Analysis of selected physicochemical properties of biomass pellets intended for heating purposes

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Abstract

The paper analyzes the suitability of four types of biomass pellets as a fuel for heating purposes. The moisture, ash, and volatile matter content of the analyzed pellets were determined. Their dimensions, bulk density, elemental composition, net calorific value and costs of generating 1 GJ of heat were also determined. It was shown that the analyzed types of pellets generally meet the standards and, due to their high calorific value and appropriate elemental composition, they can be successfully used as a fuel in domestic boilers.

Materials and methods

One type of wood biomass - pine sawdust, two types of biomass constituting waste from the production of vegetable oils - sunflower husk and rapeseed cake, and one type of biomass grown for energy purposes - willow *Salix viminalis*, were selected. The methodology of using selected types of biomass as a heating fuel is shown in Figure 1:

FIGURE 1. Schematic diagram of use of selected types of biomass as a heating fuel, where: 1 - pine, 2 - sunflower husk, 3 - rapeseed cake, 4 - willow (Salix viminalis)

Results

TABLE 1. Comparison of selected physicochemical properties from PN-EN-ISO-17225-2: 2014 standard with the produced pellets

Physicochemical properties	Pine sawdust	Sunflower husk	Rapeseed cake	Salix viminalis	Threshold values
NCV, MJ/kg	17.5	17.2	17.3	18.0	≥ 16.5
Length:. mm	5-30	5-30	5-30	5-30	3.15-40
Diameter, mm	6	6	6	6	6 ±1
Bulk density, kg/m^3	660	650	635	625	≥ 600
Moisture, %	4.6	5.7	9.3	5.8	≤ 10
Ash, %	0.5	1.9	6	2.5	≤ 2

TABLE 2. Comparison of the elemental composition [C, H, N, and O] of the analyzed pellets

Elemental composition	Pine sawdust	Sunflower husk	Rapeseed cake	Salix viminalis
C, %	48.4	47.8	55	50
H, %	6.4	6.4	7.8	6.1
N, %	1.1	0.9	4.7	0.6
O,% (bal.)	37.0	37.3	17.2	35

TABLE 3. Analysis of the profitability of using the produced pellets for heating purposes

Value	Pine sawdust	Sunflower husk	Rapeseed cake	Salix viminalis
Raw biomass cost, zl/t	100	500	1000	100
Pellets price including VAT, zl/t	123	540	1080	107
NCV, MJ/kg;	17.5	17.2	17.3	18.0
η, %	88	88	88	88
C_{PD}, zl/GJ	7.99	35.68	70.94	6.95

Conclusions

The pine, sunflower husk, rapeseed cake, and willow pellets comply with the EN-ISO-17225-2: 2014 standard in terms of net calorific value, bulk density, dimensions, and moisture content. Rapeseed cake pellets may not be used as a fuel for heating purposes due to the three times higher ash content and almost five times higher nitrogen content compared to the above-mentioned standard. This waste is characterized by a high protein content and is commonly used as a feed additive therefore their price is high, which results in high costs of producing 1 GJ of heat.

In terms of price and calorific value, willow and pine pellets seem to be the best fuels. They also have low moisture content; however, slight deviations from the norm in terms of ash content and nitrogen content can be observed for willow and pine pellets, respectively. Only sunflower husk pellets meet the standard in every aspect, but have the lowest calorific value and high price. On the other hand, taking into account the results obtained and the VAT on raw materials, willow pellets seem to be the best fuel.

This does not change the fact that, based on the research conducted, the produced pellets should be further analyzed in terms of fuel consumption and temperature changes during their combustion, and in terms of exhaust gas analysis and the impact on the operation and maintenance of the boiler.