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| Research Article

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Creation of Polymer Compositions with Improved Performance Properties based On Secondary Waste Raw Materials

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Annotation

The article analyzes the classification of polymer waste.

The structure of production, polymer processing and use of finished products is disclosed. Particular attention is paid to the methods of processing composites. And each of them is briefly characterized.

Keywords: Production waste, waste management, consumption waste, polymer composite materials, secondary polymers.

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The main technological method for obtaining polymer composites for a long time was the mechanical mixing of the filler and the polymer matrix. Polymerization filling - chemical grafting of a catalyst or initiator to the surface of the filler and subsequent polymerization or copolymerization of monomers on these surfaces - may open a new page in the chemistry and technology of composites. The development of the technology of composite polymer materials is currently determined by scientific research in the field of polymer materials science, since the problem of interaction of fillers and matrices is very multifaceted. Modern man encounters polymer materials not only in technology, but also in everyday practice, so knowledge of the basic properties of these materials and the ability to use them correctly are gradually becoming necessary for an increasingly wide range of people. Therefore, this manual provides the basic principles of obtaining and using polymer composite materials and information on the most important types of composites.

The main class of materials that meet strict, often conflicting requirements, such as ensuring minimum structural weight, maximum strength, rigidity, reliability, durability when operating under severe loading conditions, at high temperatures and in aggressive environments, are composite materials.

As a rule, the cost of composite materials is very high, which is associated with the complexity of technological processes, the high price of the components used. However, it should be noted that it is possible to save money by reducing the number of technological connectors, reducing the number of parts, and reducing the number of assembly operations in the production of complex

structures. The labor intensity of manufacturing products from composite materials can be reduced by 1.5-2 times compared to metal analogues. When developing modern composite materials in the early 80s of the 20th century, a principle was formulated that provides for a comprehensive solution to the issues of choosing composite materials, designing structures from them and developing technological processes. These are three sides of a single problem and in many cases a new design, a composite material for its manufacture and a technological process for obtaining a part are developed simultaneously.

The most important feature of the production of modern composite materials is that the composite and the technology of its manufacture are developed for use in a specific design. In this regard, the following stages represent three sides of a single problem: development of the part design; creation of a composite material for its manufacture; development of a technological process for obtaining the shape required by the design documentation. Taking into account the above, the issues of development of new composite materials and their technological processing should be considered together and taking into account the purpose of the part, its shape, dimensions, and operating conditions. In general, the technology of manufacturing products from polymer composite materials includes the following operations: preparation of a reinforcing filler; preparation of a polymer binder; combining the matrix with a reinforcing filler; shaping of the part; curing of the binder; mechanical finishing of the part (if necessary); quality control of the part. This chapter will focus on the methods of shaping parts from polymer composite materials. Currently, a large number of methods have been developed for manufacturing parts from polymer composite materials, the main ones being the following: contact molding; molding with an elastic diaphragm; pressure molding; pressing in forms; winding; preliminary forming of blanks and mats.

Contact molding is widely used in the production of polymer composite products. This method is used to manufacture boat and yacht hulls, car parts, furniture, panels and other structures. The molding process includes the following operations: layer-by-layer laying of reinforcing elements on a prepared mold; their impregnation with a polymer binder; compaction to remove air bubbles. Impregnation of the fibrous filler can be carried out not only after its placement in the mold, but also at the preceding stage. There are three types of contact molding: manual laying; automated laying; spraying.

About 50% of products made of polymer composite materials are produced using mold pressing methods. The use of molds ensures the required configuration of products. The use of mold pressing methods is most advantageous in cases where it is necessary to manufacture large batches of parts. However, in some cases, the pressing technology can be used even in the manufacture of small-scale production parts, which is explained by the high quality of the material obtained in the molds and the high accuracy of the dimensions and shape of the products. There are three main pressing methods: direct, casting, and thermocompression. To implement any of the developed and used pressing methods, it is necessary to make a mold, the working volume of which corresponds to the shape of the product being obtained. The main elements of the mold are the punch and the matrix. When they close, a working gap remains in the mold, the thickness of which corresponds to the thickness of the product. The choice of pressing method is determined by the mold design, the properties of the material used, and the method of loading it into the mold. Direct pressing of polymer composite products The materials for the manufacture of parts by the direct pressing method are: fibrous mass impregnated with a binder; tableted polymer composites; mats or fabrics impregnated with a binder; preformed blanks made of polymer composites; premixes. Depending on the processing modes and impregnation methods, the content of reinforcing elements in composite materials obtained by pressing can be 20...50%.

