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Technology of Producing Parts from Thermoplastic Polymers and their Properties

Yusupov Oybek G'ofir o'g'li, Makhmudov Shokhrukh Sadridin o'g'li

Master

Eshkobilov Olim Kholikulovich

Doctor of Technical Sciences

***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.*

Introduction

It is known that one of the most common methods of processing thermoplastic polymers and composites made of them is the injection moulding method, which has a number of advantages over other processing methods. Despite the obvious advantages of this method, the use of industrial casting equipment in the manufacture of prototypes and small batches of parts is inexpedient because of the need to manufacture complex tooling for molding parts of composite polymeric materials (CPM), leading to higher costs of parts and inefficient use of casting equipment, making this method of processing unprofitable.

2. Methods

In some prototype or small batch applications, simpler, more affordable machining methods are used for machining plastic parts. It is true that machining can often be cheaper than injection moulding when producing small batches of parts. However, this method has low productivity and high cost, and is inefficient in the manufacture of small batches. The non-pressure forming method is less labour-intensive and makes it possible to manufacture products with complex shapes. However, the range of

materials suitable for this process is limited to epoxy resins and compounds.

In this connection we have developed flexible technology for production of prototypes and small batches of parts from local raw materials on the basis of thermoplastic polymers polyethylene and polypropylene, processed by injection moulding and technological regulations for their production.

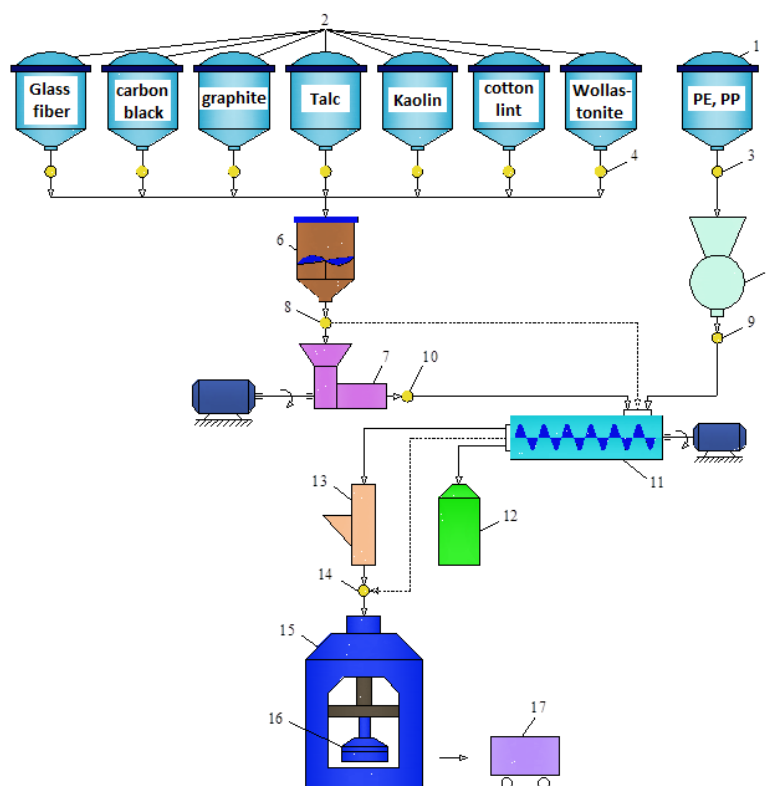
On the basis of the analysis of possibilities of various methods of CPM processing we have chosen a method of injection molding based on thermoplastic polymers. The chosen processing method makes it possible to produce parts with specified properties and sizes without using expensive industrial casting equipment.

3. Results and Discussion

Figure 1 shows the developed technological line for production of composite polymeric materials and casting from them disk samples and parts for study of their physical and mechanical properties, and also products for working elements of cotton machines.

Parts made of thermoplastic polymeric composite materials (CPM) have become an integral part of working elements of various machines and mechanisms, operated in conditions of frictional interaction with fibrous mass (raw cotton). Wide assortment of developed antifriction and antifriction-wear composite materials allows to make parts with the set physical-mechanical and tribotechnical properties.

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 mould tooling (moulds) is simple to design and manufacture and does not require significant manufacturing costs. This makes it possible to put the tooling into operation in a short period of time and significantly reduce the cost of products.

Let's illustrate possibilities of the developed technological line by stages of technological process of production of composite polymeric materials and manufacturing of sheet disks for tribometer. The technological process of production of composite polymeric material is carried out by the continuous scheme.

