properties of the compositions					
Tensile strength, MPa	1.8	2.1	2.7	2.3	2.2
Elongation at break,%	72	78	80	64	61
Shore A hardness, units Shore A	70	75	80	80	80

Table 2

Recipes of elastomeric compositions using rubber crumb fractions 1.0–2.0 mm

Names of parts	Samples, the mass fractions of 100 pts. wt of rubber				
	1	2	3	4	5
Rubber CKMC-30 APKM-15	100.0	100.0	100.0	100.0	100.0
Rubber crushed (fraction 1.0–2.0 mm)	90.0	100.0	110.0	120.0	130.0
Sulfur	7.0	7.3	8.0	8.3	9.5
Thiazole	5.0	4.7	4.0	3.7	3.5
Technical Carbon P-803	45.0	45.0	45.0	45.0	45.0
Stearic acid	2.0	2.0	2.0	2.0	2.0
Bitumen BN 90/10	30.0	30.0	30.0	30.0	30.0
Oil softener Mon-6SH	35.0	35.0	35.0	35.0	35.0
Phthalic anhydride	1.5	1.5	1.5	1.5	1.5
Physical and mechanical properties of the compositions					
Tensile strength, MPa	1.6	1.8	2.4	2.0	1.9
Elongation at break, %	80	75	69	58	50
Shore A hardness, units Shore A	70	75	80	80	80

Table 3

Recipes of elastomeric compositions using rubber crumb fractions 2.5–4.0 mm

Names of parts	Samples, the mass fractions of 100 pts. wt of rubber				
	1	2	3	4	5
Rubber CKMC-30 APKM-15	100.0	100.0	100.0	100.0	100.0
Rubber crushed (fraction 2.5–4.0 mm)	90.0	100.0	110.0	120.0	130.0
Sulfur	7.0	7.3	8.0	8.3	9.5
Thiazole	5.0	4.7	4.0	3.7	3.5
Technical Carbon P-803	45.0	45.0	45.0	45.0	45.0
Stearic acid	2.0	2.0	2.0	2.0	2.0
Bitumen BN 90/10	30.0	30.0	30.0	30.0	30.0
Oil softener Mon-6SH	35.0	35.0	35.0	35.0	35.0
Phthalic anhydride	1.5	1.5	1.5	1.5	1.5
Physical and mechanical properties of the compositions					
Tensile strength, MPa	1.4	1.58	2.1	1.7	1.6
Elongation at break, %	68	64	59	50	45
Shore A hardness, units Shore A	60	64	68	68	68

Crumb of various sizes (0.2–1.0, 1.0–2.0 and 2.5–4.0 mm) was used in the composition. Tables 1–3 show the results of the research. They show that the dispersion of the rubber crumb has a great influence on the properties of rubber products. Decreasing the size of crumbs (Table 1) increases its content in rubber products. Thus the strength properties of the material increase (sample 1 and 3).

This becomes possible by using the rubber crumb with particle size of several micrometers, which is achieved with the newest methods of grinding, for example by abrasive disc chopper, where the rubber crumb is crushed in the gap be-

tween the two abrasive wheels rotating in different directions. However, the use of the crumb of small fraction fines increases crumb-making costs which affects the cost of the products obtained, so it is better to use rubber mixtures based on crumb rubber with dispersion of 0.5–1.0 mm (Table 2).

The use of crumb rubber of this fraction allows to obtain elastomeric compound having good physical mechanical properties. Sample number 3 has the best properties. A wide variety of rubber products for different purposes can be produced on the basis of these composites. The investigation of the crumb size effect on the deformation properties of the composites showed that the use of larger particles results in a substantial reduction in elongation at break as compared with smaller particles (Table 3).

The reason for the negative impact of large size particles on the deformation properties of composite materials, is probably insufficient strength of connections in the system "polymer – polymer"; and that is probably adsorption of plasticizers and softeners occurs on the surface of large crumbs that in turn, negatively affects the properties of the polymeric material.

Conclusion. In compliance with the results of the studies we can conclude that the rubber crumb is a promising ingredient for the creation of new non-critical rubber products For a given product set of properties appropriate to use crumb fraction 0.5–1.0 mm, since the use of a crumb fines increases the cost of products and the use of chips in the form of large particles leads to a deterioration of the physico-mechanical indicators.

To obtain products with appropriate properties it is reasonable to use crumb with fraction 0.5–1.0 mm as crumb application of small faction files increases prime cost of goods but the crumb application in the form of large particles makes worse physical mechanical factors.

References

1. Корнев, А. Е. Технология эластомерных материалов / А. Е. Корнев, А. М. Буканов, О. Н. Шевердяев. – М.: Химия, 2000. – 288 с.

Received 27.02.2013