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The Modified Fibrous Material on the Basis of Polyethyleneterephthalate and Metal / Carbon Nanostructures

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Results of theoretical justification and experimental receiving a fibrous material on the basis of the polyethyleneterephthalate, modified metal/carbon nanostructuresare, presented in article. Possibility of receiving the polymeric fibers possessing the increased durability and sorption ability in comparison with not modified fibers is established.

Keywords: Polyethyleneterephthalate, Polymeric fibers, Metal / carbon nanostructures, Modification.

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1. THEORETICAL PART

Perspective way of utilization of polymeric waste is their processing in a fibrous material as a result swelling of streams of the melted raw materials the air stream directed through the swelling device. In this case all production operations are carried out on one unit with the minimum harm for environment [1]. For improvement of operational characteristics of fibrous materials (sorption ability, durability), giving of new properties to them (an electromagnetic susceptibility, assignment of a static charge) and as the stage of modification of intermediate fusion by nanostructures is offered to include expansions of area of industrial application of this technology.

The most perspective direction of use of the received fibrous materials is collecting oil spills and oil products, their separation from water. Use of polymeric fibers practices in this area long ago, however, modification of fibers by nanostructures does them by more effective in comparison with available analogs [2]. Thus the product can be executed in the form of mats which spread directly on oil spill or in the form of standard the filter cartridges, used as a part of constructions on sewage treatment. For separation of oil from a sorbent it is possible to use an extraction in rolls or processing in centrifugal installation. After that the sorbent can be used again. After the fibrous material will become useless, it utilize as a reinforcing additive when making roads.

Object of research of the real work is process of modification of thermoplastic polymers by nanostructures. As thermoplastic polymer within our research polyethyleneterephthalate (PETF) is chosen. It is thermoplastic polyair of p-phthalic acid and ethylene glycol with a molecular formula $[–CH_2–CH_2OC(O)–Ar–C(O)O–]_n$ and with the temperature of melting of 250-265 °C. As secondary raw materials the crushed plastic bottles from PETF were used. As nanostructures it is offered to use metal / carbon nanocomposites (production of JSC IEMZ KUPOL). For example, it is established that the carbon cupriferous nanocomposite contains copper with impurity of oxides one – and bivalent copper. The average size of nanoparticles corresponds 25 nm. Nanoparticles are located in the carbon nanofilm structure formed by carbon nanofibres, associated with a metal phase.

From existing methods of introduction of a filler in structure of a polymeric matrix - polymerization in the presence of an additive, additive introduction in polymer solution, additive introduction in polymer fusion – the last is the most acceptable in the conditions of processing of fusion of PETF by a way of swelling. For hashing of structure extruders and mixers are used.

For theoretical justification of possibility of modification of PETF with copper/carbon nanocomposite carried out quantum-mechanical modeling of process of their interaction in the computer program HyperChem v. 6.03. As a result of calculations it is established that the critical increase in length of communications in components of system isn't present, that speaks about lack of a rupture of any communications (chemical reactions doesn't proceed). Interaction copper/carbon nanocomposite and PETF is limited to coordination forces, it isn't expected chemical destruction of components, PETF modification with the help copper / carbon nanocomposite is possible.

2. PRACTICAL PART

For modeling of processes of modification of polyethyleneterephthalate with metal/carbon nanocomposite the experimental stand consisting of the compressor, a reducer with the manometer, systems of adjustment of supply of the compressed air in a swelling head, a temperature regulator, a support, the melting camera, a mixer with the electric drive and a swelling head was assembled. The general view of installation is presented in fig. 1.

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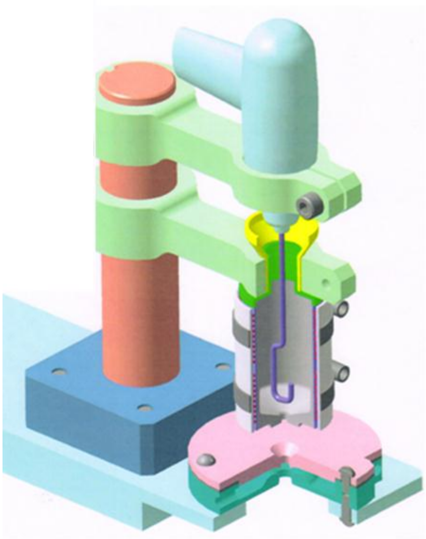

Fig. 1 – General view of installation for modeling of processes of modification of polyethyleneterephthalate with metal / carbon nanocomposite

The crumb of polymer is loaded into the melting camera. Under control of the regulator of temperature equipped with the thermocouple, heating and temperature support at the level necessary for receiving fusion of PETF (about 280 °C) is carried out. After polymer fusion in fusion bring powder of copper/carbon nanocomposite and carefully mix. After that include supply of the compressed air to a swelling head and open the opening gate in day of the melting camera. The following stream of fusion gets to an opening of a swelling head where occurs it having inflated and splitting on thin fibers. Samples with various maintenance of an additive percentage of weight are so received: 0; 0,1; 0,3; 0,5; 0,7; 1; 3; 10 %.

In structure of fibers various defects (furrows, variable diameter, etc.) which increase a specific surface of fibers are found. Existence of defects is explained by features of crystallization of fusion in the presence of an additive. That is nanostructures act as the crystallization centers, that leads to emergence of tension in being formed fiber of small diameter. Important feature of fibers with the maintenance of an additive 0,7 and, especially, 0,1 % of the lump of fusion is their "fluffy" surfaces, as a result of formation of thinner fibrils on a surface of the main fiber (fig. 2).

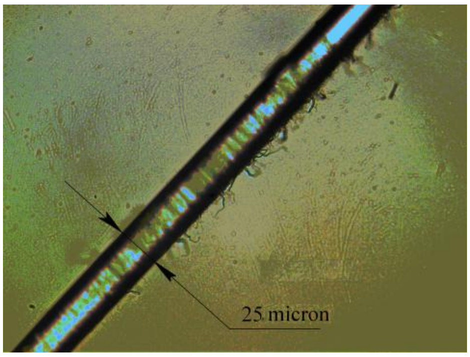

Fig. 2 – Defects of the modified fibers: "fluffy" surfaces of main fiber

Probably, at the specified maintenance of an additive, the blanket of already created fiber remains liquid some time, sufficient for formation of secondary fibrils in the crystallization centers in the form of nanostructures. This feature of structure of fibers has to promote growth of their specific surface and sorption ability.

At tensile strength research separate fibers hooked on the arm established on scales, and gradually loaded to a gap. Further loading in sN / mc^2 was calculated. It is established that the greatest tensile strength 112 sN / mc^2 fibers from additive shares $\omega = 0{,}7$ % of fusion lump, that is 22 times more than durability of a control sample possess.

Research of sorption ability of fibers, according to their basic purpose, carried out in relation to the oil cleared of foreign inclusions in the gravimetric way. It is established that the fibers containing nanostructures in quantity $\omega = 0{,}5\text{-}0{,}7$ % of lump of fusion, possess the sorption ability increased in 1,5-2 time in comparison with a control sample without additives. At the big maintenance of an additive sorption ability falls that is explained by process violation swelling as a result of agglomeration of nanostructures in fusion. Growth of sorption ability of the modified fibers is explained by increase in their specific surface owing to formation of defects.

3. CONCLUSIONS

Modification of fibers of polyethyleneterephthalate with copper / carbon nanostructures opens new opportunities to improvement of their properties. Further it is necessary to solve a compromise problem: to provide the maximum sorption ability of a material and durability, sufficient for a repeated extraction of fibers and their reuse.

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