Prospects for the Production of Materials with Biodegradable Properties: the Way to Minimize Environmental Damage in Russian Practice

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Abstract. The prospects for the development of the production of materials with biodegradable properties in Russia are considered, based on an analysis of the situation in Russian practice, with a proposal of possible options for their implementation. The relevance of the study is determined by the importance of the problem and the need to solve it in relation to the organization of the production of materials with biodegradable properties in the conditions of the refusal of the world community from the use of artificial polymeric materials, the disposal period of which is more than 100 years. It is shown that the global market for the production of materials with biodegradable properties has an average growth rate of 20%, which will amount to 2300 million tons by 2027, while the Russian market for biodegradable packaging is no more than 10,000 tons per year. In the future, according to the action plan for the Development of Biotechnologies and Genetic Engineering, the share of biodegradable materials in the total consumption of polymer products in Russia will increase from 10 to 25%, and the share of bioplastics will be about 640,000 tons. A conclusion is made regarding the development of the production of materials with biodegradable properties in Russia, which should be carried out at a pace at the world level, and for this, favorable conditions and a developed infrastructure should be created, focused on promoting own scientific developments and their commercialization in domestic production. The study revealed the technological possibilities of organizing the production of biodegradable materials of natural origin in Russia, which determines the practical significance of this study.

1 Introduction

The problem of environmental pollution is becoming more acute every day, and, unfortunately, it is simply impossible to ignore it today. The trend towards the reduction of resources and their inefficient use can lead to the fact that resources simply will not be enough for a long time.

Modern realities are such that the life of society is threatened by an ecological catastrophe. The growth of industrial production, the inefficient use of non-renewable

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resources, the attitude to nature as a natural environment, have led to the fact that resource reserves have been depleted in some cases to zero. The manufacturing sector, mercilessly using natural resources, does not always care about their purification and reuse, for example, water, which, even after technological purification, remains unsuitable for living organisms to live in it, not to mention drinking it.[1]

The growth of consumer preferences in the service, the accelerated development of civilization and the service sector, and the need to purchase products whose packaging makes products more attractive, the need for plastic packaging as the most convenient, led to the fact that the production of plastic products began to grow year by year, as the needs and the need for it has grown and continues to grow at an accelerated pace. And today, plastic in everyday form has become the main problem associated with its disposal. It should definitely be noted that civilization in its modern form and the benefits created for the convenience of human life cause unjustified and irreparable damage to nature. Let's turn to the numbers: over the past ten years, more plastic bags and products made of polyethylene and plastic have been produced in the world than in the previous 100 years. Clogging, for example, the world's oceans with plastic waste is 80%, a little more and there will be no living creatures in the ocean. The same can be said about the environment, which is already more than half filled with plastic waste, the timing of the decomposition of which has not yet been specified. There are a lot of ways to clean the environment from plastic waste and they are all known, their application and use certainly gives results and to some extent eliminates the negative consequences of polluting nature, but the rates of pollution and elimination do not match, and the process of pollution is faster than the elimination of for increasing production in view of the growth in demand. Ten ways to combat plastic waste and microplastic pollution have been proposed by scientists in Canada, France and Portugal. [2]

But a lot depends on us. If we set the task of not using plastic bags daily, replacing them with reusable products, such as cardboard. The decline in demand may lead to the fact that the production of plastic bags will stop or simply decrease their production. In turn, a decrease in the production of plastic bags can become a point of growth in the production of eco-friendly reusable bags. And although, when making a choice, the consumer will still measure his choice based on the criteria of quality, convenience and price, the option of environmental friendliness is also not excluded, but for this, the culture of the consumer and the culture of purchase must be brought up. This approach is not formed immediately, it is brought up over the years, and is not always implemented, since a real consumer will choose a reasonable combination of price and quality, therefore, in terms of choosing packaging, as not a product, but only a service, the choice will be in the direction of cheapness.

The foregoing leads to the fact that one of the real ways to solve the problem of minimizing environmental damage is the transition to the production of biodegradable materials as an alternative to plastic containers and packaging. [3]

Thus, the solution to the problem of minimizing the damage caused to the environment by organizing the production of materials with biodegradable properties in the modern conditions of the development of civilization in Russia is an urgent task, the solution of which determines the mission of society, which consists in the development of unique biodegradable materials, on the basis of which production is organized. environmentally friendly packaging and other short-term products.

