

Bioethanol is a biofuel that can be used for various purposes, including as a fuel for vehicles, an additive to gasoline, a source of electricity, and a chemical product in industry. The production of bioethanol typically begins with the collection and transportation of agricultural raw materials, such as corn, wheat, sugar beets, sugarcane, or grains, to the production plant. The raw materials are then subjected to a grinding process, which aims to reduce their size and consequently increase the surface area for sugar extraction. After grinding, the raw materials are mixed with water and subjected to a hydrolysis process, in which enzymes break down starch or cellulose into simple sugars. This process can be carried out using acids or enzymes, depending on the chosen production method. Subsequently, in the fermentation process, yeast is added to the solution, which converts sugars into ethanol and carbon dioxide. After fermentation is complete, the solution containing bioethanol is separated from the remaining components, such as grain residues or cellulose. Finally, bioethanol undergoes purification processes, including distillation, to obtain the final product with the desired purity. In the case of industrial-scale bioethanol production, these processes are typically carried out in a continuous flow, allowing for efficient mass production of bioethanol. In Poland, as well as in the Mazovian Voivodeship, bioethanol finds wide application. Below are a few examples.

**Vehicle biofuel:** Bioethanol is commonly used as a biofuel in Poland. There are already several plants in the country producing bioethanol from various sources, including grains, sugar beets, as well as agricultural and forestry waste. Bioethanol is added to gasoline in an amount of 5-10% and is intended to reduce harmful emissions.

**Electricity production:** There are many power plants in the Mazovian Voivodeship that generate electricity from various sources, including bioethanol. These power plants usually burn bioethanol to produce steam, which drives turbines to generate electricity.

**Chemical industry:** There are many chemical companies in the Mazovian Voivodeship that use bioethanol as a raw material for producing various chemical compounds, including ethanol, acetic acid, ethyl acetate, as well as various polymers.

**Food industry:** In Poland, bioethanol is also used in the food industry. It is a raw material for the production of various alcoholic beverages such as wine, beer, vodka, as well as for the production of yeast.

**Cosmetics and medicines:** Bioethanol is used in the production of cosmetics and medicines as a solvent and disinfectant.

**Bioplastic production:** Bioethanol is a raw material for the production of bioplastics, which are becoming increasingly popular due to their biodegradability and low environmental impact. Bioplastics made from bioethanol can be used in many areas, including the packaging, agricultural, and automotive industries.

**Cleaning products production:** Bioethanol can be used as a component of household and industrial cleaning products. Thanks to its solubility properties, bioethanol can help in removing various types of pollutants and stains.

**Biomass processing:** Bioethanol is one of the products obtained from biomass processing, that is, organic plant or animal residues. Biomass can come from various sources, such as agricultural residues, wood waste, or manure. Processing biomass into bioethanol has great potential as an alternative fuel and energy source.

**Natural cosmetics production:** Bioethanol can be used as an ingredient in natural cosmetics. Its solubility and antibacterial properties help in removing impurities and bacteria from the surface of the skin. Bioethanol is used in the production of hand sanitizers, air fresheners, and colognes.

**Production of aviation biofuels:** Bioethanol is one of the alternative biofuels that can be used in aviation. Bioethanol can be converted into aviation biofuel, which reduces emissions of pollutants and harmful gases into the air. In Poland, tests are being conducted on the use of aviation biofuels, and bioethanol is one of the potential raw materials for the production of these biofuels. Bioethanol is a versatile biofuel with many applications, including as fuel for vehicles, a source of electricity, a chemical

product in industry, a raw material for the production of bioplastics and cosmetics, an ingredient in cleaning agents, and an alternative fuel and energy source from biomass processing. In Poland, bioethanol is already widely used, and there are many companies, power plants, and facilities producing bioethanol in the Mazovian Voivodeship. Bioethanol can also be used as a biofuel for aviation, which helps to reduce air pollution emissions.