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SERVICE CHARACTERISTICS OF PINE BARK' AS BIOFUEL FOR ELECTRICITY GENERATION

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The influence of the bark content in pine pellets on their mechanical strength is studied. It is shown that wood pellets made from bark and branches have static bending strength compared with standard samples made of sawdust.

Currently, coal, oil and gas that are exhaustible energy sources provide about 80% of the energy demands of mankind. However, the availability of those resources is reduced. It's use make the negative impact on the environment such as acid rain, carbon dioxide emission and so on. Economic and political problems with energy supplies in Ukraine stimulates the search of alternative sources of energy such as solar, wind, use of biomass for energy [1,2,3].

Biomass energy accounts for less than 1 percent of U.S. electricity generation and 2 percent in Europe, where much of the available biomass is waste from lumbering operations in Finland and Germany [3]. Sharp rise in prices and changing conditions of gas supply in recent years have led to the introduction in Ukraine the heating technologies using wood pellets and briquettes. These technologies are used in the EU. Traditionally wood pellets are made from sawdust. In modern manufacturing sawdust is used to product chipboards. That makes sawdust a valuable resource. Therefore, its use for making wood pellets can be economically impractical. The perspective raw material for making wood pellets is bark. Volume content of bark in the wood of pine is 10–11% of the total volume of wood [4]. This amount of material that is not used in the processing industry, prompted us to research the efficiency of bark use as fuel [4,5,6,7].

Dajneko and colleagues [8] investigated the chemical composition of the bark, and found that the percentage of elements that determine the caloric value such as C, H, O, N, P is almost according to the stem wood. It means that calorific values of bark were similar to stem wood. The main obstacle to the use of bark as raw material for wood pellets is their low mechanical strength [4, 6] that leads to their destruction during storage. The literature has emphasized the importance of such research. But Tsyvin [4] to create pellets used old-fashioned technology, products moisture content reached 20%. This indicator does not meet modern requirements. Rynkevych [6] carried out research exclusively for one type samples (bark content 10%), which would be insufficient to determine the dependence.

The aim of this essay is to explore the relationship between content of the bark in wood pellets composed of pine and its mechanical properties.

Materials and methods. Samples of bark and sawdust from the tree trunk were obtained from pine industrial wood. Samples were selected in 2014 year during the procurement of timber. Sawdust was obtained by crosscutting of a pine trunk during procurement of timber, previously the bark was cut from a place with an ax. The samples were dried in the open air in the hangar without direct sunlight at a temperature of 20 ± 8 ° C during 4 months. Samples were stored on a flat surface, the thickness was 2 cm. Intermittently they were mixed up to prevent decay. Wood pellets were manufactured from samples in October 2014. Their diameter was 8 mm. Wood pellets were produced in accordance with DIN 51731 on industrial equipment. The length of the pellets was 35-40 mm. The following examples were produced:

C – sample made only from sawdust (standard sample);

CK10 – sample (90% - sawdust, 10% - bark). This proportion is specific to pine needle;

CK30 – sample (70%- sawdust, 30% - bark);

K - sample made only from bark (waste is obtained during primary processing of sticks).

Percentage of components of samples contained in the composition sawdust and bark was defined on their mass. The components were previously fragmented, so as to ensure maximum fraction of 5 mm. Humidity and quantity of minerals in the composition of bark and sawdust was significantly different [4]. Total moisture of samples and percentage weight that accounts for ash matter was determined.

Tests were conducted according to the method created on the basis of "National State Standard 16483.3-84 Wood. The method of determining the ultimate strength in static bending" The methodology of National State Standard stated that the samples should have a moisture content of 12%. If more humidity value results should be recounted. Therefore, we decided to carry out comparative characterization of samples where 100% strength accepted sample C (only sawdust).

In studies samples were placed on a stand of two monolithic copper wires. Wire diameter was 3 mm. They were placed parallel to each other. The distance between them was 30 mm. The load on the prototype was carried out using a lever kit. Lever kit was made of copper wire, it's diameter was 3 mm, it was placed in the middle between the supports. At the end of the lever kit we suspended the load. Thus changed the capacity. At this time, the other end of the lever kit was fixed on the link. Before the test samples were visually checked for absence of cracks and chips. The strength of the pellets was determined in triplicate.