2 Research Methodology

As part of the study, the leading approach has become a systematic approach based on theoretical analysis and synthesis in the area under study. Using statistical and other

Internet materials, an analysis of the possibilities was carried out and the prospects for the development of the production of materials with biodegradable properties were shown as a way to minimize environmental damage in the Russian Federation. The prospects of the studied direction are determined by the time and speed of solving global environmental problems.

3 Results and Discussions

Etiological factors of CHD.

1) Chromosomal disorders (5%). With various chromosomal aberrations, quantitative and structural mutations of chromosomes occur. Aberrations of large and medium chromosomes are in most cases incompatible with life. Aberrations compatible with life are manifested by various clinical syndromes of multiple chromosome anomalies, which include congenital heart defects (CHDs) [4]. Heart defects associated with chromosomal abnormalities are always part of the syndrome of multisystem malformations, and not isolated defects. Screening of patients with congenital heart disease for chromosomal abnormalities is not of particular importance if the heart lesion is not combined with other malformations. With trisomy of autosomes, septal defects (atrial and interventricular septal defects, their combination) are the most frequent. CHD with anomalies of sex chromosomes are much less common than with trisomy of autosomes. Only 10-16% of women with a 45X karyotype have a malformation of the cardiovascular system, most often aortic coarctation or ventricular septal defect (VSD).

2) Mutation of one gene (2-3%). Most congenital heart diseases are combined with developmental anomalies of other organs and are part of clinical syndromes with autosomal dominant (Holt-Oram, Noonan, Crouzon, Marfan, etc.), autosomal recessive (Gurler, Kartagener, Carpenter, Ellis-van Creveld, Roberts, etc.) types of inheritance or linked to the X chromosome (Aase, Ehlers-Danlo syndromes of type V, Goltz, mucopolysaccharidosis type II – Gunther's syndrome, etc.).

3) Environmental factors (1-2%):

• the impact of X-ray radiation on the body of a woman in the first trimester of pregnancy

• exposure to ionizing radiation

• exposure to drugs (a significant risk of disruption of organogenesis and the formation of congenital malformations has been proven only for a small number of drugs: anticonvulsants, lithium, progestogens, amphetamines)

• exposure to infectious and viral agents (in 1.3-2.4% of cases, the cause of CHD is rubella transferred during pregnancy: the classic congenital rubella syndrome includes a triad of the most common developmental anomalies - cataracts or glaucoma, heart defects (PDA, TMS, general truncus arteriosus, atresia or malformations of the atrioventricular and semilunar valves, VKA, tetralogy of Fallot, VSD, pulmonary artery stenosis) and deafness, less often - malformations of the nervous system (microcephaly), impaired development of the skeleton, skull, lag in physical and mental development, neonatal manifestations - thrombocytopenic purpura, hepatosplenomegaly, hepatitis, hemolytic anemia, pneumonia, lesions of tubular bones).

• exposure to alcohol - 1% (plays a leading role among other toxic factors in the occurrence of CHD [5]: it leads to the birth of a child with embryofetal alcohol syndrome, especially when exposed to a period of intensive organ formation - the first 3 months of pregnancy).

When evaluating the role of environmental factors, one takes into account the dose effect, the genetic predisposition of individuals to the formation of malformations in general and the cardiovascular system in particular [6]. When assessing the teratogenic

effect of various damaging factors, the coincidence of teratogenic effects with periods of intensive formation of fetal organs and systems is also taken into account.

4) Polygenic multifactorial inheritance - 90%. The main features of this CHD inheritance model are:

• the risk of re-lesion increases with an increase in the number of patients among relatives of the first degree

• if population data indicate sex differences in the frequency of the disorder, relatives of the less commonly affected sex are more likely to be affected

• the more severe the defect, the higher the risk of its recurrence Risk factors for having a child with congenital heart disease: mother's age, endocrine disorders in spouses, toxicosis in the first trimester and threats of termination of pregnancy stillbirth in history, the presence of other children with congenital malformations, the woman taking endocrine drugs to maintain pregnancy, etc.

Only a geneticist can quantify the risk of having a child with CHD, but every doctor should be able to qualitatively assess the risk as significant, moderate or small.

