УДК 674.81

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TECHNOLOGY FEATURES OF FUEL PELLETS FROM DECIDUOUS WOOD

The present researches are aimed at studying the physical and mechanical properties of pellets produced from hardwood. For the experiment black alder and birch widespread on the territory of the Republic of Belarus hardwood timber has been chosen. It is stated that the use of wood in an unaltered form is impractical because the pellets derived from them have a low mechanical strength. The technological solution of this problem was the treatment of crushed wood raw material by saturated steam. The results of industrial tests confirmed that wood particles activation of hardwood fuel pellets gives the required quality standard. Technical feature of the technology is the use of a matrix with the length of the pressing channel 33 mm.

Introduction. The current trend in the development of fuel-power complex in the Republic of Belarus contacts with the greatest possible use of renewable and non-polluting sources of raw materials. Timber cutting wastes and wood processing belong to such most available sources. These raw materials are a high-calorific fuel. The perspective using direction of wastes woodworking productions is considered to manufacture the pressed materials (biofuel) in the form of fuel granules. Today the market of fuel pellets extends enormous rates, and after the ratification of Kyoto Protocol about environmental protection by the majority of the states in the world (the Republic of Belarus ratified the contract in 2005) the demand for them grew in several times [1].

Coniferous woods in the form of sawmill wastes are traditionally applied in fuel pellet technology. The wood of coniferous species is an expensive and scarce raw material that is widely used in the woodworking industry [2]. Therefore the resources of this wood are steadily reduced. It results in the work necessary to involve the direction of cheaper and invaluable softwood in fuel pellet technology that in a large part still doesn't find practical satisfactory application in various branches of industrial production.

The technology and the properties of used wood raw material are known to make essential impact on the quality of produced biofuel. Therefore physics and mechanical quality indicators of fuel pellets derived from deciduous wood, and their comparison with those ones from coniferous wood – i. e. pine is of interest to study. According to references the structure, the morphology and the sizes of anatomic elements essentially differ not only coniferous and deciduous wood, but also a separate species [3].

Main part. The fuel pellets from the following forest species of Belarus – birches [Betula verrucosa Ehrh], an alder [by Alnus glutinosa (L.) Gaertn] and a pine [Pinus silvestris L.] were produced in vitro at the chemical woodworking processing chair of BSTU. The samples were made at granulation temperature 110°C and time of pressing 15 minutes. Humidity of initial raw materials was from 8 to 11 %, the fraction size was used 1.0/3.0, cooling of pellets was made as far as 20°C.

To research the physics and mechanical characteristics of obtained fuel pellet samples according to the requirements of STB 2027, humidity, ash-content, density, the lowest heat of combustion and mechanical durability was defined. The tests results of obtained fuel pellets are presented in Table 1.

Table 1
Physics and mechanical characteristics of fuel pellets

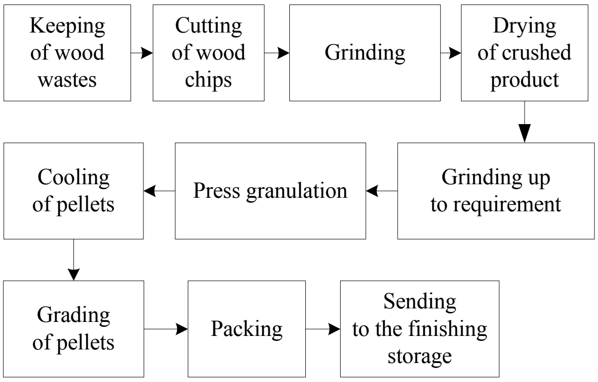
Name indicator	Wood species		
	Pine	Alder	Birch
Humidity, %	8.36	8.95	7.96
Ash-content, %	0.27	0.71	0.77
Density, kg/m^3	1150	1200	1110
Mechanical durability, MPa	9.83	8.74	8.06
The lowest heat of a combustion, MDZh/kg	18.39	17.49	18.43

From Table 1 we can seen that the lowest heat combustion indicators of pellets from deciduous and coniferous wood are comparable and vary in the range from 17.49 to 18.43 MDZh/kg. As to an ash-content, deciduous wood pellets have approximately in 3.5 times higher ash-content in comparison with coniferous ones. However the ashes that were formed during combustion can be applied as a fertilizer.

