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WASTE POLYMER DISPOSAL METHODS

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Abstract

The article analyzes the recycling of polymers. Particular attention is paid to the methods of pre-treatment of polymer waste. The features of obtaining mixtures for the manufacture of compositions based on crushed and modified waste are noted. The features of secondary polymers and chemical processing of waste polymers are disclosed.

Keywords: Recycling, polymeric materials, methods, secondary waste raw materials.

The introduction of polymer materials based on macromolecular compounds in all sectors of the national economy has created the problem of recycling and recycling of polymer waste.

Currently, the problem of using polymer waste is relevant, both from an environmental and economic point of view. Particular attention should be paid to the processing of cross-linked elastomers, since their amount in the total mass of polymer waste is the largest part, and the methods of their processing and disposal still do not fully ensure their use in industry.

The main ways of recycling plastics and elastomers are sorting, cleaning, grinding, partial or complete destruction of waste [1].

Recycling homogeneous polymer waste is a relatively simple task if their structure is preserved and there was no significant degradation either during manufacture or during primary use. The recycling technology requires that the collected waste be granulated and only then be recycled. Thus, the polymeric material is subjected to at least two consecutive temperature exposures. Of course, degradation processes lead to a significant deterioration of all physical properties, and this should be taken into account when recycling. While recycled materials that retain their properties can be used in the same applications as virgin polymers, recycled materials with reduced properties can only be used in special applications. The depth of degradation processes in a sample of secondary polymer material is determined not only by its chemical nature, but also by operating conditions. As an example, consider PE. Recycled LDPE is produced mainly from packaging film and film used for agricultural purposes. In the first case, the structure of the material is very close to the structure of the original polymer due to the short service life and mild operating conditions.

For the recycled polymer from the greenhouse film, the presence of an insoluble gel and, at the same time, a high value of the melt flow index are observed, which clearly indicates the presence of cross-linked structures. This can create certain problems in all processing operations that require low viscosity. Apparently , a decrease in molecular weight and the presence of poorly deformable structures reduces the relative elongation, and premature rupture can reduce the breaking stress. The relative elongation in some cases can be reduced up to 30 - 40%, for the original material this value can be more than 450%. In the mechanical processing of secondary polymers, it is necessary to avoid further degradation during the technological process. This can be achieved by the right choice of processing equipment, processing conditions and the introduction of stabilizers.

Degradation during processing can be very significant. Since stabilizers are consumed during the processing and operation of polymers, it is necessary to introduce additional amounts of additives with

optimal chemical efficiency before each technological operation of recycling [2]. The original and recycled plastics are subject to the same degradation mechanisms and therefore the same approaches to stabilization are possible for them. In addition to stabilizers during recycling, anti-acid chemicals are introduced into polymers - additives, compatibility agents, impact modifiers, additives that increase the molecular weight. The reintroduction of pigments improves the appearance of recycled plastics. As in the original polymers, fillers are introduced into secondary materials. Targeted proprietary additive concentrates have been developed that have properties aimed at working with specific recycled plastics. Despite the fact that the mixed waste consists predominantly of polyolefins, the components of this system are thermodynamically incompatible. This leads to a deterioration in the physicochemical parameters of products from mixtures, compared with individual polymers. As follows from Table. 7, PVC is the only polar component in this composition, so the optimal solution for the joint use of polymer waste is to remove it from the mixture and process it individually. This fact, as well as the toxicity of this polymer during recycling, has led to the fact that PVC is increasingly being squeezed out of the market for containers, disposable tableware, bottles and packaging. However, even when polar components are removed, mixed polymeric wastes, even with intensive mixing in the melt and dispersion to micron-sized phases, form brittle heterogeneous materials. Separation of phases in the melt or after cooling leads to the formation of a colloidal system, where a component with a lower concentration forms a dispersed phase in a continuous larger phase-matrix [3]. Today, a lot of experience has been accumulated in improving the compatibility of the components of polymer mixtures, which is widely used in relation to recycled materials. A stable supramolecular structure can be obtained in various ways. Recycled polymer materials are used in many products, from soft drink bottles to car parts. In the US alone, more than 1,400 types of products made from recycled polymers are now produced. Catalogs are provided that allow managers and consumers to find products made from recycled materials. The use of recycled polymeric materials has a number of advantages. So in many cases they are sold at a price of 20 - 25% lower than the price of the original counterparts. The environmental factor is also important. The benefit is that less waste has to be disposed of or incinerated. Less energy and raw materials are spent on the production of original plastics. For example, the recovery of PET from bottles reduces the energy consumption for the production of this polymer by 84%. Currently, the most promising direction for recycling waste from LDPE (and from any other polymers) is the creation of intermediate materials to replace traditional wood materials [4]. The main advantage of polymer recycled materials over wood is its biological stability: polymers are not destroyed by microorganisms and can be in water for a long time without jeopardizing the structure. To improve the mechanical properties , various inert additives are introduced into the composition of polymers , for example, powdered wood shavings or fibers. The market for such products is huge. U.S. Plastic Company lumber Corp. _ estimates it at $ 10 billion . The scope of recycled HDPE is very wide and is distinguished by a variety of technological processes. It is often used for the production of film, containers of various sizes, irrigation pipes, various semi-finished products, etc. Recycled HDPE has found the greatest use in the production of containers (canisters) by blow molding. The rheological properties of high-density recycled polymers do not allow blowing large containers, so the volume of such canisters is limited. A typical area of use for canisters based on HDPE waste is the packaging of fuels and lubricants and detergents. Cans can be made either entirely from polymer waste, or co-extrusion with primary granulate . In the latter case, the secondary polymer layer forms a core between the two primary polymer layers. Canisters obtained in this way are used for filling detergents by a number of companies (Procter & Gamble , Unilever , etc.). Another example of a mass-produced product made from recycled HDPE is irrigation pipes [5]. As a rule, they are made from a mixture of secondary and primary polymers in different ratios. Given that irrigation pipes are not designed to be used under pressure, the mechanical properties of recycled HDPE are well suited for their production. The high viscosity of canister and film recycled HDPE can often be compensated for by the low viscosity of the virgin polymer, whereby impact resistance can be improved . The production of large diameter pipes from recycled HDPE is no problem either: irrigation and drainage pipes are up to 630 mm in diameter. When using injection molding technology, the percentage of recycled plastic is lower. This technology is applied to cladding panels, municipal waste bins, etc. The cladding panel market is

