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Efficiency of Thermal Recycling of Biowaste in the Energy Supply System of Greenhouses

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Annotation: Based on the thermal processing of biowaste, it is possible to obtain various energy fuels and use these fuels for energy purposes. With the help of biomass, it is possible to provide reliable energy to greenhouses, domestic enterprises and rural households, and at the same time, to provide reliable energy to regions that do not have access to energy. Biomass is a renewable resource that can solve problems such as saving natural resources and rising oil prices. Flexibility and efficiency in production are key principles for biomass conversion technologies in future energy systems. In this article, it is stated on the basis of analysis that thermal processing of biomass is highly flexible and optimal use is effective.

Key words: Biowaste, cogeneration, energy, pyrolysis, conversion, fuel, engine, pyrolysis gas, liquid fuel

In order to reduce economic costs in the production of agricultural products and the production of exportable products, which are the most important branches of our country's economy, great attention is paid to increasing energy efficiency and introducing new energy-saving technologies [1]. Greenhouses in our republic are considered one of the most important energy facilities in agriculture, and their need for energy is increasing day by day. In the winter mode of a single solar greenhouse, 30% of the heating energy is obtained from the sun, and the remaining 70% requires additional fuel resources. Saving these fuel resources and applying new innovative technologies using alternative energy sources in the system is one of the priority directions for the development of the industry [2]. At present, developing countries are rapidly growing energy production from waste and its practical application. Because it is possible to obtain inexpensive environmentally friendly fuels from the biomass part of the waste. For example, if the bio-waste from the greenhouses is processed and various energy fuels and electricity are produced from them, the problems in places where energy is not available can be completely solved.

Different technologies, energies and materials are available for biomass type and properties and conversion processes, including biochemical, thermochemical and physicochemical conversion types.

The scheme below (Figure 1) shows a simplified scheme of biomass conversion methods and final products

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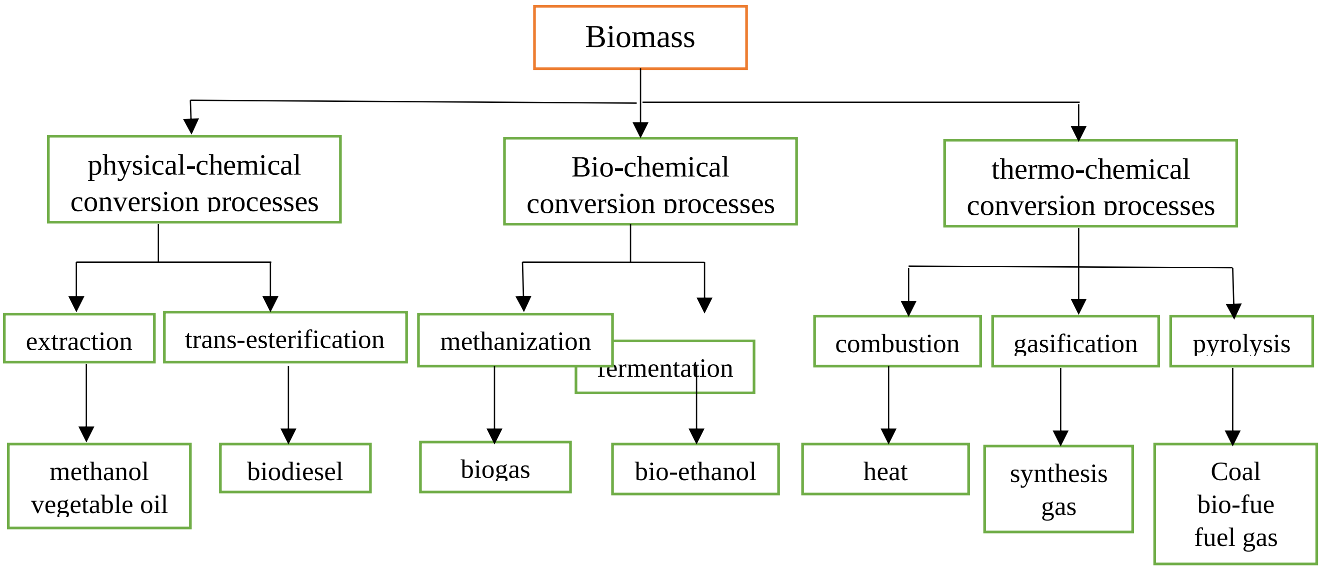

Figure 1. A simplified scheme of biomass conversion methods and final products

Among these methods, thermochemical processes are the most common and effective technology. Biomass can be converted into a variety of materials, including heat, electricity, and convenient forms of energy such as gaseous, liquid, or solid fuels.

Recently, the pyrolysis process has attracted the unprecedented attention of many scientists. An opportunity was created to change almost all sectors of forestry, agriculture, energy and chemical industry. It is possible to make biomass species usable for commercial purposes, to produce biofuels and valuable chemical raw materials for industrial sectors [3].