This experiment showed basically a possible replacement of coniferous wood by softwood in fuel pellets production. However obtained from alder and birch wood the pellets possessed the lowered mechanical durability (respectively for 11 and 18%) in comparison with the reached one, when using wood of a pine. It doesn't allow its fully using in fuel pellet composition. The results of industrial tests presented below showed that on applying additional processing by saturated steam of wood particles from deciduous species, it is possible to reach mechanical durability value of fuel pellets (granules), comparable with the reached one of coniferous wood. The process of wood particles steaming is a rather efficient way to increase the mechanical durability of fuel granules. Saturated steam effect resulted in the activation of wood components, the formation of new functional groups enhancing adhesive interactions during the process of pellets creation (granules). In the result of additional humidification of wood particles the temperature in the press granulator increased from 110 to 120°C. The high temperature of pressing provided a fast course of reactions and accumulation in a bigger amount of high-molecular compounds generally at the expense of high- reactionary gemicelluloses. The melted and softened components filled emptiness between fibers both capillary and submicrocapillary systems of cellular walls [4, 5]. Thus the quantity of wood components molecule cross-links, including spatial ones that provided the formation of strong products more and more increased.

The trial tests of fuel pellets, derived from deciduous wood particles previously processed by saturated steam were carried out on JSC Vitebskdrev. The pellets were obtained in the form of granules in the following geometrical sizes: in the length of 10–30 mm and in diameter of 6 mm. The content of a birch in composition of granules made 35%, an alder – 20%, aspens – 40%, pines – 5% (definition of pedigree structure was carried out in accordance with GOST 15815–83).

The full cycle production industrial line of fuel granules from vaporized wood particles includes the following basic equipment: the chopper, the crusher, the mill, the dryer, the press granulator equipped with the device for supply of saturated steam, the cooling column and the line on packing. The drawing shows the sequence of operations performance with use of the latter equipment [6].



The sequence of operations in the production of fuel pellets with using deciduous wood

In the whole the technological process of fuel pellets produced with use of pine wood in addition to deciduous wood is rather simple, effortless and the most automated.

The technical feature of production process was a matrix application with the length of the effective pressing 33 mm(instead of 45 mm) channel as deciduous in comparison with coniferous wood demanded a shorter-term thermal processing. As a result there was an electricity consumption decrease that involves a particular interest in use of various deciduous wood species in the fuel pellets technology.

Physics and mechanical characteristics of the obtained fuel granules are presented in Table 2.

Table 2

Physics and mechanical characteristics of fuel pellets made of the wood processed by saturated steam

Indicator name	Requirements STB 2027	Wood species	
		Pine	Deciduous wood composition
Humidity, %	9–10	7.9	6.3
Ash-content, %	0.4–1.2	0.22	0.78
Density, kg/m^3	1,200–1,400	1,170	1,220
Share of a trifle, %	7.0–8.5	1.4	2.0
The lowest heat of combustion, kJ/kg	more than 16,900	17,520	17,810

Note. The indicators of a trifle share and the lowest heat of combustion were defined in scientific research institute PCP BSU.

From Table 2 we can see that the trifle share indicator of the fuel granules made of wood particles processed by saturated steam has a low value that not only corresponds to STB 2027 requirement, but also exceeds it in 3.5 times that confirms a high mechanical durability comparable with that one of pellets obtained of pine wood. Deciduous woods emit enough heat at combustion and their high-calorific capacity is allowed to be proved. Some increase of the ash-content indicator of the granules obtained from composition, containing deciduous wood is limited by permitted values on STB 2027.

In general fuel pellets in the form of the granules, made during the experimental industrial tests corresponded to STB 2027 requirements.

Conclusion. The carried-out researches showed the possibility of almost complete replacement in the production of fuel pellets in the form of granules of expensive and scarce coniferous wood on cheap and invaluable softwoods. It is realized by processing of wood particles by saturated steam directly before their pressing (granulation). The steam activation of deciduous wood particles enables to obtain fuel granules with the quality indicators satisfying the requirements STB 2027.

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Received 21.03.2012