In 1995, CJSC Policell was established, which is a research and production enterprise with a developed infrastructure and stable external relations. The creation of the enterprise took place in close cooperation with OAO Tatneft. The moment of establishment of the enterprise was preceded by many years of experience in the technological field of production of cellulose ethers and esters and pilot production of low capacity equal to 150 tons per year [7]. The idea of creation was based on the principle of creating new competitive in the world market demanded productions of biodegradable products. CJSC Policell, as well as other modern productions with technological profile processes related to non-waste production, the essence of which is the absence of a negative impact on the environment, which is economically beneficial and expedient from the standpoint of environmental requirements.

At an accelerated pace, over four years of hard work, by 1999, the production capabilities of CJSC Policell had grown to 15,000 tons. Another advantage of the enterprise was the fact that its structure included a scientific division supported by highly qualified scientific personnel [8]. Thanks to them, the production system was modernized, developed and introduced the original latest technologies for the production of polymeric materials with bio-properties, competitive at the world level in terms of efficiency and technological capabilities.

Today CJSC Policell remains the leading company in its industry, which can respond flexibly to market changes and work solely on market demands, but the most important company is focused on the production of products with biodegradable properties and the company has opportunities for this.

In order to preserve a clean environment for future generations, environmental management methods are used that are based on the following principles of "green chemistry":

- the ideal condition for the organization of any production is the prevention of losses than their processing and waste treatment;

-organization of the process of complex processing of raw materials into a finished product without by-products;

- organization of the synthesis process using reagents with a lower negative impact on humans and the environment, with the production of environmentally friendly marketable products on this basis;

- organization of the process of developing new chemical products with minimal toxicity;

- organization of the production process of materials using auxiliary substances, for example, solvents or separating agents, using only harmless ones, in other cases, exclude their use;

- optimization of energy consumption in the cost of the product from the standpoint of assessing the impact of energy output on the environment: the choice of synthesis conditions close to natural, room temperature and atmospheric pressure;

- organization of the process of production of materials, both initial and consumable, on the principles of renewability, from the standpoint of mutual benefit, both technical and economic;

- the preferred organization of the catalytic process for the production of materials as the most selective;

- a product of chemical origin must have the properties of decomposition into safe products that do not harm the environment.

We list the main directions of development of "green chemistry" [8]:

1) synthesis with the use of catalysts and the development of new technologies on this basis;

2) focus on the use of renewable source reagents, excluding reagents derived from oil and/or natural gas;

3) non-traditional use of hydrogen peroxide as an oxidizing agent, "blue" hydrogen in eco-technologies, effective catalysts as a means of providing a high level of conversion, supercritical carbon dioxide, water in its supercritical state, as substitutes for traditional organic solvents, more efficient and non-toxic ;

4) the use of photochemistry, microwave radiation as effective energy sources for the activation of reagent molecules [9];

Evaluation of the effectiveness of these new processes quantitatively, from the standpoint of "green chemistry", can be carried out using two parameters: the E-factor and the index of atomic efficiency. The "E-factor" indicator is determined by the ratio of the mass of all by-products obtained during the reaction to the mass of the resulting target product. From the position of a technologist, this is an assessment of the intended use of raw materials and finding losses during the technological process and evaluating its effectiveness. By the value of the "E-factor", one can correlate the technological process and the industry in which it takes place, for example, for the oil refining industry, E-factor = 0.1. The process of organic basic synthesis is characterized by an E-factor equal to from 1 to 5, and fine chemical synthesis from 5 to 10. The largest run-up and high values of the "E-factor" in the pharmaceutical industry are from 25 to 100. The "atomic efficiency" indicator is determined by the stoichiometry of the equation reactions as the ratio of the mass of the resulting target product to the sum of the masses of all products, taking into account involved in the process. Renewable energy sources usually include environmentally friendly types: solar energy, biomass energy, geothermal energy, light and surf.[9]

Modern new technologies are effective and allow reducing the consumption of material resources, expanding the use of by-products. So, modern refrigerators consume 75% less electricity than refrigerators of 1970. Today, air transport consumes 5–6% less energy per passenger, freight transport consumes 10–25% less fuel for transportation. The use of lightweight thermal insulation materials is an effective way to save fuel, and the use of lightweight construction materials in vehicles leads to a reduction in the amount of energy consumption during their operation.

Let's move on to examples of Russian practice in the field of developing the organization of production of biodegradable materials and products in terms of presenting the available opportunities. For example, an investment project for the creation of pilot lines for the first in Russia production of bio-based and biodegradable plastics and fibers

based on polylactide (PLA) was implemented at the Bio Planeta enterprise. Processes have been launched to replace polyethylene and traditional plastic products with an environmentally friendly alternative.