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. В соответствии с работами, свойства композиций, наполненных механоактивированными добавками, в значительной степени определяются прочностью связи полимера с частицами наполнителя, конформацией и плотностью упаковки макромолекул полимера в абсорбционном слое, характер которого изменяется механоактивацией наполнителей, одновременно сочетающей механические и химические воздействия.

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 obtained results of studying the properties of modified polypropylene and polyethylene compositions show that when using mechanically activated mineral fillers - talc, kaolin, wollastonite, graphite and soot, which have a developed specific surface area and adsorption properties, interfacial interactions with the polymer increase, leading to an improvement in the complex of antifriction-wear-resistant properties. Polypropylene compositions (AIPPK) and anti-friction wear-resistant polyethylene

compositions (AIPEC).

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 in tables 1-2.

Table 1 Physical and mechanical properties of antifriction compositions based on thermoplastic polymers

Composite property values	Antifriction polymer compositions based on polypropylene and polyethylene			
	APC-1	APC-2	APC-1	APC-2
Breaking bending stress, σ , MPa	85,7	88,4	33,4	35,5
Impact strength, a , J/m ²	91,3	94,2	17,5	21,3
Brinell hardness, HB, MPa	76,2	78,9	55,1	58,4
Modulus of elasticity at bending, E, GPa	1,75	1,80	0,62	0,65

Table 2 Physical and mechanical properties of antifriction and wear-resistant compositions based on thermoplastic polymers

Composite property values	Antifriction and wear-resistant polymer compositions based on polypropylene and polyethylene			
	AIPPK-1	AIPPK-2	AIPEC-1	AIPEC-2
Breaking bending stress, σ , MPa	92,5	93,3	40,9	37,8
Impact strength, a , J/m ²	101,5	103,7	27,3	23,0
Brinell hardness, HV, MPa	72,3	73,8	51,5	49,3
Modulus of elasticity at bending, E, GPa	1,65	1,70	0,75	0,71

In addition, the developed technological line can process other polymer materials (high and low density polyethylene, polypropylene, and polyamide, polystyrene) by direct injection moulding. These products successfully compete in terms of price and quality with similar products manufactured by other polymer processing methods.

References

1. Негматов С.С. Технология получения покрытий. - Ташкент, 1975. - 231 с.
2. Negmatov S.S., Abed N.S., Gulyamov G., Eshkobilov O.Kh. Features of contact interaction of anti-friction-wear-resistant polypropylene composite materials with raw cotton // Ra journal of applied research, –India, 2021. Vol. 07 Issue 11. –P. 2672-2679. DOI:10.47191/rajar/v7i11.09.
3. Negmatov S.S., Abed N.S., Gulyamov G., Eshkobilov O.Kh. Technologies for the production of machine-building composite polymer materials and coatings working in contact with raw cotton // International journal of multidisciplinary research and analysis, –California: USA, 2021. Vol. 04 Issue 11. –P. 1685-1690. DOI: 10.47191/ijmra/v4-i11-32, Impact Factor: 6.072.

