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FEATURES OF POLYPROPYLENE MODIFICATION FOR FILM THREAD MANUFACTURING

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ABSTRACT

The article discusses various methods for modifying polypropylene. Compositions have been developed that have improved physical and mechanical characteristics and have an optimal composition for the production of thin oriented products. A comparative analysis was carried out for various indicators: melt flow rate, ultimate strength, deformation, activation energy of thermo-oxidative destruction. Industrial approbation of some compositions has been carried out.

KEYWORDS: *Polypropylene, Composition, Approbation, Deformation.*

INTRODUCTION

Polypropylene belongs to the class of polyolefins and is a synthetic thermoplastic non-polar polymer. It is a white solid that is industrially obtained by the polymerization of propylene. Polymerization is carried out at low and medium pressures in the presence of organometallic catalysts. Polypropylene is produced stabilized, dyed or unpainted. Polypropylene is a plastic material that is highly resistant to repeated bending and impact. It is also characterized by wear resistance and good electrical insulating properties over a wide temperature range. It has a gloss and good transparency, is chemically resistant and does not crack when exposed to the environment.

Polypropylene is characterized by a more complex molecular structure compared to most industrially produced polymers, since, in addition to the chemical composition of the average molecular weight monomer and molecular weight distribution, its structure is influenced by the spatial arrangement of the side groups with respect to the main chain. In technical terms, the most important and promising is isotactic polypropylene. Depending on the type and ratio of the stereoisomers present, the properties of polypropylene vary over a wide range [1].

By the type of molecular structure, three main types of polypropylene can be distinguished: isotactic, syndiotactic and atactic. Isotactic and syndiotactic polypropylenes are referred to as stereoregular polymers. Isotactic polypropylene is a polymer in which the methyl groups are directed to one side of the imaginary plane of the main chain; syndiotactic - methyl groups alternate strictly; atactic - methyl groups are randomly located. Depending on the molecular weight and isotactic content, the properties of polypropylene can vary over a wide range. Of greatest industrial interest is polypropylene with a molecular weight of 80,000–200,000 and an isotactic content of 80–98%.

Due to its crystal structure, stereoregular polypropylene retains good mechanical properties and shape up to the melting point. Effective expansion of the brand assortment of polymeric materials is achieved due to their directed modification, which makes it possible to significantly improve their technological and operational properties, to create new types of products for new areas of application, including in more severe operating conditions [2].

Modification of polymers should be understood as a purposeful change in their properties by carrying out chemical reactions on the functional groups present in the polymer, or by changing its supramolecular structure.

This definition logically implies the division of polymer modification into chemical and structural.

Chemical modification of polymers consists in a directed change in the properties of the polymer by conducting interactions of the polymer macromolecules with low- or high-molecular substances - modifiers [3].

Chemical modification includes several varieties.

1. Reactions not accompanied by a change in the degree of polymerization of macromolecules (polymer-analogous transformations and intramolecular reactions). Intramolecular reactions occur with the participation of functional groups or atoms belonging to the same macromolecule. Often, as a result of such reactions, sufficiently heat-resistant polymers with a system of conjugated double bonds or polymers with intramolecular cycles are formed.

The introduction of a small number of units of a different nature into the composition of macromolecules at the stage of their synthesis can lead to significant changes in the properties of the polymer material. Monomers containing a peroxide or hydroperoxide group, unsaturated derivatives of dyes, stabilizers, physiologically active substances, etc., are used as modifying agents. When using the chemical modification method, it is possible to obtain polymer materials in one stage in which all components, including poor compatible with the polymer, are bound to its macromolecules by strong covalent bonds. This prevents the release of components on the surface of polymers during their processing and use.

1. Reactions leading to an increase in the degree of polymerization.
2. Reactions during which the degree of polymerization decreases.

Structural (physical) modification of polymers is a directed change in the physical and mechanical properties of polymers by modifying their supramolecular structure under the influence of physical factors. The physical modification of polymers does not change the chemical structure of macromolecules.

One of the methods of structural modification is polymer orientation, which is achieved by stretching the polymer body. The simplest and most common orientation for linear polymers is uniaxial orientation. As a result, chain macromolecules, chaotically (statically) oriented in the original body, under the influence of an external directional stretching effect, acquire one or another degree of orientation. In an amorphous flexible-chain polymer, the oriented state is non-equilibrium and, in order to fix it, it is necessary to cool the polymer below the glass transition temperature without removing the tensile stress. In the case of flexible-chain crystallizing polymers, the oriented state can be considered equilibrium below the melting point of the crystallites, and the removal of the tensile stress at the drawing temperature does not lead to misorientation, since the crystallites form an oriented framework that preserves the amorphous regions of the polymer body in the oriented state.