The pyrolysis process is different from other high temperature processes. The temperature of the process is about 500-800 ^{o}C, and the main components that make up the plant material begin to decompose. At the first stage of the process, under the influence of heating, the constituents of high molecular compounds are separated and the main part of plants is gasified. The released gaseous products are separated in the next cooling stage, and liquid (bio-oil) and non-condensed gaseous (pyrolysis gas) fractions occur. In general, the pyrolysis reaction can be expressed as follows: BM (biomass) + HEAT = C (carbonaceous material) + tar + C_nH_m + CH_4 + CO_2 + CO + H_2. The yield of gaseous products of pyrolysis is medium caloric gas and can reach about 70% by weight of the initial plant material. The chemical group composition of the gas depends on the raw materials and process parameters. The product of liquid pyrolysis is of great interest due to its high energy density and the possibility of using it as a component of liquid fuel [4]. The resulting liquid product is a thick black resinous substance with a yield of up to 80% by weight. The solid product of pyrolysis is a carbonaceous substance, the yield of which can be up to 30-35% by weight of dry raw material [5].

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The figure below shows a simplified scheme of the pyrolysis process.

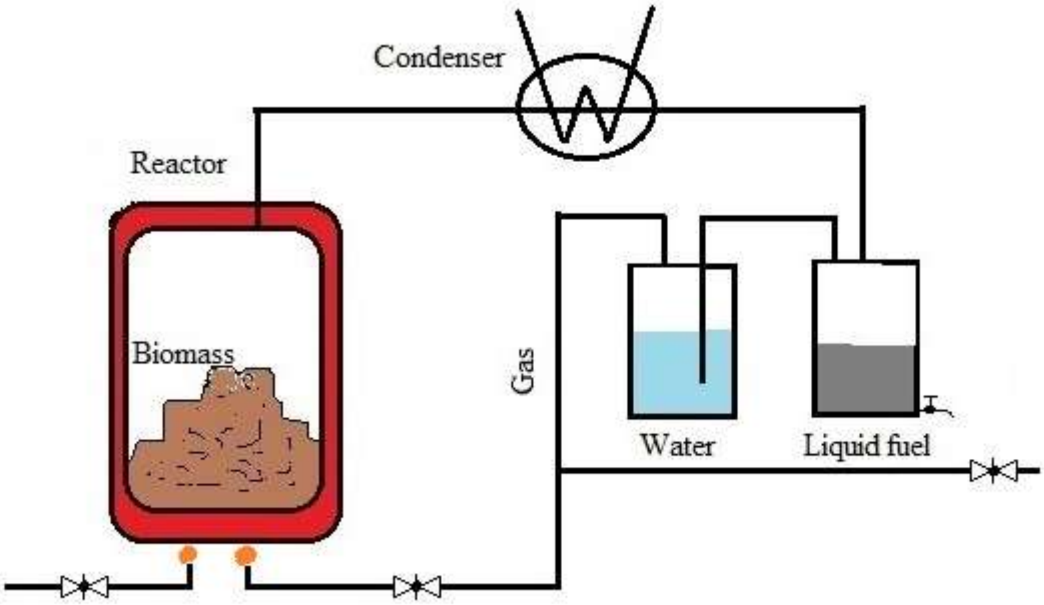

Figure 2. A simplified scheme of the pyrolysis process

Modern pyrolysis technologies available today can classify biomass according to the following technological parameters:

- **heating rate (fast, slow pyrolysis);**
- **pyrolysis environment (vacuum, hydropyrolysis, methanopyrolysis).**

Todays, the most well-known method is the process of pyrolysis, depending on the rate of heating of raw materials.

Slow pyrolysis is the most efficient method of biomass conversion.

Therefore, biochar and biochar production are cited as the most promising technologies in many literatures. Slow pyrolysis requires low to moderate (500-700°C) temperatures and can typically last from 1-2 hours to 24 hours.

Fast pyrolysis is a high-temperature process, in which the raw material biomass can be rapidly heated to a temperature of 450-900 °C (heating rate 300 °C per minute). Under these conditions, pyrolysis gases and coal are formed. The resulting vapors are condensed into bio-fuel. In this case, as a rule, 60-70% of the raw material is converted into bio-oil. This type of pyrolysis is used to obtain the maximum amount of gas or liquid according to the given process temperature [6].

In the following table, the comparative characteristics and heat of combustion of biomass with different appearance are presented based on the analysis

Table 1. Types and properties of biomass in biowaste

Biomass	Burning heat , kW s/kg	Ash quantity , %	Nitrogen quantity , %	Chlorine quantity, %	Sulphur quantity , %
Spiked plants straw	4.78	5.68	0.47	2,503	737
Rapeseed straw	4.76	6.20	0.84	4,668	2,703
Big cereal spiked plant	4.76	4.24	1.16	1,807	1,370
Spiked plants cereal	4.72	2.26	1.96	660	1,050
Rapeseed grain	7.35	4.60	3.94	-	1,000
Herbs	4.83	5.71	1.14	3,112	1,581
Field wild herbs	4.74	7.09	1.26	7,588	1650
Needle leafy a tree remains	5.23	0.79	0.14	87	234
Leaf leafy wood remains	5.11	0.55	0.49	163	402

In the process of pyrolysis, rather than only obtaining fuel, it is also effective to produce electricity from this process. There are two main methods of generating electricity from woody biomass. The first method is to convert the heat of combustion products generated during the direct burning of biomass into electricity, and the second method is to use the gas obtained as a result of gasification or two-stage pyrolytic conversion in gas engines, gas turbines and external combustion. devices, can be obtained by enabling [7].

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