СЕКЦІЯ 5.
ХМІЧНІ НАУКИ

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MODERN STEP INTO FUTURE: BIOPLASTIC

The history of the development of chemical knowledge begins from ancient times, when in the V century BC the ancient Greek philosopher Leucippus was the first to suggest the hypothesis of the atomic structure of matter. Much later, from about the 3rd century AD, the ancient natural-philosophical atomistic doctrine of the structure of matter was opposed to alchemy, a pre-scientific direction that developed in Western Europe in the 11th-16th centuries. The main tasks of alchemy consisted in the search for the so-called “philosopher's stone” to transform base metals into gold and silver, to recreate the elixir of longevity. During the Renaissance, the results of chemical research were increasingly used in metallurgy, glass making, the production of ceramics, paints, etc.

As chemistry developed, many of its branches such as organic chemistry, physical chemistry, analytical chemistry, etc. were formed. Biochemistry, agrochemistry, geochemistry appeared at the junction of chemical and other branches of natural science. The results of chemical research form the basis of many modern technologies [1].

Modern chemistry has reached the level of molecular research, which made it possible to reveal the mechanisms of many processes in a living organism, synthesize substances that do not exist in nature, and decipher the genetic mechanisms of heredity.

The modern theory of chemical processes includes fundamental knowledge of physics, chemistry and biology. The desire of scientists to create laboratories of a living organism, where it would be possible to reproduce chemical processes in biological systems, testifies to the need for an organic relationship between various natural science branches.

Modern chemistry addresses the topic of how atoms and molecules interact through chemical bonds to form new chemical compounds. There are four types of chemical bonds: covalent bonds, in which the compounds share one or more electrons; ionic bonds, in which a compound donates one or more electrons to another compound to form ions – cations and anions; hydrogen bonds; Van der Waals power ties.

Today, energy efficient biotechnologies of environmental protection are gaining momentum. In this direction, the development of technologies for the production of biopolymers and materials based on them using enzyme engineering is relevant.

What plastics can be called biodegradable? According to the type of raw material (fossil or renewable) and the ability of plastics to spontaneously degrade in the environment (in other words, their biodegradation), experts suggest dividing plastics into four groups:

1) non-biodegradable plastics from fossil raw materials: polyethylene, polypropylene, PVC, polyethylene terephthalate (PET), polystyrene, polybutylene terephthalate, polycarbonates, polyurethanes and others;

2) conventionally biodegradable plastics from fossil raw materials – synthetic materials from hydrocarbon raw materials that are capable of biodegradation. These include traditional plastics modified with special additives such as d2w; 3)

3) non-biodegradable plastics from natural raw materials – "classic" plastics such as polyethylene, PVC. The raw materials for them are partially or completely obtained from biomass;

4) biodegradable plastics from natural raw materials [2].

Biopolymers are synthesis products based on sugar, starch, cellulose, lignin, and vegetable oils. According to available calculations, significantly less carbon dioxide is generated during the life cycle of biopolymers – from production to complete decomposition at a landfill or burning as fuel, than in plastics from petrochemical raw materials. Plant-based polymer production is a way to save energy. For example, in comparison with polyethylene, in the production of each ton of bioplastic, energy costs are saved from 12 to 40 GJ. This is understandable, because oil must be extracted, moved to the place of processing, followed by the processes of distillation, cracking, obtaining monomers, synthesis of polymers. All these are quite energy-intensive stages, in contrast to the process of obtaining bioplastics, for example, from corn starch using the fermentation process. In addition, biodegradable plastics from natural raw materials alleviate the problem of burial, composting of plastic waste, in particular container materials that have a very short life cycle and make up a significant part of municipal solid waste. Finally, the development of green technologies contributes to the development of the agro-industrial complex. All this serves as the basis for the rapid growth of interest in biopolymers and biofuels in the world [3].

Thermoplastics, composites and film materials based on starch, cellulose, cellulose ethers have become especially popular. One of the examples is long familiar cellophane. The most promising substitutes for traditional plastics are poly-α-hydroxy propionates – in other words, polymers of lactic acid, polylactates (PL). The monomer for PL production is lactic acid, which is obtained by fermentation of carbohydrates (glucose, sucrose, lactose) or crude raw materials (starch, syrup or whey) using bacteria such as Lactobacillus, Pediococcus, Lactococcus and Streptococcus, as well as some fungal strains such as Rhizopus Oryza. The synthesis of PL from lactic acid can proceed by bulk polycondensation or through the production of lactide and its subsequent ring-opening polymerization. The latter method is more preferable because it allows you to obtain a high molecular weight polylactide. Acceptable mechanical, barrier and aesthetic-hygienic properties of polylactate make it possible to use it as a food container material, practically not inferior in quality to polyethylene terephthalate. Degradable plastics from plant materials are used for the manufacture of film, porous and multilayer packaging for food and cosmetic products, as well as for the production of all kinds of durable goods, auto parts, cell phone cases, and even for the encapsulation and delivery of certain dosage forms.

In conclusion, it should be emphasised that the development of the production of both biologically derived and biodegradable polymers cannot be stopped. Nowadays biopolymers in many areas represent a serious alternative to traditional polymeric materials. The notion that they are not competitive will not hold out for a long time. What is more, they certainly will not become a panacea for all environmental problems. The concept of biopolymers as 100% resource conserving agents is also premature. However, they open up new prospects in the post-oil era.

References:

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