DOI: <https://doi.org/10.47059/revistageintec.v11i2.1721>

4. Негматов С.С., Абед Н.С., Гулямов Г., Эшкobilов О.Х., Тухташева М.Н. Методика определения величин электростатических зарядов и температур, возникающих в зоне трения в трибосистеме «композит-волоконистые материалы» // Композиционные материалы, – Ташкент, 2019. –№1. –С. 79-81.
5. Негматов С.С., Абед Н.С., Гулямов Г., Эшкobilов О.Х. Исследование влияния углеродистых и волоконистых наполнителей на антифрикционные свойства полиолефинов // Инновационные технологии, –Карши, 2019. –№3. –С. 22-26.
6. Negmatov S.S., Abed N.S., Gulyamov G.G., Eshkobilov O.Kh. Physico-chemical interactions of polymers with mineral, carbon and fibrous fillers // International Journal of Advanced Research in Science, Engineering and Technology, –India, 2020. –Vol. 7, Issue 11. –P. 15499-15504.
7. Негматов С.С., Абед Н.С., Гулямов Г., Эшкobilов О.Х., Тухташева М.Н. Экспериментальное исследование влияния волоконистых наполнителей на антифрикционные, износостойкие, технологические свойства полиолефинов // Композиционные материалы, –Ташкент, 2020. –№1. –С. 125-128.
8. Негматов С.С., Абед Н.С., Гулямов Г., Эшкobilов О.Х., Тухташева М.Н. Исследование прочностных свойств антифрикционных антистатически-теплопроводящих композиционных материалов на основе полиолефинов // Инновационные технологии, – Карши, 2020. –№4. –С. 33-37.
9. Негматов С.С., Абед Н.С., Эшкobilов О.Х. Конструкционные материалы для деталей рабочих органов хлопкоперерабатывающих машин и механизмов // Современные материалы, техника и технологии, –Курск, 2021. – №1, –С. 14-22.
10. Negmatov S.S., Abed N.S., Gulyamov G., Eshkobilov O.Kh., Tukhtasheva M.T. Development of a disc tribometer and determination of its optimal parameters and modes of contact interaction of composites with raw cotton // International Journal of Mechatronics and Applied Mechanics, – Румыния, 2021. Issue 10, Vol. 1 –P. 214-221.
11. Негматов С.С., Абед Н.С., Гулямов Г., Эшкobilов О.Х. Устройства для изучения комплексных антифрикционных свойств машиностроительных композиционных полимерных материалов при взаимодействии с хлопком-сырцом // Universum: технические науки, –Москва: Издательства «МЦНО», 2021. –№11(92). DOI - 10.32743/UniTech.2021.92.11.12612.
12. Negmatov S.S., Abed N.S., Gulyamov G., Eshkobilov O.Kh. Features of contact interaction of anti-friction-wear-resistant polypropylene composite materials with raw cotton // Ra journal of applied research, –India, 2021. Vol. 07 Issue 11. –P. 2672-2679. DOI:10.47191/rajar/v7i11.09.
13. Negmatov S.S., Abed N.S., Gulyamov G., Eshkobilov O.Kh. Technologies for the production of machine-building composite polymer materials and coatings working in contact with raw cotton // International journal of multidisciplinary research and analysis, –California: USA, 2021. Vol. 04 Issue 11. –P. 1685-1690. DOI: 10.47191/ijmra/v4-i11-32.
DOI: <https://doi.org/10.47059/revistageintec.v11i2.1721>.
14. Негматов С.С., Абед Н.С., Гулямов Г., Эшкobilов О.Х., Тухташева М.Н. Antifricition-wear-resistant composite polymer materials for engineering // International conference on integrated innovative development of Zarafshan region. Achievements, challenges and prospects: Матер. Междун. научно-практ. конф. –Navoiy: НКИ, 2019. –С. 262-265.

15. Негматов С.С., Гулямов Г., Эшкobilов О.Х., Даминов Л.О. Антифрикционно-износостойкие композиты для автомобиле и тракторостроения // Автомобиле- и тракторостроение: Матер. Междун. научно-практ. конф. –Минск: БНТУ, 2019. –С. 28-31.
16. Negmatov S.S., Abed N.S., Gulyamov G., Eshkobilov O.Kh. Features of contact interaction of composite polymer materials with raw cotton in the process of friction // Integration, Partnership and Innovation in Construction Science and Education: VII International Scientific Conference - IPICSE 2020. IOP Conference Series: Materials Science and Engineering. –Tashkent, ТИАМЕ, 2020. –Vol.1030. DOI: 10.1088/1757-899X/1030/1/012172.
17. Эшкobilов О.Х., Негматов С.С., Абед Н.С., Гулямов Г. Современный метод и устройство для определения антифрикционных свойств композиционных полимерных материалов // Новые функциональные материалы, современные технологии и методы исследования: Матер. VI Респуб. научно-техн. конф. молодых ученых. –Гомель, ИММС НАН Беларуси, 2020. –С. 169-171.
18. Abed N.S., Gulyamov G., Eshkobilov O.Kh. Tuhtasheva M.N. Engineering composite materials for the cotton processing industry // Construction Mechanics, Hydraulics and Water Resources Engineering: International Scientific Conference CONMECHYDRO–2021. –Tashkent, ТИАМЕ, 2021. DOI: 10.1051/e3sconf/202126405053.
19. Eshkobilov O.Kh. Gulyamov G. Composite polypropylene polymer materials that work in contact with raw cotton // Construction Mechanics, Hydraulics and Water Resources Engineering: International Scientific Conference CONMECHYDRO–2021.
DOI: 10.1051/e3sconf/202126405055.
20. Negmatov S.S., Abed N.S., Eshkobilov O.Kh., Ulmasov T.U. Investigation of the process of electrification of composite polymer coatings in the case of frictional interaction with the fibrous mass // International conference on problems and perspectives of modern science ICPPMS–2021. – Tashkent, ТИМЕ, 2021.
21. Negmatov S.S., Abed N.S., Gulyamov G., Eshkobilov O.Kh. Anti-friction-wear-resistant composite polypropylene materials working in conditions of contact with raw cotton // Композиционные материалы на основе техногенных отходов и местного сырья: состав, свойства и применение: Межд. научно-техн. конф. –Ташкент, ГУП "Фан ва тараккиёт", 2021.