very attractive due to its large capacity. It is estimated that the US market alone consumes 2 billion units of sheathing panels and boards, which are still traditional lumber.

The secondary processing of polymers is often limited by the high contamination of raw materials, their compositional heterogeneity, and a significant level of material degradation. Chemical processing of polymer waste involves their transformation into low molecular weight fractions: gases, monomers, oligomers, crude oil, etc. This type of disposal also includes controlled reactions leading to the reduction of the polymer and its chemical modification. Pyrolysis is the thermal decomposition of organic products with or without oxygen. Pyrolysis of polymer wastes makes it possible to obtain high-calorie fuel, raw materials and semi-finished products used in various technological processes, as well as monomers used for polymer synthesis. The gaseous products of the thermal decomposition of plastics can be used as a fuel to produce working steam. Liquid products are used to obtain heat transfer fluids. The range of application of solid (waxy) products of pyrolysis of waste plastics is quite wide (components of various kinds of protective compounds, lubricants, emulsions, impregnating materials, etc.). In order to obtain high-quality pyrolysis oils of constant composition, it is necessary to comply with special requirements for the feedstock [6]. This should preferably be a waste with a high content of hydrocarbons. To convert thermoplastics such as low molecular weight PE or atactic PP, low-temperature liquid-phase pyrolysis is used in continuously or intermittently operating reactors. In some cases, fluidized bed reactors find use in the low temperature region . Low molecular weight PE is pyrolyzed at 400 - 450 °C to produce aliphatic olefin-rich oils and aliphatic waxes. Atactic PP thermally decomposes in the temperature range of 400 - 500 °C. The operating temperature range in this case is determined by the processed product. For example, PVC waste and by-products above 200 ° C split off hydrogen chloride , and during further heat treatment (above 400 ° C) they decompose into carbon black and hydrocarbons. Liquid-phase pyrolysis of PS at temperatures above 350 °C leads to the formation of styrene with a high yield. To obtain low molecular weight raw materials from such special types of waste polymers as mixtures of thermoplastics, cable insulation, high-temperature pyrolysis is used, while high productivity is achieved only in the case of continuous methods. The low molecular weight saturated hydrocarbons formed during the pyrolysis are subjected to subsequent cracking in order to increase the yield of unsaturated compounds used in the synthesis of polyolefins [7-9]. Catalytic hydrocracking processes have also been developed to convert waste polymers into gasoline and fuel oils. Artificial liquid fuel is a very promising area for the disposal of polymer waste. Recently developed technologies make it possible to obtain high-quality grades of gasoline, kerosene, diesel and boiler fuel. However, the main disadvantage of these technologies is the high cost of the equipment used and, accordingly, the high cost of the produced artificial liquid fuel. Legacy polyolefins can be added to coal, carbonized and incorporated into coke to make iron. The contribution of chemical recycling today is only a percentage of all polymer recycling. However , in some special cases it can be used successfully.

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