In addition to pressure, temperature and time are important technological parameters of the pressing process. Heating of the material is necessary to ensure its plasticity, facilitating the filling of the working space of the press mold. When using thermosetting binders as a matrix material, heating is necessary for the material to harden. Heating of press molds can be carried out using special built-in heaters, as well as heated plates on which the elements of the molds are attached. The direct pressing method is used to process both thermoplastic and thermosetting materials. In practice, this method is usually used to manufacture products from thermosetting materials. The processing of thermoplastic materials is limited by the relatively long duration of the pressing process.

Today, polymers are widely used in the production of technical products; containers and packaging, medical products, and household goods. Up to 40% of global polymer production is used in the packaging industry.

Polymer products end up in landfills after use, and containers and packaging have the shortest service life - from several days to a year. The share of polymers in solid household waste is constantly increasing. In Russia, it is estimated at 5-8% on average.

Polymer waste, like the polymers themselves, is divided into:

thermoplastic – polymers that, when heated, acquire the properties of plasticity and fluidity; this type includes polyethylene, polypropylene, etc.;

Thermosets are polymers that do not change into a viscous-plastic or fluid state when exposed to temperature.

Thermoplastic polymers are of the greatest interest for reuse. The main types of thermoplastic polymers and products made from them, which after use turn into waste.

Polymer waste gets a second life in new products. It is known that increasing production efficiency is closely related to the use of secondary raw materials. In the rubber industry, this is especially important, since the cost of raw materials makes up a large part of the cost of production.

In the last 20 years, there has been an intensive growth in the volumes of polymer production and their consumption in the rubber industry. This is due to the fact that various types of elastomers and products made from them are increasingly used in all sectors of the national economy. The maximum involvement of production waste in the national economy is an integral part of the work on saving, and saving material resources is becoming an important source of ensuring production growth in modern conditions.

The problem of economic consumption of materials is especially acute in the production of rubber products (RP), where rubber waste makes up on average 20–25% of the volume of manufactured products.

Considering that technological waste is inevitable for rubber production, the problem of rational use of raw materials and materials should be solved in two directions. Firstly, reduction of waste in technological production processes by improving equipment, technology and organization of production. Secondly, increase in the volume of processing and secondary use of production waste.

It should also be noted that if the material consumption of rubber products mainly depends on their design, then the amount of waste and losses is determined by the technical level of the main technological processes of production, the state of technological discipline and general order at the enterprise.

In this regard, all production waste generated at the enterprise can be divided into two groups: technically unavoidable, caused by the existing level of technological production of rubber products, and waste, the formation of which is caused by equipment malfunction, organizational problems, insufficient qualifications of service personnel, and violation of technological discipline.

As in other industries, waste disposal issues are closely linked to environmental protection issues, since rubber's resistance to oxygen, ozone, solar radiation, and bacteria pollutes the environment for a long period.

Waste from rubber production is heterogeneous. It differs in composition, appearance and other characteristics. First of all, it includes waste related to the features of the technological process, the so-called "technologically inevitable waste". When manufacturing molded products, both by compression molding and injection molding, the formation of extrusions is inevitable.

When manufacturing non-molded products, losses are inevitable at the beginning of the work when adjusting the profile size, in addition, part of the rubber mixture remains after the end of the work in the worm press.

In the process of manufacturing sleeves, losses are inevitable when cutting their ends, when injecting chambers or applying intermediate and outer layers, etc. In the process of manufacturing conveyor belts and flat drive belts, waste is generated when cutting edges, when calendering fabrics at the filling ends and at the joint.

To ensure the correct choice of processing method, the generated waste is classified according to certain defining characteristics.

Waste is classified as: by sources of formation (waste from molded products, non-molded products, sleeves, V-belts, conveyor belts, etc.); by composition and degree of structuring (non-vulcanized and vulcanized rubber, rubber-fabric, etc.); by possible use (non-recyclable), tonnage, impact on the human body and the environment, etc.

When determining the direction of processing and the rational method of use, it is most correct to classify waste by composition, physical condition, and degree of vulcanization.

This classification has received the widest distribution. According to this classification, **waste is divided into:** rubber (vulcanized and unvulcanized); rubber-fabric (vulcanized and unvulcanized); rubber-metal and textile; ebonite; metal; waste adhesives and solvents, etc.

Thus, the processing of secondary material resources, in particular, tires and other rubber products that have ceased to be used, has great technical, economic and ecological significance. It was of interest to study the possibility of reducing the cost of polymer compositions based on rubber industry waste.

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