

**TECHNOLOGY DEVELOPMENT FOR MAKING COMPOSITE MATERIALS USING
THERMOPLASTIC POLYMERS**

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Abstract: *This article presents the technology of line for the production of products from thermoplastic polymeric materials based on polyethylene and polypropylene. Described the technological process for the production of products from thermoplastic polymers, i.e. polyethylene and polypropylene materials. And also, physical and mechanical properties of composite polymeric materials based on thermoplastic polymers are given.*

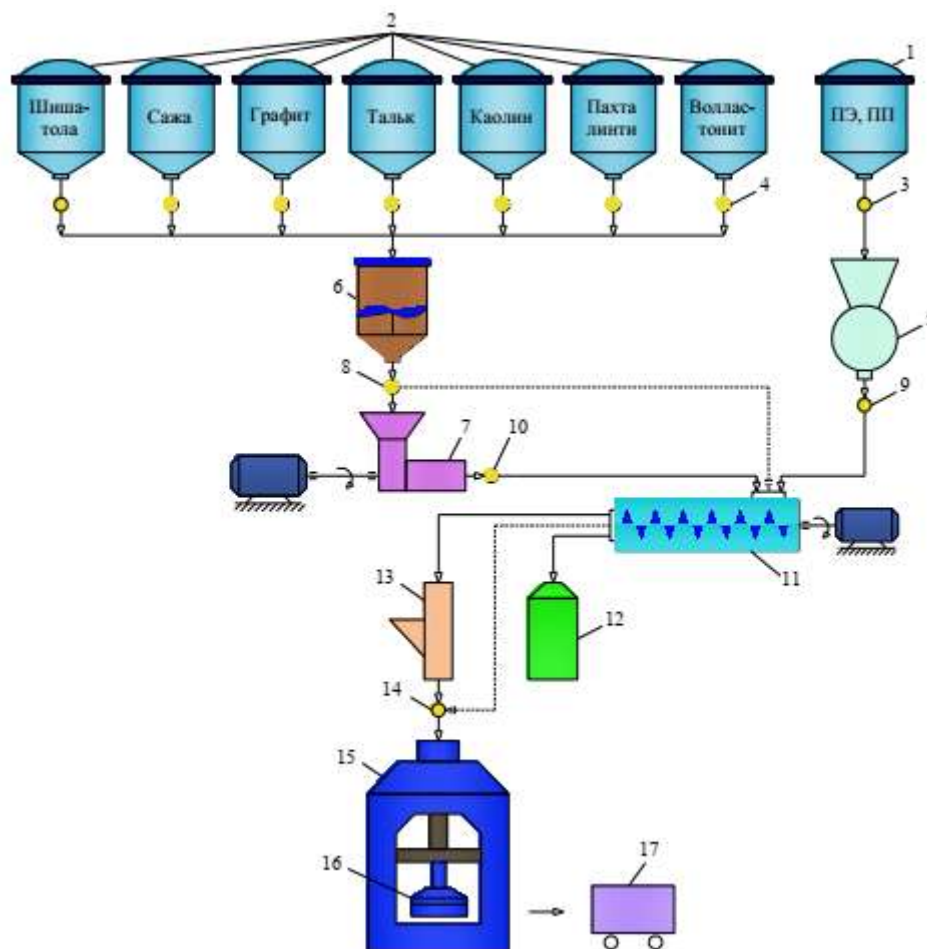
Key words: *composite, polyethylene, polypropylene, injection moulding, anti-friction and anti-friction-wear properties.*

1. Introduction. Injection molding is one of the most popular techniques for processing thermoplastic polymers and their composites, and it offers several advantages over other processing techniques. Despite the clear benefits of this process, the use of industrial casting equipment in the production of prototypes and small batches of parts is inefficient due to the need to manufacture complex tooling for molding parts of composite polymeric materials (CPM). This results in higher part costs and inefficient casting equipment use, rendering this processing method unprofitable.

2. Methods. Plastic parts are machined using simpler, less expensive machining techniques in some prototype or small production applications. It is true that when making small quantities of parts, machining can frequently be less expensive than injection molding. Nevertheless, this approach is ineffective for producing tiny batches and has low productivity and high costs. Products with intricate shapes can be produced using the less labor-intensive nonpressure forming technique. However, only epoxy resins and compounds are appropriate for this technique. In this regard, we have created adaptable technology based on thermoplastic polymers polyethylene and polypropylene, processed by injection molding and technological regulations for their manufacture, to produce prototypes and small quantities of parts from local raw materials. We have selected an injection molding technique based on thermoplastic polymers after analyzing the potential of several CPM processing techniques. The selected processing technique eliminates the need for costly industrial casting equipment and allows for the production of pieces with specific sizes and characteristics.

3. Results and Discussion. The established technological line for producing composite polymeric materials and casting from them disk samples and components for the research of their mechanical and physical properties, as well as products for cotton machine

operating elements, may be seen in Figure 1. Thermoplastic polymeric composite material (CPM) parts are now an essential component of many machines and mechanisms that operate in frictional interaction with fibrous matter (raw cotton). Parts with specific physical-mechanical and tribotechnical qualities can be made using a wide range of developed antifriction and antifriction-wear composite materials. However, when manufacturing prototypes and small batches of parts from AICCM, the issue of selecting the optimum CPM processing mode inevitably arises. This is due to both technological and technical-economical reasons. The main parameters when selecting the method of CPM processing are their physico-mechanical and rheological properties, which determine the possibility of processing of materials by one or another method.



1 - vessel for polymer granules; 2 - vessel for powder fillers; 3, 4, 8, 9, 10, 14 - batchers (weight measuring device); 5 - shredder; 6 - mixer; 7 - mechanical activator; 11 - extrusion mixer with heating; 12 - packing container; 13 - shredder; 15 - moulding machine; 16 - mould; 17 – trolley for finished samples.

