

Innovative technologies of waste recycling with production of high performance products

I.R. Gilmanshin¹, A.V. Ferenets², Yu.I. Azimov¹, A.I. Galeeva³, S.I. Gilmanshina¹

¹ Kazan (Volga region) Federal University, Russia

² Kazan National Research Technical University named after A.N. Tupolev - KAI, Russia

³ Kazan State Power Engineering University, Russia

E-mail: is-er@yandex.ru

Abstract. The innovative ways of recycling wastes as a tool for sustainable development are presented in the article. The technology of the production of a composite material based on the rubber fiber composite waste tire industry is presented. The results of experimental use of the products in the real conditions. The comparative characteristics of the composite material rubber fiber composite are given. The production technology of construction and repairing materials on the basis of foamed glass is presented.

1. Introduction

The concept of effective and sustainable development is including the development of raw materials with high performance characteristics and the formation of a closed life cycle [7]. Additional incentive to research in the field of composite materials and waste treatment technologies is systematic increase of primary raw materials cost [8, 9]. The waste management in Russia for a long time has not been given much attention, in the result the problems of landfills overload and waste sorting are occurred, when in meanwhile the major amount of waste could be used as the raw materials for the production of high-quality innovative products.

The target of using new types of raw materials is being given to modern production, such as composite materials, which could ensure the production of products with high technical performance, physical and mechanical properties [4, 10]. Rubber mechanical products must have high wear resistance, durability, ensure the long life of mechanisms [4, 5]. In particular, obtaining a composite of fiber-filled rubber compound ensures the production of rubber products, such as wedge transmission belts with high heat resistance and durability of the resource.

2. Governing equations

Wedge belts which are used in the power and energy mechanisms and units are given requirements such as heat resistance and high resistance on wearout. The requirements for heat resistance and wear resistance are defined by the mechanisms work conditions, in which wedge belts are exposed to high mechanical stresses with dynamically changing parameters, with a high friction effect, bending moments of stretching and compression, causing internal stresses in the material with heat and rapid



wearout effects on the surface of the material friction [1, 6]. Nowadays abroad to increase heat resistance for rubber (100-120 ° C), chloroprene caoutchoucs are used with the addition of special types of natural caoutchouc, which causes a significant cost of product. To ensure the strength parameters for wearouts in the technology of rubber mechanical products in recent years the use of composite rubber compounds filled with short fibers are being given greater interest [2, 3]. Short fibers, which are anisotropic particles, are able to navigate in the elastomeric materials. This makes it possible to directionally regulate the properties of the rubber quality control, in particular, on the wear resistance.

The currently developed innovative technology of extrusion obtaining of fiber-filled composite mixture is giving the possibility to use secondary resources of industrial production - waste tire production (e.g. cutting parts of rubberized cord JSC "Nizhnekamskshina"). At the same time the problem of waste utilization and prevention of solid waste disposal is solving. Taking in account that the volume of this waste is 500-600 tons per year, the economic effect of the technology introduction at JSC "Nizhnekamskshina" could be up to 30 mln. rubles per year.

The experiments' results on the use of the obtaining composite for the manufacture of rubber fiber composite have shown that the raw material guarantees the high technical and operating characteristics of the final products, which is confirmed by field tests of wedge belts type C-4000 on the oilpumpers of oilfield NGDU "Zainskneft" of JSC "Tatneft".

The pilot line of wedge belts, installed with the staffing at oilpumper by 4 pieces after a work time about 5000-5500 hours, later have been transferred to the complete set of 2 pieces, which gave the opportunity to continue testing the strength of the belt in a double load to the total 8500-8700 hours.

Data on the properties of rubber fiber composite (RFC) and rubber compounds of isoprene caoutchoucSKI-3 with the introduction of the RFC is determined by the following indicators:

- The minimum torque on the rotor of the rheometer according to the content in the rubber mixture RFC varies slightly, which substantially defines the viscous consistency of the mixture.
- Curing speed is reduced by 25-30%.
- Cohesive strength at high levels in the RFC in rubber composition is rising upsharply, adhesion is increasing to steel cord.
- Tear resistance increases significantly.
- Hardness of rubber mixture by Defoe is increasing and elongation of vulcanizates is decreasing sharply.
- Relative strength is being reduced by 30-35%.

