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CONSTRUCTIVE AND TECHNOLOGICAL FEATURES OF UNITS FOR MILLING POLYMER MATERIAL

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Abstract. This article presents specific physical and mechanical properties of techno genic polymer materials. The features of their processing are revealed. The ways of constructive and technological perfection of grinders are proposed, namely, the creation of units based on needle-milling working parts that ensure selective complex influence on the processed materials with the cantilevered ends of their rod elements and the creation of energy-efficient mechanisms of destruction.

At present, various methods for the utilization of techno genic polymer materials (TPM) are known, among which we can mention the processing of biodegradable polymers, thermal processing, chemical processing and recycling of polymeric materials. There are sufficient incentives for recycling of utilized polymer waste such the environmental aspect, consumer demand, legal requirements and low cost [1].

Secondary recycling of used polymers is an important task. Although the content of TPM products in wastes is relatively small (about 7-8% by weight),the problem of utilization of these wastes (about 18% 20% by volume) is significant because of a low specific gravity [2].

Due to their high resistance to environmental influences, these materials remain in natural conditions for a long time. On the basis of laboratory experiments, it was possible to establish thatit will take from one hundred to five hundred years for a full decomposition of a plastic bottle under the influence of ultraviolet and temperature drops. Some environmentalists also indicate a period of up to 1000 years [3]. At the same time, production from polymer materials is more than three hundred million tons every year and continues to grow. In this regard, it can be argued that TPM is one of the most dangerous pollutants of the environment.

Polymeric materials have a wide range of physical and mechanical characteristics, which strongly depend on their structure. In addition,various external factors in the process of processing can influence on the mechanical properties of the substancea lot [1-3]. These include: thermal impact; frequency, duration or rate of loading; type of stress state; pressure; nature of the environment, etc. A feature of the physical and mechanical properties of polymeric materials is their relatively high strength at very low rigidity (in comparison with metals) [4].

In this regard, the aim of this paper is to analyze the structural and technological characteristics of units for grinding polymeric materials and to develop energy-efficient equipment for the processing of TPM.

Polymers are usually divided into solid, the modulus of elasticity of which is equal to E = 1..10 GPa (fibers, films, plastics), and soft highly elastic substances, the modulus of elasticity is E = 1..10 MPa (rubber). The regularities and the mechanism of destruction of these and other are different [5]. In some cases, in order to increase the productivity of the grinders, it is necessary to pre-prepare the polymer materials before the crushing stage beforehand. The type of the preparatory technological operation depends on the physical and mechanical characteristics of the waste, on their quantity, geometric dimensions, etc. For example, materials having a small bulk density must be compacted before grinding beforehand [6].

When developing energy-efficient equipment for grinding TPM, it is necessary to take into account their specific physical and mechanical properties. A new direction of constructive and technological perfection of grinders includes the creation of multifunctional technological units based on needle-milling working parts that ensure selective complex effect on the processed materials by the cantilevered ends of their rod elements and the creation of energy-efficient mechanisms of destruction [7-8]. Of the whole va-

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riety of known sets of rod that form wire brush of various designs disc, cylindrical, flat, finger and etc. wire brushes canbedistinguished asthe most common ones [9].

The task of intensifying the process of grinding and the expansion of technological possibilities is materialized in the device for grinding of techno genic materials with wire brush working parts[10] (Fig.1, 2).

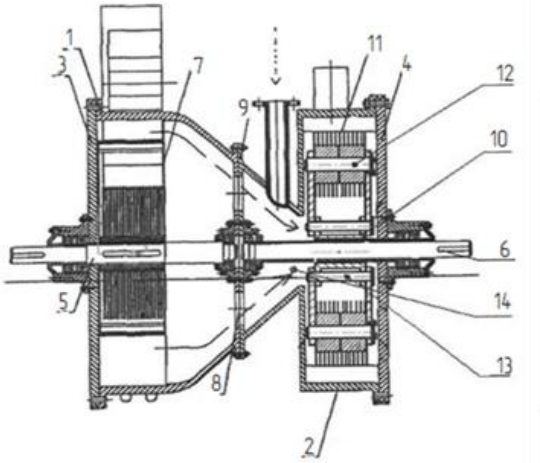

Figure 1. Plant for grinding of techno genic materials: 1, 2 - cylindrical-camera; 3, 4 - the cover; 5.6 - shaft; 7 - partition of the first chamber; 8 –transitional aperture; 9 - inter-chamber partition; 10 - the hub; 11 - the brush;
12 - an axis; 13 - cotter pin; 14 - inlet openings of the second chamber