Physicochemical modification can be distinguished as a separate type, in which a physical effect on a polymer entails a change in the chemical structure of macromolecules. In this case, as a rule, the physical structure of the polymer also changes, which manifests itself in the rearrangement of supramolecular formations.

Modification of industrial polymers is widely used to obtain polymer materials with improved properties. The introduction of small amounts of polymer additives has become widespread. At the same time, there is a complex effect of additives on the structure and properties of polymers.

The introduction of the modifier can be carried out both during the synthesis process and during the processing of polymers. With the introduction of small amounts of modifiers, the physical and mechanical properties of the material increase, the durability increases, and the performance of plastic products increases. In addition, the reduction and stabilization of viscosity due to modification improves the processability of materials at the stage of forming products, increases productivity and reduces equipment wear [4].

Main part. The work investigated compositions based on polypropylene, to which various modification methods were applied. Specimens were made by injection molding; the rheological and physical-mechanical characteristics of the material were assessed by the existing methods. Polypropylene of the PPG1035-08 grade (TU 2211-008-50236110-06) was used as a base polymer in the work, and polyamide of the Grodnamid PA6-L-U1 grade was used as a modifier. According to the production regulations, it is necessary to introduce a chalk additive, therefore, compositions containing chalk and also without chalk were made. This was necessary to assess the interaction of the chalk with the modifier.

Based on the listed requirements for thermal stabilizers, a choice was made from three thermal stabilizers of different classes: phenolic type Hostanox 03 Pills, phosphite type Sandostab-P-

EPQ, complex type Kretilen. In fig. 1 shows the structural formula of Hostanox 03 Pills. It consists mainly of ethylene-1,2-bis (3,3-bis (4-hydroxy-3-tert-butyl-phenyl) -butyrate).

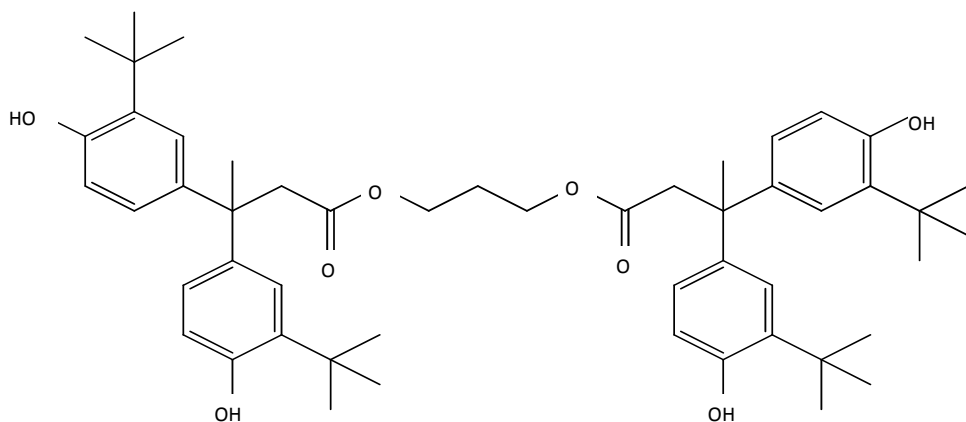


Fig .1. Structura formula H ostanox 03 Pills

Sandostab-P-EPQ is used for thermal stabilization of polymers, especially polyolefins and polycarbonates. Sandostab P-EPQ consists mainly of a phosphonite of the formula tetra- (2,5-di-tert-butyl-phenyl) -4,4-diphenylene diphosphonite (Fig. 2).