Experimental data are proved by suggest guidelines for opportunities of the effective use of RFC in rubber elements and parts of machines and mechanisms of transport, agricultural and industrial equipment, which are subjected to high stress abrasion and wear.

In terms of ensuring energy efficiency of the production process is of interest to the innovative technology of production of decorative thermal insulation material of construction on the basis of foam glass with high performance [11, 12].

Glass waste is one of the main components of municipal solid waste (MSW). It could cause negative environmental impact by processes of leaching certain hazardous substances and open-pit dumping poses a serious threat to wildlife. The proportion of glass waste in the process of re-cycle is unacceptably low, however it could be used for different purposes.

Re-cycle of glass waste is reducing the energy consumption by more than 30%. A range of products allowing the inclusion of recycled glass is quite wide.

The proposed technology relates to the production of porous silicate foams as decorative foam glasstiles used as cladding, thermal insulation, high strength construction material.

Products of porous silicate foam (foam glass, ceramic foam, glass foam grit), as well as products made on the basis of light porous aggregates, due to their high rates of heat and sound insulation for simultaneously with sufficient strength characteristics found widespread use in the conduct of thermal barrier coatings of building envelopes having significant advantages relatively shielding with existing technologies in terms of reliability, durability resource, technology.

It is known the method described in the book “Foam glass” by Demidovich and some other way of preparation of raw materials mixture, a glass melting furnace, heating granulation, mixing the granules with blowing agent, grinding the batch, peaking in the tunnel furnace annealing product.

Disadvantages of these methods are defined by complexity and energy inefficiency of technological process which are including the aggregate of complex multi-stage operations with the considerable processing time and low productivity.

The proposed method makes it possible to produce a wide range of construction and finishing materials with high energy-saving performance.

3. Conclusions

As result, waste recycling is the way of human impact reduction on the environment, energy consumption of production processes and the formation of approaches to sustainable development. The products made from the recycled materials not only inferior, but often outperform counterparts made from raw materials.

References

- [1] Repeated vulcanizates of rubber crumb. Thematic review TsNIITeneftchim / OG Polyakov, AM Chaykun, Moscow, 1993. P. 30.
- [2] Makarov V.M., Drozdovskii V.F. The use of amortization tires and waste production of rubber products. -A. : Chemistry, 1986., Leningrad branch.
- [3] Solovyov E.M., Zakharov N.D. Processing and use of waste tire industry. M., TsNIITeneftchim, 1986.P. 66.
- [4] Zachiesova G.N., Stallions A.N., Zinoviev L.A. Preparation and use of fine powders and powder rubber reclaim. M. TsNIITeneftchim, 1987. - P.60.
- [5] V.N.Yaroshevsky. Recovery and recycling of used tires abroad. - M., TsNIITeneftchim, 1994. - P. 84.
- [6] Shahovets S.E., Bogdanov V.V. Integrated regeneration tires. - St. Petersburg: "Prospect of Science", 2008 P.192.
- [7] The processing and use of waste tire industry. Thematic review. - M., TsNIITeneftchim, 1983. Solovyov E.M., Zakharov N.D.
- [8] Nanotechnology in the production of foamed glass building materials // Construction of a new generation, new technologies - new equipment. - №1.- 2010.- 15-19.
- [9] Puzanov S.I., Kets A.A. Complex processing of cullet in the production of building materials // Ecology and Industry of Russia. - №12.- 2009.- 4-7.
- [10] A.I.Puzanov, S.I.Puzanov, A.A. Ketov. Utilization of Glass Cullet for the Production of Binding Materials // Role for Concrete in Global Development: Proceeding of the International Conference / Dundee. United Kingdom, 2008, P. 317-324.
- [11] TECHNOLith insulating concrete - The ecologically green shade of gray. Betonwerk und Fertigteil-Technik/Concrete Plant and Precast Technology, Volume 78, Issue 4, 2012, Pages 62-63
- [12] G.Betti, U.Pinori, A.Marradi. The use of recycled glassfoam aggregates for lightweight embankment // Sustainability, Eco-Efficiency and Conservation in Transportation Infrastructure Asset Management - Proceedings of the 3rd International Conference on Transportation Infrastructure, ICTI 2014 / Pisa, Italy , 2014, P. 245-254.