preferable to use it in a two-beam DCQP, since it ensures not only uniform washing of coke by the coolant, but also the time of contact of coke with the coolant on the coke and boiler sides increases at the same productivity of the DCQP.

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PREDICTION OF THE HEATS OF COMBUSTION OF PLANT RAW MATERIALS BASED ON THE ELEMENTAL ANALYSIS DATA

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The relationships of the data of proximate (moisture content, ash content, yield of volatile matter, and nonvolatile carbon content) and elemental (carbon, hydrogen, nitrogen, sulfur, and oxygen contents) analyses of various plant raw materials for the production of biogas, charcoal, and torrefied biomass with their gross calorific values were analyzed. Mathematical relationships were developed for predicting the gross calorific values of plant raw materials with high accuracy based on the carbon and oxygen contents and atomic ratios between carbon and oxygen.

Keywords: *vegetable raw materials, proximate analysis, elemental composition, heat of combustion, mathematical relationships*

The heat of combustion of fuel is determined as the amount of thermal energy released upon the combustion of a certain amount of this fuel [1, 2]. Heat of combustion is an important property of plants, which can reflect the ability to absorb solar radiation during photosynthesis. The heat of combustion of coniferous wood is higher than that of deciduous wood, and different components of wood, such as stump, trunk, top, bark, foliage, and branches also have different heats of combustion.

The heat of combustion of plant raw materials is related to their elemental composition, in particular, to carbon, hydrogen, and oxygen contents. Different types of plant raw materials are characterized by different elemental compositions; therefore, they have different heats of combustion [3].

The heat of combustion of plant raw materials also depends on their chemical composition, in particular, on the concentrations of cellulose, lignin, hemicellulose, and resinous substances in them.

Within the framework of this study, we analyzed the relationships of the proximate (W_t^r, A^d, and V^{daf}) and elemental (C^{daf}, H^{daf}, N^{daf}, S^{daf}, and O^{daf}) analysis data and C/H, C/N, C/S, and C/O atomic ratios of various types of plant raw materials with their gross calorific values (Q_s^{daf}).

For the analysis, we used a unique database [4], which contains information on the composition and properties of plant raw materials, which can be used for the production of biogas, charcoal, and torrefied biomass [5]. A total of 362 samples were studied, including the following: untreated wood, which included fresh wood and waste from parks and sawmills; the samples of hard (deciduous) and soft (coniferous) wood species were presented; treated wood—composted wood, saw cut wood, preservative-treated wood, and chipboard; straw—residues of cereals such as wheat, barley, rice, corn, rapeseed, rye, sorghum, sunflower, oats, beans and other unspecified crops; grass and vegetation—various (undefined) grass mixtures and hemp, jute, kenaf, fruits, vegetables, and flowers; husks, shells, and kernels—hard parts of various nuts (walnuts, almonds, hazelnuts, cocoa, etc.) and olive industry waste; seaweed—leaves, stems, roots, and parts of the vascular system of marine plants.

The quality characteristics of plant raw materials were determined according to the following regulatory documents: CEN/TS 14774:2004 Methods for the Determination of Moisture Content: Oven Dry Method for moisture content (W^r_t); CEN/TS 14775:2004 Solid Biofuels: Method for the Determination of Ash Content for ash content (A^d); CEN/TS 15148:2005 Solid Biofuels: Determination of the Content of Volatile Matter for the yield of volatile matter (V^{daf}); CEN/TS 15104:2005 Solid Biofuels: Determination of Total Content of Carbon, Hydrogen, and Nitrogen. Instrumental Methods for the carbon (C^{daf}), hydrogen (H^{daf}), and nitrogen (N^{daf}) contents; CEN 15289:2006 Solid Biofuels: Determination of Total Content of Sulfur and Chlorine for the sulfur content; and CEN/TS 14918:2005 Solid Biofuels: Method for the Determination of Calorific Value for the gross calorific value (Q_s^{daf}).

Although the oxygen content is a calculated value, its role in the formation of the calorific value of plant raw materials can be compared only with that of the carbon content because its concentration can be 50 % or higher.

The article summarizes the maximum, minimum, and arithmetic mean values and the ranges of quality characteristics of plant raw materials. Based on an analysis of the data, we can state that they are characterized by rather wide ranges.

The above changes in the proximate and elemental analysis data were reflected in the gross calorific values (Q_s^{daf}) of the test samples: they varied from 16.25 to 33.82 MJ/kg.

Paired correlation coefficients between different quality characteristics of plant raw materials were calculated for the test samples.

An analysis of these relationships allowed us to state that they were predominantly quadratic in nature. The only exception is a relationship between C^{daf} and O^{daf}, which is a linear function.

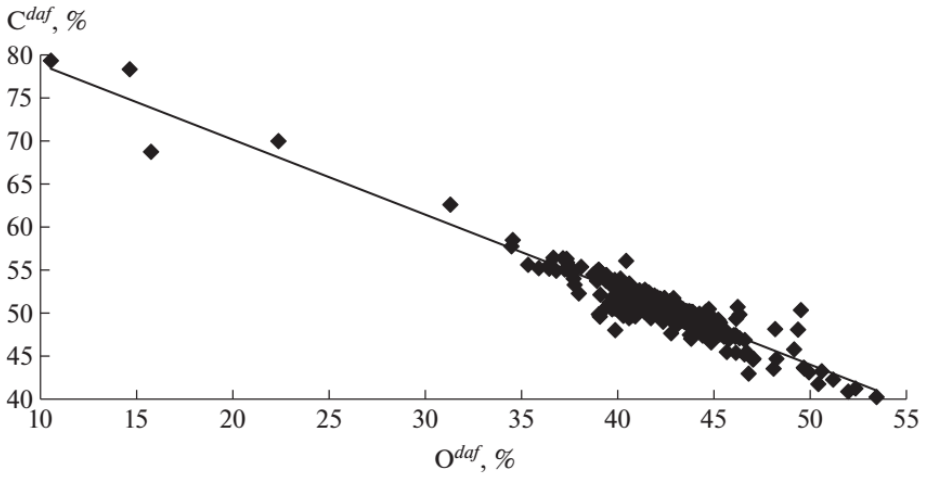

Fig. 1. Relationship between C^{daf} and O^{daf}.

The statistical analysis of the test relationships showed that they were generally characterized by satisfactory accuracy, as evidenced by the high values of determination coefficients ($R2 > 0.849$).

The only exceptions were mathematical relationships between the C/H ratios and C^{daf} ($R2 = 0.345$) or H^{daf} ($R2 = 0.562$).

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COKING OF STAMPED COAL BATCH. YIELD OF CHEMICAL PRODUCTS

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Given that coal may be oxidized and the yield of ammonia and hydrogen sulfide cannot be predicted from the volatile matters, mathematical formulas describing the yield of the basic coking products as a function of the elemental composition of the initial stamped coal batch are derived. It