At one of the enterprises of the city of Omsk, the production of stream-line production of bio-canisters, harmless and safe from an environmental point of view, having decomposition properties in natural conditions, is not 400-500 years, as conventional plastic is supposed to decompose, but approximately twenty years, as shown by prototypes subjected to degradation under conditions of accelerated aging. Testing of biocanisters showed their better properties in comparison with their counterparts made of polymeric material. But their main advantage still remains the property of biodegradability, since the elements of organic origin that make up the material help it (the biocanister) decompose over time under the influence of sunlight, oxygen and moisture and disappear. on the fields after harvesting., and as a rule it is disposed of by burning, however, as practice has shown, its use, utilization, that is, the use turned out to be much more effective.[10]

Specialists of the Vyatka State University with colleagues from the Institute of Chemical Physics named after V.I. N.N. Semenov RAS developed a biodegradable plastic from raw materials of plant origin. The developed plastic is based on polylactic acid, which is a promising biopolymer that is widely used in industry. Plastic has replaced plastic bags, containers and other environmentally friendly polyethylene products [11].

An analysis of the market for the production of biodegradable materials showed that research on the development of formulations and technologies for the manufacture of biodegradable materials is actively conducted in world practice. But there are problems associated with the organization of the production process, since the use of natural raw materials for the most part lays down features in the technological methods of their processing, which increases the cost of the final product and, in some cases, the new biomaterial packaging lacks the necessary characteristics.

Speaking about the biodegradation of biomaterial, it should be recognized that biodegradable plastic itself cannot decompose on its own, since this process will take a long time. For its decomposition in natural conditions, special conditions are needed, for example, compost pits. Despite this, one should still take into account the main advantage of biodegradable material, it is much better and easier to recycle than classic plastic, because renewable vegetable, non-toxic raw materials are used in production. And another advantage, perhaps the most significant, is the fact that the development of the production of materials with biodegradable properties is a direct way to abandon oil dependence, which forms the basis of the strategic environmental security of the Russian Federation for the period up to 2025. [eleven]

Summarizing, we can say that Russia has every chance to take a leading position in the market for the production of materials with biodegradable properties, having the technological capabilities for this [12].

Biodegradable materials are one of the ways to save humanity from the catastrophe associated with the spread of garbage dumps with waste of polymeric origin, the decomposition time of which goes to half a century. Considering that while waiting for the decomposition process, more than one generation of living is changing, it can be understood as a habitat filled with garbage and toxic gases released during the impact on plastic waste from the environment, one can understand the conditions under which a person lives. In this regard, there is only one way to preserve the environment and human habitat - this is a course towards the development of production of materials with biodegradable properties. Work related to the development of biodegradable materials continues in the direction of reducing their decay period, and not only. The search for suitable technologies, standard or non-standard, continues, but today we can already say that time has turned towards the protection of the human environment, towards the

development of the production of materials with biodegradable properties as a way to minimize environmental damage.

4 Conclusions

1. Environmental problems are forcing humanity to switch to new types of energy resources, radically reduce harmful emissions into the atmosphere, develop and implement waste-free production everywhere.

2. Russia has the technological capabilities to organize the production of materials with biodegradable properties. Russia has every chance to take a leading position in the market for the production of materials with biodegradable properties, having technological capabilities for this.

3. CJSC Policell, as well as other modern productions with technological profile processes related to non-waste, meeting all the criteria for environmental requirements, from the position of the absence of harmful emissions into the environment, successfully pursues a policy of energy and resource efficiency, wastelessness and a closed cycle .

4. Biodegradable materials are one of the ways to save mankind from the catastrophe associated with the spread of landfills with waste of polymeric origin, the decomposition time of which goes to half a century. Considering that while waiting for the decomposition process, more than one generation of living is changing, it can be understood as a habitat filled with garbage and toxic gases released during the impact on plastic waste from the environment, one can understand the conditions under which a person lives. In this regard, there is only one way to preserve the environment and human habitat - this is a course towards the development of production of materials with biodegradable properties. The search for suitable technologies, standard or non-standard, continues, but today we can already say that time has turned towards the protection of the human environment, towards the development of the production of materials with biodegradable properties as a way to minimize environmental damage.

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