STUDIES OF PHYSICAL AND TECHNICAL CHARACTERISTICS OF BIOWASTE AS COMPONENTS OF GASIFICATION

A.A. Osmak, A.A. Seregin

National University of Food Technologies

Proved promising use of plant biomass as a fuel due to the widespread introduction of bioenergy technologies. Justified the use of biomass for heat and electricity. The basic reasons for the use of organic materials as a source of renewable energy. The examples of industrial use of energy from biomass in the EU.

Investigated the variation of the calorific value of the product gas from the humidity of the incoming raw materials. By experiment investigated the suitability of various types of plant biomass (sunflower husks, hulls of buckwheat and oats) to further thermochemical conversion for alternative fuel.

The results of the technical analysis (moisture, ash, calorific value) of a number of analytical samples of agricultural waste.

Studied the elemental composition of certain types of plant material, which suggests that these agricultural residues are highly reactive fuel with a high yield of volatiles.

Keywords: biomass, sunflower husks, buckwheat husks, oat hulls, wood, peat.

I. Introduction

In recent years, in the world there is great interest in the use of biomass for heat and electricity, its involvement in the energy balance of the country. This is indicated by numerous studies in the European Union and the United States, aimed at identifying the best ways of using biomass energy [1, 3, 6].

Ukraine has significant biological resources, including the processing of biowaste in the form of food raw materials that can be used as alternative or additional fuels. At present, the consumption of biomass is limited mainly to wood and waste wood processing industry: about 1 million. Tons of fuel per year is used for heating private houses, as well as enterprises of timber and woodworking industries of the country [2, 4, 5].

Studies show that by diversifying sources of energy fuels country can expect the replacement of about 10 million tons of fuel per year, which is certainly a positive factor in ensuring the country's energy independence. Undoubted is the fact that the involvement of biological resources in the fuel balance of the country will benefit the environment as a result of the combustion of biomass, both directly and in different versions with coal-biomass mixtures, environmental performance processes of thermal processing of raw materials in which there is much biomass better than conventional [2, 6].

Biomass energy has significant advantages compared to fossil fuels and a number of other renewable energy sources, ensuring energy supply, improving living standards, increasing welfare. Energy systems based on biomass are a potential mechanism contributing to sustainable development and environmental protection. Among the main reasons for this attention is worth noting:

• widespread availability, even in remote areas: biomass fuel is available wherever there are trees and crops, as well as processed food products and fibers;

• resource is used if necessary: biomass is to be stored fuel energy source, which at any moment could be used to power, unlike other renewable energy sources, which are characterized by irregular and / or seasonality;

• versatility: Biomass is a potential source of primary energy - liquid, gas, heat and electricity;

• no effect on the climate: Provided environmentally sound preparation and combustion, biomass energy does not cause climate change and greenhouse gas emissions.

Therefore plant biomass due to such their basic characteristics as renewability of this type of fuel, ecological cleanness in comparison with other types of fuel, no impact on the balance of free carbon in the atmosphere, leading to development of the "greenhouse effect", is considered one of the most "noble" fuels and is considered in many countries as a promising source of energy in the near future.

II. Materials and methods

In the laboratory, it is examined the suitability of various types of plant biomass to further thermochemical conversion for alternative fuel.

Taking into account the technical characteristics of the plant biomass for the further work was selected sunflower husks, buckwheat and oat hulls, wood waste (chips), and peat.

Ash content was determined according to GOST 1.1.022-90, in accordance with GOST 27314-91

humidity, volatile substances according to GOST 6382-91, carbon and hydrogen in accordance with GOST 24081-88, GOST 8606-93 sulfur, and oxygen from the difference of 100% - programming components. The heat of combustion was determined according to GOST 147-95.

III. Results and discussion

According to the authors, to begin the process of large-scale introduction of bioenergy technologies is necessary with the introduction of modern boilers, gas generators for the thermochemical conversion of renewable raw materials of organic origin. All other technologies for energy production from biomass (biogas, liquid fuels, energy crops) are no less important priority, but at this stage of technology development in our country are not able to quickly replace the traditional types of fuels for the production of thermal energy with the lowest investment costs and the shortest period payback.

