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RESEARCH OF INFLUENCE OF HARDWOOD SPECIES COMPOSITION ON PROPERTIES OF THERMOMECHANICAL PULP (TMP) AND PAPER MADE FROM IT

The paper studies the influence of widely zoned in Belarus hardwood birch, alder and aspen on the properties of thermomechanical pulp and paper made from it. Temperature of steaming intensifies the process of grinding chips of each tree species, mostly aspen wood. Bleaching with hydrogen peroxide helps to reduce energy consumption for grinding more than 15% and increase freeness of mass at 20%, besides bleaching can significantly improve the strength characteristics of paper. Aspen wood is the most significantly influenced.

Key words: birch, aspen, alder, unbleached and bleached thermomechanical pulp, two-step grinding, bleaching of paper.

Introduction. One of the main tendencies of the rational use of natural resources in pulp and paper industry is the obtaining of high output semi-finished products. Recently the technologies of mechanical pulp mass production from chipped wood providing the output of the target product from wood at the amounts exceeding 80% have been in the stage of intensive development. Among such types are thermo-mechanical pulp in the bleached and unbleached form [1]. These prospective fiber semi-finished products are used as the substitutes of expensive pulp in different kinds of paper.

At present the Republic of Belarus the most preferred raw material for the production of wood mass, in particular TMP is fir tree pulp wood. In the conditions of the constantly growing deficit of soft wood the most actual is the use of hard wood in these purposes that is widely spread on the territory of our country and at present has no wide practical use. For the enterprises of the Republic of Belarus such as RUE "Shklov Newsprint Plant" (Shklov), JSC "Dobrush Paper Factory "Hero of Labor" the issue of hard wood processing is very urgent in relation to large volumes of the planned consumption of source raw materials. As hard wood in comparison to soft wood has more complex and less ordered structure this determined the reduction of mechanical strength of the obtained sheet material, however, compensated by the reduced cost.

The conduction of real research was aimed at the increase of hard wood TMP and paper produced from it.

Main part. As source components for wood pulp such main hard wood trees as birch (*Bétula verrucose* Ehrh.), aspen (*Populus tremulae* L.) and alder (*Alnus glutinosa* L. Gaerth.) were considered that are widely spread on the territory of the Republic of Belarus. The data on the content of different anatomical elements in wood are provided in Table 1 [2, 3].

The contents of morphological elements in hard wood varies and it can be reflected on the properties of the obtained pulp used for the production of paper. Significant quantity of short libriform fibers in alder (70%) and birch (up to 68%) will have a negative effect on strength properties of paper quality. Pressroom properties of TMP made of alder and aspen wood can be higher in comparison to birch wood, it is caused by the greater number of cellular tubes in such wood (Table 1).

Table 1

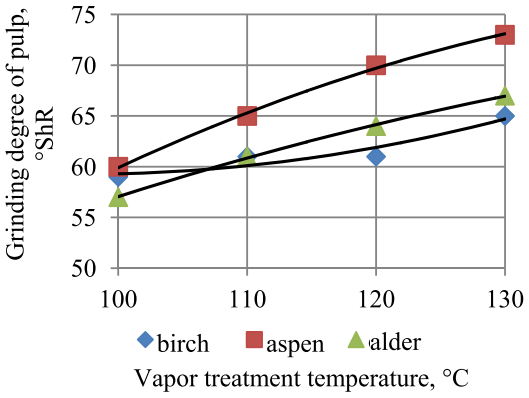
Average content of anatomical elements in the hardwoods

Anatomical elements	Content in the hardwoods, %		
	Birch (*Bétula verrucose* Ehrh.)	Aspen (*Populus tremulae* L.)	Alder (*Alnus glutinosa* L. Gaerth.)
Libriform fibers	60–68	61.0	65–70
Cellular tubes	21–27	34.0	44–46
Rays cell	10–11	13.0	11–12
Parenchyma	Below 1	Below 1	Below 1