Figure 1. Process line for the production of composite polymer materials based on the local raw materials polyethylene and polypropylene.

The design of the mold tooling, or molds, is easy to create and requires little in the way of manufacturing expenses. This enables the tooling to be put into use quickly and drastically lowers product costs. Let's use the stages of the technological process of producing composite polymeric materials and sheet disks for tribometers to demonstrate

the potential of the created technological line. The continuous scheme is used in the technological process of producing composite polymeric material.

In the continuous process the granule-polymer (binder) and fillers come from the containers 1 and 2 in batchers (weight measuring devices) 3 and 4, where the initial components of the mixture are dosed in a certain proportion, then from dispensers the granule-polymer goes to the shredder 5, and fillers go to the mixer 6. Then the crushed polymer and mixed fillers simultaneously through batchers 8 and 9 arrive in the extrusion mixer with heating 11. Thus the process of mixing occurs simultaneously with heating of the components of a mixer at temperature 403-512 K. The mixing time is 5-10 minutes, depending on the composition of the mixture. In many cases, it is desirable to avoid introducing various particles and air into the mixture during mixing, the presence of which leads to a reduction in the strength of the composition. From the extrusion mixer 11 the obtained composition mixture in the form of pellets goes to the packaging chamber 12, or immediately, through the dispenser 14, is loaded into the hopper of the molding machine 15. Composite polymer disc parts are produced by injection molding, which provides process stability, accuracy of the required dimensions and high quality products that do not require additional mechanical treatment. In addition, injection moulding makes it possible to produce a variety of products with complex configurations such as various parts of working elements of cotton processing machines with smooth surfaces. Casting of products is carried out in the casting machine 15 in the press - moulds 16, made for this purpose. When the production is single or small-scale, casting is performed in simplified moulds. The mould must be made of heat-resistant and sufficiently strong stainless steel, taking into account the loads arising from material shrinkage during polymerization and cooling. Injection moulding of composite polymer disc and other parts is recommended on LM series injection moulding machines. The prepared moulding material from the feed hopper enters the preheated cylinder of the injection moulding machine, where the composition mixture is melted (523-543 K) and the fillers are impregnated. The thus obtained filled composition is injected into a slightly heated mould (313-343 K) at a pressure of 110-140 MPa and maintained for 5-20 seconds, after which the form is opened and the finished product is extracted. The final stage is pressing the mould and extracting the product (piercing). Over the mould parting plane no rust is formed as the mould parts remain tightly closed until it is filled with melt. Therefore no additional machining of the finished product is required. Surface quality, optical and mechanical properties of the products are not inferior to those obtained by industrial moulding equipment.

Thus obtained disc and other parts for working elements of cotton machines and mechanisms are packed in polyethylene or paper bags or stacked in trolleys for finished product sample 17. In the second option, polymeric binder and fillers, as in option I, are fed from the containers 1 and 2 in batchers (weight batchers) 3 and 4, where the initial components of the mixture are dosed in a certain ratio. Then, from dispenser 3 polymer granules are fed into the mixer 5, and from dispenser 4 fillers go to the mixer 6. After

mixing the fillers, passing through the feeder 8, enter the mechanoactivator 7 (the speed of the working body $V = 1500$ rpm), where they are mechanoactivated and grinding of the material to a size of 5-50 microns.

Then, powdered polymer binder from batcher 9 and mechanically activated fillers passing through batcher 10 simultaneously enter the extrusion mixer with heating 11. Subsequently, the mixture of compositions from the mixer 11 is fed into the packaging container 12 or directly into the shredder 13 (rotational speed of the working body $V = 2800$ rpm), where it is loaded into the hopper of the casting machine 15, where it is cast in the mold 16. Sheet discs made of antifriction and antifriction-wear composite materials are produced by injection moulding, which ensures process stability, accuracy of the required dimensions and high quality products that do not require additional machining. In addition, injection moulding makes it possible to manufacture a large variety of complex workpieces for cotton processing machines with smooth and curved surfaces. A distinctive feature of this technology is the use of mechanical activator for mechanoactivation of mineral fillers, allowing to obtain finely dispersed particles of fillers. As noted in the papers, the mechanoactivation mechanism in the treatment of mineral fillers in the mechanoactivator occurs in the shock-grinding-grinding mode, mainly due to changes in the particle size distribution and improvements in the specific and adsorption surface of the dispersed particles, as well as the formation of reactive active centres, contributing to improved interfacial interactions, which have a significant impact on the physical-mechanical and tribotechnical properties of the polymeric compositions. Mechanical activation is regarded as an effective method for increasing the reactivity of the components of a mixture of compositions. During mechanical activation of components the change in properties is due to both the production of highly dispersed particles with increased specific surface area and surface energy, and the formation of defects in the polymer structure in solids, as well as an increase in specific surface activity. The surface changes are manifested by the creation of active point centres, which contribute to an increase in the sorption capacity of a unit surface.

4. CONCLUSION

The results of analyzing the characteristics of modified polypropylene and polyethylene compositions demonstrate that the complex of antifriction-wear-resistant properties (AIPPK) and anti-friction wear-resistant polyethylene compositions (AIPEC) improves when mechanically activated mineral fillers, such as talc, kaolin, wollastonite, graphite, and soot, are used. These fillers have developed specific surface area and adsorption properties. Physico-mechanical and tribotechnical properties of antifriction and antifriction-wear-resistant compositions and coatings on the basis of local raw materials polyethylene and polypropylene for application in parts of rubbing pairs of working bodies of machines and mechanisms, working in conditions of interaction with fibrous mass-cotton raw materials are resulted.

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