On the basis of scientific research team of the Department of Theoretical Mechanics and resource-saving technologies of the National University of Food Technologies (NUFT) prepared a set of design documentation for which was made a prototype gas-generating energy complex Huck-3 (Figure 1).

Enterprise-based UV "Saharenergoservis" AK "Suter", p. Ustimovka, Vasilkovskaja district., Kyiv region. together with employees NUFT conducted preliminary and acceptance tests of the prototype Huck-3.

Figure 1. *Prototype gas-generating energy complex Huck-3*

In the study it was found that the gas generator is working steadily on raw humidity 20 ... 30%. Stuck of fuel in the mine was not observed. The produced Synthesis gas had a composition typical for generating gases produced in the so-called "reverse" process. The Calorific value of the product gas was also responsible standard size and ranged from 3.6 ... 4.94 MJ / m 3. The Calorific value of the gas depended on the initial moisture content of the fuel (see Fig. 2).

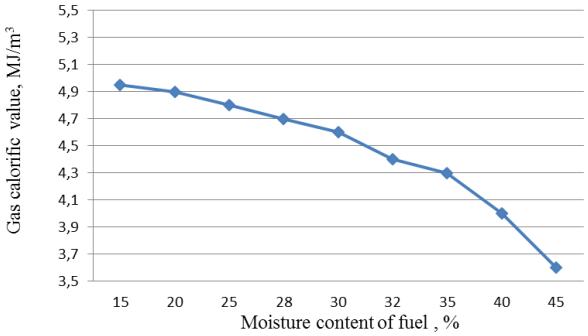

Figure 2: *A plot of the calorific value of the product gas from the initial moisture content of fuel*

The composition of plant biomass and, consequently, its physical and technical characteristics depend on the origin [2]. Significant impact on the gasification of biomass have characteristics such as moisture and ash content [7].

Moisture may be condensed and adsorbed, the amount of the latter depends on the ambient humidity. Wood moisture content may be 50% [2]. Agricultural waste, such as straw, contains about 10 ... 12% of water [2]. Moisture reduces the efficiency and effectiveness of the use of plant biomass as a fuel and also increases the cost of transportation.

Mineral content of the plant biomass varies within a wide range. Wood contains about 0.5% ash consisting essentially of carbonates, carboxylic acid salts and small amounts of silicon and sunflower husk it is to 30% [2]. The water-insoluble inorganic compounds reduce the enthalpy of the biomass.

For The generalization of the physical and technical characteristics of different types of biomass, we used the results of studies of a number of agricultural waste (husks of sunflower seeds, buckwheat husks, oat hulls), and the data of foreign authors [2, 7].

Results of analyzes based on the mass of workers:

Name	Indicator
Humidity,%	45,5
Ash,%	1,35

Carbon,%	30,5
Hydrogen,%	1,8
Sulphur%	0,05
Nitrogen,%	0,3
Oxygen%	10,1
Net calorific value, MJ / kg	8770

The elemental composition of the fuel ash is shown below:

Compound	Amount%
SiO_2	25,74
TiO_2	0,75
$A1_2O_3$	4,9
Fe_2O_3	3,38
CaO	43,81
MgO	6,43
SO_3	0,15

Composition of the fuel and ash according to foreign researchers on the dry weight does not differ from that shown above. Moisture can vary from 45% to 60%.

Waste wood processing plants, as a rule, are dry sawdust, wood shavings and lumpy waste. An exception is the fine dust from sanding chipboard containing abrasives and resin. Humidity of the sample taken from the point of collection of waste in the open air was about 25%, and the operating heat of combustion of about 17.35 MJ / kg.

Specific weight of the sample taken is only 150 kg/m^3. About half of the waste is "soft" with a particle size of about 0.2 ... 1 mm; others - swarf and chips with a maximum size of 50 mm.

