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Biofuels

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One of the features of the development of the modern world is the increased attention of the world community to the problems of proper and efficient use of energy resources, the introduction of energy saving technologies and the search for renewable energy sources.

Today, the development of renewable energy in the world has taken an accelerated nature, which is associated with the growing multifactorial crisis phenomena of a global nature. On the one hand, there is limited geological reserves of the main types of fuel resources – oil and gas, which leads to an inevitable increase in prices [1]. On the other hand, there is an obvious increase in the negative impact of environmental factors caused by the consequences of human activity.

The main environmental damage associated with global climate change – the greenhouse effect – is caused mainly by the extraction, processing and combustion of fossil fuels-coal, oil and gas. The greenhouse effect accounts for up to 75 % of anthropogenic environmental damage. In this regard, meeting the growing needs of the world's population in fuel, electricity and heat, while ensuring environmental safety, necessitates the development of renewable energy, because oil is not the only raw material for producing high-octane organic matter for engines.

Biofuels occupy a special place in the structure of renewable energy sources. As one of the few alternative fuels in the transport sector, biofuels are seen as an important resource for energy selection and energy security, agricultural and rural development, and climate change mitigation by reducing greenhouse gas emissions.

Conventionally, biomass, as a raw material for the production of biofuels, can be divided into three generations:

- edible oil and sugar-containing terrestrial plants;
- non-food and cellulose plants;
- non-food aquatic plants, i.e. algae.

Biofuels of the first generation are made from sugar, starch, vegetable oil and animal fat, using traditional technologies. The main sources of raw materials are seeds or grain. For example, vegetable oil is extracted from rapeseed, which can then be used in biodiesel. From wheat starch is obtained, after fermentation – bioethanol.

Deforestation, the negative impact on traditional agriculture, the imbalance in the use of agricultural land towards industrial crops and the threat to food security are some of the challenges facing humanity in the production of biofuels. The main problem in the production of biomass fuels is food security, as first-generation biofuels are produced from crops in the food chain of humans and animals (corn, soybeans, oil palm, rapeseeds, sugar cane, wheat, rye). The public has already realized that large areas where food was produced, commercially oriented farmers gave under the technical culture. As the world's population grows and more food is needed, the use of these areas for biofuel production reduces the amount of food available and increases their cost.

Second-generation biofuels are produced from non-food raw materials. The sources of raw materials are lignocellulosic compounds that remain after the parts of vegetable raw materials suitable for use in the food industry are removed. For this purpose, fast-growing trees and herbs (poplar, willow, miscanthus, jatropha and others) can also be used. They are otherwise called energy forests or plantations [1]. About 20 different species of plants – woody, shrubby and herbaceous- have been tested.

The advantage of this biofuel is that the plants from which it is derived do not compete with food crops for land. They can grow on slopes, hills, ravines, as well as on unproductive and degenerate lands, sometimes even with the prospect of restoring these lands. For their cultivation, you can use a minimum amount of water, fertilizers, pesticides and equipment. Every 4-7 years trees are cut, their annual harvest can reach up to 7 tons per hectare. In the aisles can be further planted crops. The collected biomass is used for the production of heat and electricity, and can also serve as a raw material for the production of liquid biofuels.

Unfortunately, economic, social and ethical aspects constrain the development of production of the first two generations of biofuels. The more acute these problems are, the greater the interest in the development of the third generation of biofuels. Algae is an effective renewable biomass that does not require arable land and fresh water.

These are simple organisms adapted to growth even in polluted or salt water. The determining factors for the accumulation of biomass by algae are: the intensity of solar radiation; water temperature; presence of nutrients; concentration of carbon dioxide.

Algae convert solar energy and carbon dioxide into cheap and highly productive raw materials for food, biofuels, animal feed and high-value, biologically active substances. That is, these organisms have an effective apparatus of bioconversion of solar energy and are its natural bioaccumulators. The productivity of microalgae in biomass exceeds the productivity of terrestrial plants. The maximum real values of algae biomass growth at solar radiation intensity of 5623-7349 MJ per m^2 per year (180-235 W/m^2) are 38-47 g of dry biomass per square meter per day [2].

Algae include many species of both unicellular and multicellular organisms. They consist of proteins, carbohydrates, fats and nucleic acids. The percentage of these substances depends on the type of algae. Some strains of algae are ideal for biofuel production due to their high oil content [2]. Microalgae on potential energy yield in 8-25 times greater than palm oil and 40-120 times-rapeseed, which allows us to refer them to the typical representatives of vegetable oilseeds. There are separate species of these plants containing up to 40 % fatty acids.

Summing up, we note that biomass can be converted into energy-intensive compounds that can be used for transport, for heating homes, for the chemical industry. Such use of biomass can play a significant role in energy security and environmental protection. All of this will require significant long-term interdisciplinary efforts. In order to achieve this, a number of bottlenecks in the integrated biofuel production chain must be eliminated: metabolic design and modelling of strains, accumulation of specific compounds, processing of biological substances, design and operation of photobioreactors and, finally, the use of logistics that integrates all these processes into a single whole and makes them cost-effective.

References:

1. Вадим Яковлев (ИК СО РАН) о перспективах биотоплива [Электронный ресурс]. – Режим доступа: https://computerra.ru/584522. – Дата доступа: 25.03.2019.

2. Microalgae biofuels: a brief introduction [Electronic resource]. – Mode of access: https://adelaide.edu.au/biogas/renewable/biofuels_introduction.pdf. – Date of access: 03.04.2019.