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

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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 [1].

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 [2], 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. A total of 362 samples were studied.

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.

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} ($R2 = 0.562$).

References

1. Demirbas, A. Relationships between heating value and lignin, moisture, ash and extractive contents of biomass fuels // Energy Exploration & Exploitation. 2002. – Iss. 1. – P. 105–111.

2. Database for the Physicochemical Composition of (Treated) Lignocellulosic Biomass, Micro- and Macroalgae, Various Feedstocks for Biogas Production and Biochar. https://phyllis.nl/