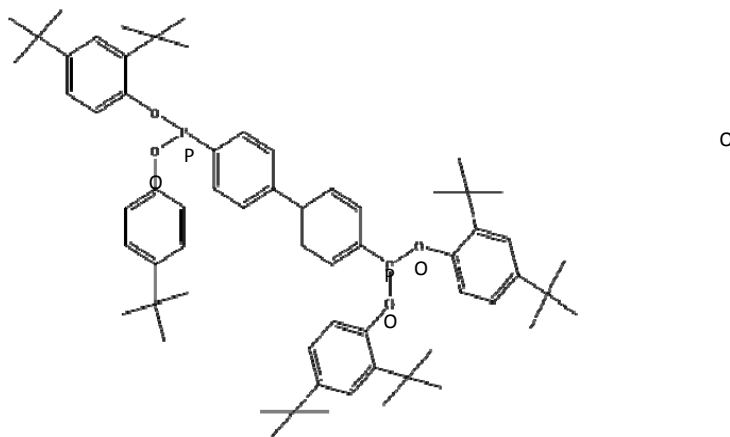


Fig. 2. Structural formula of Sandostab-P-EPQ stabilizer

Based on the analysis of scientific literature, we came to the conclusion that it is necessary to use a complex stabilizer [5]. The thermal stabilizer, known under the trademark "Kretilen" PP AO 15 (TU 2243-001-796831892009), has the necessary qualities and is also more affordable compared to its counterparts. This thermal stabilizer is a synergistic mixture of phenolic and phosphite type stabilizers. Has a complex effect and protects the polymer from thermal oxidative degradation during processing by extrusion and during the operation of products from it at elevated temperatures. Has some UV protection. To date, such mixtures are the most effective.

An important characteristic of a polymeric material is its supramolecular structure. Crystal size control allows you to adjust the basic physical and mechanical characteristics of the material. Substances that can change the supramolecular structure are called nucleators. The introduction of a nucleator leads to the formation of a more perfect crystal structure (it increases the number

of crystallization centers and thereby reduces the size of crystalline formations). Under the action of nucleators, the size of crystalline formations becomes less than the length of the visible light wave. The described effect leads to an increase in the heat resistance of polypropylene by 12–15 ° C. As a rule, the active substance in the composition of nucleator concentrates are salts of organic acids: sodium benzoate, potassium benzoate, sodium naphthenate; in addition, finely dispersed powders of silica, talc, quartz, kaolin and other mineral compounds are used. Therefore, in some compositions, a P0023 / 22-PP nucleator was used.

It follows from the results of rheological tests that the modified polypropylene has a lower MFI. Values range from 3-4 g / 10 min. These are optimal values for the extrusion process, but they are also suitable for injection molding processes.

The resistance of the developed compositions to thermal oxidative destruction can be estimated based on the values of the activation energy of thermal oxidative destruction (E_d). Calculations were made according to [6].

The values of the activation energy indicate that the composition of the composition: polypropylene, nucleator 1 wt. %, stabilizer 1 wt. %, dye \approx 0.1 wt. %, has a higher value of the activation energy of thermal oxidative destruction. This means that the potential barrier to the destruction reaction increases. Products made from this composition should have improved physical and mechanical characteristics, and the service life should also increase.

The values of physical and mechanical characteristics confirm that some compositions are superior to primary polypropylene in these indicators.

Then, under production conditions at the SPO Khimvolokno enterprise, an oriented thread was made from the developed compositions and physical and mechanical tests were carried out.

The mechanical properties of polyolefins vary over a very wide range. The properties of products made of polymeric materials differ from those of the initial isotropic polymers in that, as a rule, the properties of products are not the same in different directions. The filaments have the greatest modulus in the direction of stretching, the films - in the plane of the surface.

Physical and mechanical characteristics of polypropylene yarn

| Composition of the composition | Specific strength, S_N / tex | Specific thickness, tex | An effort, H | Deformation, % |
|--|--------------------------------|-------------------------|--------------|----------------|
| Primary polypropylene, chalk 3 wt. % (according to TU BY 400031289.169) | 48,2 | 93 | 45 | 22,8 |
| Polypropylene, stabilizer 1 wt. %, polyamide 3 wt. %, chalk 3% wt. | 49 | 112 | 54,88 | 19 |
| Polypropylene, stabilizer 1 wt. %, dye \approx 0.25 wt. %, nucleator 1 wt. % | 49,9 | 45,6 | 23,2 | 90 |
| Polypropylene, polyamide ($\phi = 0.15$) 3 wt. %, stabilizer 1 wt. %, dye \approx 0.25 wt. % | 51,5 | 42 | 22,7 | 80 |

The table shows the results of physical and mechanical tests of polypropylene yarns from the developed compositions. All strength indicators fit into the regulations for the production of polypropylene yarn. However, it should be noted that when using undried polyamide during the production of the film, frequent breaks of the web are observed. We assume that the moisture contained in the polyamide interacts with the chalk additive during processing, which leads to a strong heterogeneity of the material. Further, when orienting the polypropylene thread, it breaks. Drying the polyamide eliminates frequent film breakage. When using dried polyamide, the film is uniform in thickness.

