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RECYCLING AS A CHEMICAL TECHNOLOGY FOR PROCESSING POLYMER WASTE

РЕЦИКЛИНГ КАК ХИМИЧЕСКАЯ ТЕХНОЛОГИЯ ПЕРЕРАБОТКИ ПОЛИМЕРНЫХ ОТХОДОВ

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Abstract. The problems of recycling polymer waste are associated with the growth of polymer production and their processing. The problem of recycling polymer waste generated in solid municipal waste is quite acute. For the efficient recycling of polymer materials, it is necessary to develop new modifying additives that could ensure the compatibility of polymer waste in the composite system. Such additives can be used as special complex concentrates to restore the primary properties of secondary polymer materials. They include primary and secondary antioxidants, phosphites or phosphonites, thermal and light stabilizers of phenolic and amine type, neutralizing active radicals accumulated in the polymer and decomposing peroxide compounds. Using new types of equipment for recycling polymer materials based on polymer waste, it is possible to obtain high-quality products with low cost for industry, construction and agriculture.

The authors propose a hypothesis that the targeted thermal oxidative destruction of some secondary polymers may be one of the least expensive methods for obtaining

active functional additives capable of participating in the physicochemical processes of modifying other secondary polymers and/or their mixtures. In high-molecular compounds with polar groups, there are significant reserves for the manifestation of physicochemical activity. A decrease in the molecular weight of polymers could increase reserves, forming new active centers for inter- and intramolecular interactions. This can and should be used by creating conditions for obtaining stable compositions consisting of oligomeric fractions, the degree of activity of which is sufficient to manifest the desired effect. Based on the proposed idea, new methods of regulated recycling of secondary polymers could provide new chemical products with high competitiveness in the markets [1].

Due to the growing production of polymer materials in the world, there is a problem of recycling polymer waste, which is a threat to environmental pollution. The volume of polymer waste in Europe is increasing by almost 30 % per year and for every European resident their annual accumulation is approximately 20 kg. To a greater extent, this is due to the specifics of polymer materials that do not undergo rotting and corrosion for a long time, since they decompose extremely slowly under natural conditions and are practically not exposed to micrographs, being a serious source of environmental pollution. [2].

Particularly acute is the problem of recycling and disposal of polymer waste generated in municipal solid waste, a significant part of which in many countries is not used for further processing. Most of the polyethylene and polypropylene film waste generated in the municipal sector is heavily polluted and consists of polymers that have undergone destructive changes, which significantly complicates their processing, and in most cases their processing is economically impractical. Another factor constraining the widespread use of polymer wastes, especially heterogeneous ones, is their low entropy of mixing, which does not provide thermodynamic compatibility for most polymers. As a result, when composites are formed on their basis, fibrillation of components is observed. In addition, polymer waste is often formed in solid household waste in the form of osprey, which also does not contribute to the effectiveness of their use in polymer materials technology. The limiting factor of the widespread use of polyolefin waste in the production of products is the occurrence of oxidative processes in them, which can have a significant impact on the change in the structure and properties of the materials obtained. At the same time, the ability of thermoplastic polymer materials to be repeatedly processed without significant deterioration of their properties is one of their advantages. At the same time, polymer waste can be a valuable raw material that replaces primary polymer materials in a number of positions [3].

In general, recycling of polymer waste is determined by three main aspects:

- The organizational and legal aspect, where the most important is the organization of collection and sorting of household waste, as well as legislative acts that stimulate work with waste disposal, both for the population and for industrial enterprises.
- Technical and technological aspect, including hardware and technological support of the recycling process and improvement of the properties of products based

on waste. This is one of the main directions in the use of waste polymer materials, especially heterogeneous, which are inherent in MSW. At the same time, in order to obtain functional products with acceptable performance characteristics from them, it is necessary to develop specialized additives that ensure the compatibility of the components of the mixture and the formation of a homogeneous structure of the final product.

- Ecological and economic aspect is presented by the selection of an assortment of products from secondary raw materials for its rational use in various areas of the national economy, reduction of the cost of secondary raw materials and ensuring environmental safety [4].

In the field of polymer waste recycling, an important document is signed in October 2018 of the Global Agreement on Combating Plastic Pollution. In addition to the refusal to use non-recyclable, disposable and redundant packaging, the existing agreement clearly states the need to introduce innovations that would ensure the safe use of packaging and its recycling by 2025, as well as the expansion of the use of secondary polymers in production [5]. This requires scientific research, primarily in the field of polymer materials science, which will be aimed at increasing the ability of secondary polymers to recover. At the same time, the ability to recover determines the possibility of using polymer waste in production practice. Despite a number of studies in this direction, there is no holistic solution to this problem. In particular, this is typical for polymer waste generated in municipal solid waste, which is due to the lack of sorted polymer materials, their contamination and reduced mechanical and technological characteristics. For more efficient creation of multicomponent polymer systems using secondary polymers, it is necessary to:

- develop modifiers to improve the compatibility of thermoplastic waste, while compatibility should be understood as the ability of two or more polymers to be processed into a single material with properties acceptable for a particular use;
- improve the processes of combining polymer waste with modifying additives during agglomeration and granulation, especially in mixed compositions;
- investigate the features of the performance of the components of mixtures during repeated processing for purposeful regulation of the resistance of the material to thermal, oxidative and mechanical-chemical destruction;
- develop a methodology and analysis of polymer waste generation for reasonable use in the creation of new and improved composites with the best recyclability and mechanical properties;
- create and improve specialized energy-saving processing equipment taking into account the technological features of the preparation and processing of polymer waste.

Solving these problems will make it possible to create new promising multi-component polymer systems based on secondary polymer raw materials. Together with new types of equipment for recycling polymer materials, conditions will be created for the effective disposal of polymer waste and the production of high-quality products based on them with an attractive price for the consumer and reliable work in various

sectors of the national economy, as well as solving issues related to environmental protection.

Thus, the most important task in obtaining technically valuable polymer raw materials from polymer waste is the selection of additives that affect the compatibility of polymer components in the composite system and its operational properties. An equally important task is the creation of specialized energy-saving processing equipment aimed at improving the efficiency of the preparation of polymer waste into secondary polymer raw materials. This will contribute to the economy of primary polymer materials, as well as the preservation of hydrocarbon raw materials for its production. This will ensure the improvement of the environmental situation in the country.

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