In the laboratory conditions of the chair of chemical wood processing thermo-mechanical pulp was prepared from the chipped wood of each tree using vapor treatment at the temperature of 100–130°C before milling. It is known [4] that the process of chipped wood vapor treatment weakens intrafiber bonds and softens lignin. This provides flexibility and plasticity to fibers thus accelerating the process of chipped wood milling and increases the degree of grinding. This is confirmed by the research conducted by us in relation to chipped wood milling in order to produce TMP. A certain dependence of the degree of grinding from vapor treatment temperature was determined thus illustrating the picture where to-

gether with the increase of vapor treatment temperature the intensification of milling with the increase of the degree of grinding took place.

After the increase of temperature from 100 to 130°C the degree of grinding for birch increased by 6°ShR, aspen – by 13°ShR and alder by 10°ShR. Such changes in the degree of grinding of pulp speak of more significant effect of vapor treatment temperature in case of alder chipped wood.



Effect of vapor treatment temperature on the pulp's degree of grinding

The subsequent milling of chipped wood was performed in two stages. On the first stage – using centrifugal grinding machine at the speed of 130 rpm for 60 min. On the second stage – using laboratory grinding machine (LKR-1) at the speed of 2,000 rpm, blade gap 0.8 mm and duration of 5 min. Bleaching was performed between the stages of milling by addition of hydrogen peroxide to the mass after the first stage. And the concentration of mass was about 30% and the consumption of the concentrated reagent was 10%.

The specific energy consumption for the milling of the chipped wood of every kind of wood is stated in Table 2 where it can be seen that despite the similar milling parameters of the bleached TMP of all kinds of wood the degree of grinding is higher in comparison to the unbleached one and the energy consumption for milling is less. So hydrogen peroxide used as a bleaching agent (Table 3) together with its main function in the milling process demonstrated the properties of a beater additive. Under its exposure not only lignin softening and partial destruction of cell walls took place [4] but the acceleration of the subsequent milling, too. Bleaching reduced energy consumption from 3,100–3,300 kWh/t to 2,600–2,700 and exceeded the grades of grinding by 15–18°ShR. We must add that aspen parameters were the best ones.

From the obtained TMP the samples of paper were produced using Rapid-Ketten sheet paper machine. The samples were subjected to tests with the analysis of their physical and mechanical, sorption and optic properties (according to the standard methodology), the data are provided in Table 3.

As you can see from Table 3 peroxide bleaching between the milling stages provided the significant improvement of paper strength parameters, namely tearing strength parameter that was characterized by almost twofold increase for each kind of wood. This parameter was even bigger for aspen wood – increase by a factor of 2.4.

Table 2

Specific energy consumption for the milling of the unbleached and bleached TMP

Parameters	Unbleached wood TMP			Bleached wood TMP		
	birch	aspen	alder	birch	aspen	alder
Degree of grinding, °ShR	61	70	64	67	87	81
Specific energy consumption, kWh/t	3,100	3,280	3,230	2,700	2,600	2,650

Table 3

Parameters of the samples of paper received from the bleached and unbleached TMP of different kinds of wood

Parameters for the samples of paper	Samples of paper produced of the unbleached wood TMP			Samples of paper produced of the bleached wood TMP		
	birch	aspen	alder	birch	aspen	alder
Thickness, mm	0.4	0.7	0.6	0.3	0.4	0.3
Tearing strength, kN	21	80	75	123	192	150
Breaking length, m	Nondurable			2,230	2,460	2,390
Tearing effort, N	Nondurable			33.6	49.0	35.1
Paper capillary rise, mm	35	43	53	42	68	65
Whiteness, %	28	39	22	60	71	52
Opacity according to ISO, %	99.2	100	99.3	99.0	99.0	99.2

Conclusion. The research results demonstrated that all the considered kinds of hard wood (birch, aspen, alder) can be used for the production of the bleached TMP with further production of paper. Aspen TMP paper has the best physical and mechanical properties, the best whiteness and it required the least amount of energy for milling.

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