Abstract for PhD work

"Chemical foundations for polyesters recycling"

The relevance of the work. Polyethylene terephthalate (PET) is one of the most used polymer materials in the world. The main directions of its use are food (beverage containers) and textile (polyester fibers) industry. Due to their structure, such materials are characterized by high chemical resistance and practically do not decompose in the environment. As a result, thousands of tons of waste PET form man-made islands in the seas and oceans, or man-made mountains of garbage on the earth. Under the environmental conditions such materials do not decompose, but are physically crushed with formation of microplastic that penetrate into the soil, glaciers and aquifers, and then transfer into the human body and animals. To solve this problem, many countries are developing the use of waste PET as a feedstock for the production of valuable chemicals or materials. There are several main directions of PET recycling: physico-mechanical, thermal and chemical. Due to the relative simplicity, mechanical recycling methods have become the most widespread, but they decreased the properties of the secondary polymer, which significantly reduces the number of available applications of such materials. At the same time, chemical recycling of PET waste makes it possible to obtain pure chemical compounds of various structures that can be used to produce polymers with the required properties.

At the same time, as part of the development of "green chemistry", the production of fatty acids methyl esters (FAMEs) is gaining popularity. These compounds are used as diesel fuel obtained from renewable sources (biodiesel). The main waste of such production is a crude glycerol, which is a mixture of related products - glycerol, potassium or sodium salts of fatty acids, water. Often, it also includes FAMEs and methanol. Due to its multicomponent nature, utilization and further use of crude glycerol are difficult. This problem reduces the economic efficiency of biodiesel production.

Thus**, the relevance of this work** is already emphasized in the very title of the work – " **Chemical foundations for polyethers solid waste recycling** "

The main advantage of alkaline glycolysis is the possibility of PET recycling under relatively mild conditions (at atmospheric pressure) and without expensive catalysts, which are sensitive to foreign impurities. In addition, due to the use of polyols of various structures, it is possible to control the structure of the resulting products. The peculiarity of this study is using another difficult–to-regenerate secondary product - the so-called "crude glycerol", a waste of the alcali catalytic production of fatty acids methyl esters. This "crude glycerol" contains a large amount of potassium salts of vegetable fatty acids, which turned out to be good agents for solid waste PET depolymerizing. The use of crude glycerol in the processes of depolymerization of polyester waste is also of theoretical and practical interest from the point of view of ecology, efficient use of resources and the creation of energy-saving technologies.

The aim of the work is to develop an effective method of depolymerization of PET solid waste to obtain oligomers with a regulated structure.

To achieve this goal , it is necessary to solve **the main tasks of the work**:

1) To characterize the main products of the interaction of PET with various polyols in the presence of the alkaline catalysts and to develop methods for analyzing the resulting products.

2) To establish the basic regularities of the process of PET saponification by various potassium compounds in the polyols;

3) To study the basic laws of PET depolymerization by crude glycerol obtained during the production of biodiesel;

4) To determine the effect of the composition of polyester feedstock (the presence of dyes and other types of plastics) on the parameters of the process;

5) To create a mathematical description of the process and determine its main parameters.

The scientific novelty of the the research is the development of a method for recycling PET waste with glycerol, as well as analytical techniques that allow regulating the depth of degradation of plastic waste, as well as the structure and molecular weight of the resulting oligomeric products. In addition, for the first time, a mathematical description of the basic physico-chemical laws of PET depolymerization was proposed, taking into account the formation of potassium intercalates between the inner layers of polyester.

Theoretical significance

1. The scheme of destruction of waste PET is established and the composition and structure of the resulting low-molecular products are characterized. With an increase in the molar ratio of PET / K+, an increase in the molecular weight of the products is observed, as well as the appearance of hydroxyl groups in their structure.

2. A mathematical model of the PET saponification by alkaline agents in the environment of polyols of various structures is proposed.

Practical significance

1. The relationship between the degree of transformation of solid PET, the type of saponifying agent and the conditions for depolymerization of polyester (temperature, type of solvent used, amount of saponifying agent, time of the process) has been established. Based on the data obtained, the optimal conditions for PET depolymerization were determined, at which the maximum degree of PET decomposition is achieved - 100%.

2. It is proved that the process is insensitive to the presence of foreign impurities in the reaction mass (dyes, polypropylene).

3. The obtained results and the established regularities between the conditions of PET depolymerization and the composition of the resulting low-molecular products can become the basis for creating a technology for producing new polymer materials.

Confirmation of the practical significance of the work is the receipt of patents of the Russian Federation for the invention RU 2631112 and RU 2754972.