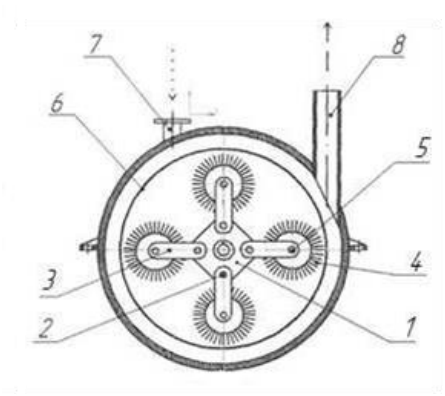

Figure 2. The chamber of a fine grinding: 1 – the hub; 2, 5 - an axis; 3 - the earring; 4 - brush; 6 - a drum; 7 - branch pipe of additives; 8 - discharge outlet

The plant comprises a body consisting of two horizontally placed chambers: coarse grinding 1 and fine grinding 2. According to the invention, the wire brush working parts of the grinding chamber are made of a set of rod elements assembled into bags and rigidly fixed by one end on the holder. Such a rotor has a developed working surface, which provides efficient grinding of the material, and expands the technological capabilities of the unit.

Thus, it can be concluded that the development of devices with wire brush working bodies is an innovative direction in the structural and technological perfection of grinders, taking into account specific physical and mechanical properties of TPM. The use of wire brush tools increases the energy efficiency of grinders by increasing the number of single contacts of the working element and material. Besides, shocking, shearing, cutting and tearing stresses in contact zones occur simultaneously, which not only intensifies the process of grinding polymeric materials, but also ensures the one-dimensionality of the product obtained.

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References
[1] Gogol E V, Mingazetdinov I Kh, Gumerovaia G I2013 Analysis of existing methods of waste treatment and recycling polymers *Vestnik of the Kazan Technological University***10** pp 163-168
[2] SverguzovaS V 2008 Industrial ecology as an indispensable condition for stable development (Belgorod: Publishing House of the Belarusian State Technical University) p155
[3] SevostyanovV S,NosovOA, VardanyanG R, Berezhnoy O L 2013 Processing of used polyethylene packaging Ecology: Education, Science, Industry and Health: Sat. doc. *V International Scientific and Practical Conf.* (Belgorod: BSTU Publishing House), pp 152-156
[4] Bystrov GA, Galperin VM, Titov B P 1982 Deactivation and disposal waste in the plastics industry (L .: Chemistry) p 264
[5] SevostyanovV S, NosovOA, BerezhnoyO L, Vardanyan G R 2015 Technique and technology of grinding secondary polymeric raw materials *Energy and Resource-Saving Environmentally Clear Chemical Processes of environmental protection:* Sat. doc. international scientific and practical conference (Belgorod: Publishing House of BSTU) pp 50-54
[6] Sevostyanov V S, MikhailichenkoS A, Sevostyanov M V 2007 Energy-saving technological complexes and units for utilization of techno genic materials *Vestnik of the Belgorod State Technological University named after V.G. Shukhov*vol 1 pp 85-90
[7] Sevostyanov VS, Sivachenko TL 2016 Wire brush grinders, their technological possibilities and ways of development Vestnik of the Belorussian-Russian University**1**pp69-78
[8] Sevostyanov VS, Sivachenko TL, Mikhaylichenko S A 2015 Technological devices with wire brush parts organs for complex processing of composite materials *Vestnik of the Belgorod State University Technological University V.G. Shukhov*vol 2 pp 50-57
[9] SevostyanovV S, UralV I, SevastyanovM V, Nosov OA 2015 Technological complexes and equipment for processing and utilization of technogenic materials*Belgorod: Publishing house BSTU V.G. Shukhova* p 321
[10] Glagolev SN, Sevostyanov VS, Sevostyanov MV Pat. 2540549 Ros. Federation, IPC B02C 18/00*Plant for grinding fibrous materials and etc*.; applicant and patent holder of BSTU V.G. Shukhov No. 2013141378/13; claimed. 09/09/2013; (publ. 10.02.2015, **4**) p 11