The table shows the results of the technical analysis of a number of analytical samples of agricultural waste. In actual agricultural production humidity can be somewhat higher (2 ... 4%), and the heat of combustion, respectively, lower. The difference in the ash content is determined by the presence of extraneous inorganic inclusions.

Table. *Physical and technical characteristics of agricultural waste*

indicator	Type of waste		
	sunflower husk	oat hulls	buckwheat husk
Moisture, W,%	8,4	9,87	6,5
Ash, A,%	2,7	4,78	7,95
Heat of combustion, Q, MJ / kg	16,89	14,4	15,82

In the literature [2], the following data on the net calorific value of a number of similar materials: rice husk – 13,3 MJ/kg, sunflower husks – 15,4 MJ/kg, straw – 15,7 MJ/kg.

Thus, the heat of combustion of agricultural residues changed within a narrow range of 13.3 to 17,0 MJ / kg, and it is quite high. Humidity of natural waste is at a level of 10% and an ash content is not exceeding 8%.

Waste has similar cell composition with a carbon content of about 50% oxygen - 42%. The low sulfur content and a moderate nitrogen content indicates that the emissions of oxides of sulfur and nitrogen in any combustion technology is unlikely to exceed 600

mg/m^3. It should also be noted that the said agricultural residues are highly reactive fuel with large (about 80%) of a volatile substance.

In contrast to the organic part the mineral composition varies within very wide limits. Especially it refers to silica (40 ... 87%), iron (0.2 ... 7.7%), calcium (0.6 ... 30.6%) and potassium (6.2 ... 20%). All elements except alkaline material cant impact render on the pollution of the heating surfaces.

The melting temperature of ash (after ashing in a muffle) is about 1300 ° C (1200 ° C to 1400 ° C).

Peat is a product of decomposition of plant residues and did not manage to decompose elements of plants, the degree of decomposition increases with increasing depth of peat. It is Distinguished horse, lowland and mixed types of peat.

In its natural state turf is heavily watered, so it requires pre-drying. In the air-dry peat moisture is 15 ... 25% [2].

It should also be noted that the peat contains a large enough volume (to 36%) of mineral substances. It is explained by silt and the remains of mineral salts from plants. The composition of the mineral part of peat has a significant impact on the process of gasification.

The elemental composition of the peat is on average: 3,4 ... 9,4% hydrogen, 54 ... 60% carbon, 0,5 ... 3,0% nitrogen, 28,5 ... 39,5% oxygen, 0,1 ... 1,5% sulfur. The calorific value of the fuel mass of peat varies over a fairly wide range, and it is 19,7 ... 25,1 MJ / kg [2].

Pyrogenic peat decomposition process is similar to the process of decomposition of wood. Young peat composition distillate approaches to wood, and the old to the brown coals. When heating the peat to a temperature of 100 ° C passes the drying process. Next, the process proceeds to the step of pyrolysis, where first is released CO_2 and H_2O. The most intensive decomposition into gaseous constituents starts from 150 ° C.

It should be noted that the timber in its various spatial axes has different coefficients of expansion. For example, pine wood along the fiber expands to 20 times greater than across the fiber. Therefore, when heated to pyrolysis temperature in the wood structure stresses arise leading to formation of macro-and microscopic cracks. Due to these cracks, fast equalization of temperature occurs and drying process is enhanced by increasing of the reaction surface of the piece of wood. In this stand volatile gases and vapors which are also comprised of hydrocarbon compounds, carbon monoxide, water vapor, resin and benzene. Remains solid residual carbon.

Share of the resulting volatile components is crucial to the regime of burning solid fuel. In the literature on this subject can be found very different data. The values vary in a wide range from 65 to 87% [2, 7]. The reason for their spread can be different methods of investigation: differences pyrolysis temperature, residence time of the particles, and others.

IV. Conclusions

Analysis and study of the properties of plant biomass as a fuel for gas plants is done, which included the systematization of data received by domestic and foreign authors, and the results of their own research to determine the physical and technical characteristics of the raw materials, the elemental composition of raw materials and ash. The results obtained are the characteristics of organic materials formed the basis for the development of processes of thermochemical conversion of plant biomass.

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