CONCLUSION

The use of complex stabilizers in the composition has shown its effectiveness. The use of a nucleator leads to the formation of a finer crystal structure, which is confirmed by the values of the activation energy of thermooxidative destruction ($E_d = 157.7$ kJ / mol) and an improvement in the strength parameters of the polypropylene thread.

The use of polyamide leads to an increase in the strength characteristics of products made by casting, however, an increase in the physical and mechanical characteristics of the thread is not observed.

The introduction of a chalk additive into the composition is necessary to control shrinkage and prevent the formation of crazes during thread orientation.

All the compositions obtained correspond to the NLA for a thin oriented polypropylene thread. The developed compositions are supposed to be used in the production of oriented film thread intended for the production of woven bags.

LITERATURE

1. White, J. L. Polyethylene, polypropylene and other polyolefins / J. L. White, D. D. Choi; lane. in English, ed. E. S. Cobcallo. - СПб .:
2. Profession, 2006. - 256 p.
3. Teraoka, I. Polymer Solutions: An Introduction to Physical Properties / I. Teraoka. – Brooklyn, N.Y.: John Wiley & Sons, Inc., 2002. – 349 p.
4. Paul, DR Polymer mixtures: in 2 tons /
5. D. R. Paul, C. B. Bucknell; per. from English ed. V. N. Kulezneva. - SPb .: Scientific bases and technologies, 2009. - T. 2: Functional connections. - 606 p.
6. An effective approach to the creation of modern polymer composite materials / E. L. Kalinchev [and others] // Polymer materials. - 2008. - No. 3. - P. 4–14.
7. La Mantia, F. Recycling of plastics / F. La Mantia; per. from English ed. G.E. Zaikova. - SPb .: Professiya, 2006 .-- 400 p.
8. Polymeric products for construction. Method for determination of durability by activation energy of thermo-oxidative destruction of polymeric materials: STB 1333.0-2002. - Introduction. June 28, 2002. - Minsk: Ministry of Architecture and Construction of the Republic of Belarus, 2002. - 11 p.

9. Plastics. Tensile test method GOST 11262-80. - Introduction. 21.11.80. - M.: USSR State Committee for Standards. - 25 p.
10. Otabek Abdulkarimovich Mirzaev, Shavkat Serabovich Tursunov // Theoretical substantiation of the deformed state of the shell of the feeding cylinder of spinning machines // Oriental renaissance: Innovative, educational, natural and social sciences // 2021.1092-1103 <https://cyberleninka.ru/article/n/teoreticheskaya-obosnovaniya-deformirovannogo-sostoyaniya-obolochki-pitayuschego-tsilindra-priyadilnyh-mashin>
11. T Khankelov, S Tursunov, Z Maksudov // Domestic Solid Waste Crusher // International Journal of Psychological Rehabilitation 24 (issue 07), 8090-8096 [psychosocial.com/article-category/issue](https://www.psychosocial.com/article-category/issue) <https://www.psychosocial.com/article/PR270784/18957/>
12. Tavbay Khankelov¹, Zokir Maksudov^{1*}, Nafisa Mukhamedova¹ and Shavkat Tursunov² // Crushing and screening complex for the production of compost from organic components of municipal solid waste // Interaction of Materials Resistance Science With Other General-Military Disciplines In Engineering Specialties // 2021. https://www.e3s-conferences.org/articles/e3sconf/abs/2021/40/e3sconf_conmechhydro2021_01026/e3sconf_conmechhydro2021_01026.html
13. OliyaNurova Salomovna¹, AsrorNazarov Allanazarovich², TursunovShavkatSerabovich // Interaction of Materials Resistance Science With Other General-Military Disciplines In Engineering Specialties // <https://www.annalsofrscb.ro/index.php/journal/article/view/5911>
14. TursunovShavkatSerabovich // Analysis of existing designs of crushers for crushing municipal solid waste// International Journal for Innovative Engineering and Management Research(IJIEMR) // <https://scopedatabase.com/documents/00000181/00000-84600.pdf> // 2021