Results. During the production of wood pellets, that contained bark, we observed large amounts of dust. It indicated a loss of material, air pollution and reasonability of using a closed system. Accordingly, changing the composition of pellets involves to select the appropriate mode of technological equipment. Humidity of sample C, CK30 and K was 6.9, 9.0 and 9.5 percent respectively, while the ash content was 0.38, 2.5 and 3.5% respectively. From this data, we can see that wood pellets, made of bark, had the highest ash content.

The benefit of biofuel for electricity generation is that wood pallets do not create an ash waste-disposal problem since ash can be spread in the forests or fields to recycle nutrients and not be directed to landfills as is ash from burning coal. [3]. In nowadays usage of ecological soil applications also is of the most immediate interest.

Good strength properties of the pellets are essential for the handling at the production plant due to the risk of dust explosions. Fine particles are more hygroscopic and have a larger relative surface area, which

permits more microbial growth than the unbroken pellets. This means a higher risk for temperature development in the pile, especially if the pellets are not properly cooled and dried before being transported to the storage pile. In small-scale handling, the dust is problematic, especially due to health risks. The durability of the pellets is dependent on the chemical and physical properties of the raw material as well as on the process variables during drying, milling, pelleting and cooling [9]. The relationship between raw materials and process variables is still poorly understood [10].

Figure presents the results for the average value of cross-breaking strength and its measurement error.

What is interesting in this data is that there were no significant differences in strength value of samples C and K. From this data, we can see that the partial introduction of the bark in wood pellets reduces their strength. This result may be explained by the fact that sample K had the least amount of fines that were lost during the milling (grinding) of raw materials. In fact fine content in pellets led to their destruction under mechanical efforts.

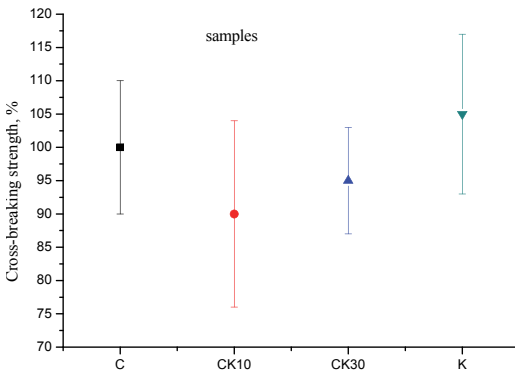

Fig. Dependence of the cross-breaking strength on the pellets composition

Conclusions

The current study found that bark is perspective raw material for making wood pellets, while introducing additional components is not necessary. Another important finding was that there were no significant differences in mechanical strength value of pellets made of pine bark and pellets made of pine sawdust.

Further research should be undertaken to investigate the certain processing modes, namely the feed rate of raw materials, steam temperature during extrusion etc.

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АНОТАЦІЯ

Опришко О.О., Опришко Н.О., Зубков І.С. *Експлуатаційні властивості кори, як біопалива для виробництва електроенергії // Біоресурси і природокористування. – 2015. – **7**, № 3–4. – С. 63–66.*

Розглянуто питання впливу вмісту кори на механічну міцність паливних гранул з сосни. Показано, що паливні гранули, виготовлені з кори та гілок, при статичному вигині мають міцність, порівняну зі стандартними зразками з тирси.

АННОТАЦИЯ

Опрышко А.А., Опрышко Н.А., Зубков И.С. *Эксплуатационные свойства коры, как биотоплива для производства электроэнергии // Биоресурсы и природопользование. – 2015. – **7**, № 3–4. – С. 63–66.*

Рассмотрены вопросы влияния на механическую прочность топливных гранул из сосны наличия в них коры. Показано, что топливные гранулы, изготовленные их коры и веток, при статическом изгибе имеют прочность, сравнимую со стандартными образцами из опилок.