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ENERGY-SAVING TECHNOLOGY FOR PRODUCING THERMOMECHANICAL PULP FOR NEWSPRINT PAPER

The paper studies the influence of widely regionalized on the territory of the Republic of Belarus hardwood aspen on the specific energy consumption (SEC) spent on milling wood chips while preparing thermomechanical pulp (TMP) in newsprint production. Increasing the share of aspen wood in the composition of TMM leads to decline of SEC. Processing chips with sodium sulfite before its milling promotes SEC decline and significantly improves the strength characteristics of paper.

Key words: spruce, aspen, thermomechanical pulp, specific energy consumption, breaking length, newsprint paper.

Introduction. Newsprint is the most widespread type of paper products. At present the world's rates of production of newsprint equal to more than 70% of all kinds of paper used for printing purposes. Thermo-mechanical pulp (TMP) is still used as raw material for the production of newsprint. It is a highly efficient fibrous semi-finished product manufactured, as a rule, of fir tree wood that guarantees the production of high quality paper [1, 2].

However, the wide use of fir tree wood with this purpose lead to the deficiency of this raw material and it became more and more expensive. At the same time the process of TMP production is rather energy-consuming and at present growth rate in the consumption of this fibrous semi-finished product the search for the possibility to reduce energy expenditures for its production become more and more urgent.

The solution of this problem first of all lies in the use of hard wood as raw materials, namely aspen wood that is widely used in the western European part of the continent and is rather cheap and more accessible. Moreover, aspen wood has light color, homogeneous structure, low density and hardness, high values of water and vapor permeability [3]. All these aspects make the prospective of aspen wood use as a raw material for TMP production very attractive.

Main part. RUE "Newsprint Plant" in Shklov manufactures newsprint from fir tree TMP with chipped wood milling in compliance with RTS method. It is based on the combination of the short time of thermal and hydrolytic treatment (10–20 s in the temperature range of 160–170°C) and high frequency of the crushing disk mill rotor – 2,300 min^{-1} established for the first stage of chip milling that is the most energy-consuming [1].

The chair of chemical wood processing of Educational Establishment "Belarusian State Technological University" and RUE "Zavod gazetnoy bumagi" performed research aimed at the possibility of the reduction of energy consumption during the production of TMP.

TMP was produced in the simulated conditions imitating RTS method. Chipped wood was autoclaved at 160°C, than chipped wood was milled at 2,000 min^{-1} by crushing disk mill of the special laboratory milling set (LKR, Ukraine) equipped with energy consumption meter. The milled mass was used for the production of the samples of newsprint with weight of 1 m^2 equal to 45 g on Rapid-Retten laboratory sheet paper machine.

As reference samples for the research the compositions with various ratio (20–80%) of fir tree and aspen chips were used. In the similar conditions the comparative standards made from fir tree or aspen wood were produced. The degree of grinding was strictly regulated achieving (65 ± 2)°ShR.

Fig. 1 contains the data demonstrating the effect of the aspen wood in the composition with fir tree on specific energy consumption during chip disintegration.

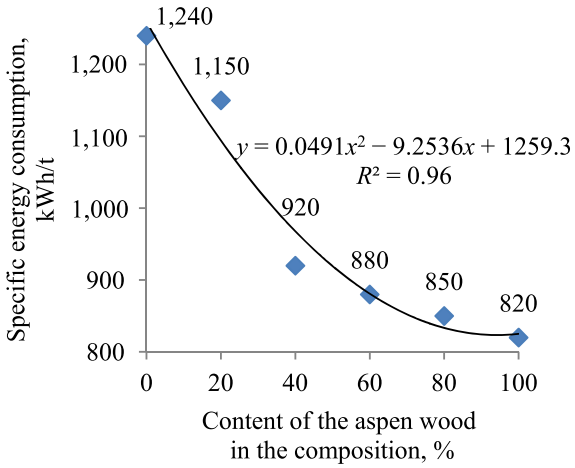

Fig. 1. Effect of the aspen wood on specific energy consumption during chip disintegration

As you can see on Fig. 1 the increase of aspen wood part consistently and proportionally to its content in the composition with fir tree caused the reduction of specific electric energy consumption on chip disintegration from 1,240 to 820 kWh/t, that is, obviously, is clearly related to the peculiarities of aspen wood anatomical structure and chemical composition.

To the contrast, the estimation of newsprint strength parameters after the addition of aspen wood demonstrated in Fig. 2 together with the analysis of the change in the breaking length of newsprint after the increase of the contents of aspen wood in TMP composition was negative.

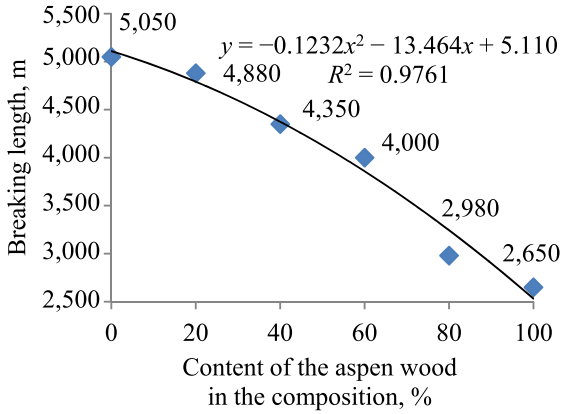

Fig. 2. Effect of aspen wood addition on the strength of the samples of paper

As you can see on Fig. 2, aspen wood consistently reduces the strength of paper produced from wood pulp. And according to GOST 6445 newsprint breaking length of grades A, B, V, O shall be in the range of 3,300 and 2,800 m. By the received data (Fig. 2) we can say that such values were achieved by the substitution of rather large quantity of fir tree wood in TMP composition for aspen wood, i.e. 80%.

The reduction of the value of breaking length is explained by the increase in the contents of fine-fibrous fraction and it is confirmed by the data of the fractionation of the produced wood pulp (Fig. 3).

Fig. 3 shows the data on the fractional composition of TMP containing of 20–80% of aspen wood with rather wide gradation.

Histograms in Fig. 3 show that upon the increase of the fir tree part substituted by aspen wood in TMP composition within the range of 20–80% the significant increase in the share of fine-fibrous fraction V in TMP is observed (from 12.5 to 27.6%) and the share of coarse- and average-fibrous fractions I, II and III is reduced by 7, 4 and 7% respectively.

It appears from this that the reactive capacity of fine fibers shall be increased by additional chemical treatment. According to the conducted studies this function is successfully performed by sodium sulfite that transforms into bisulfite in aqueous media, sulfiting lignin of wood with addition of hydrophilic capacity, increased swelling and increase reactive capacity. As a result, wood fibers bound by the middle lamella are easily separated, their length is preserved and the milling speed at the same time increases, thus, in its turn, reducing the consumption of electric energy.

The Table below contains the data on the effect of sodium sulfite consumption on specific energy consumption for chip disintegration and strength on the produced samples of newsprint.

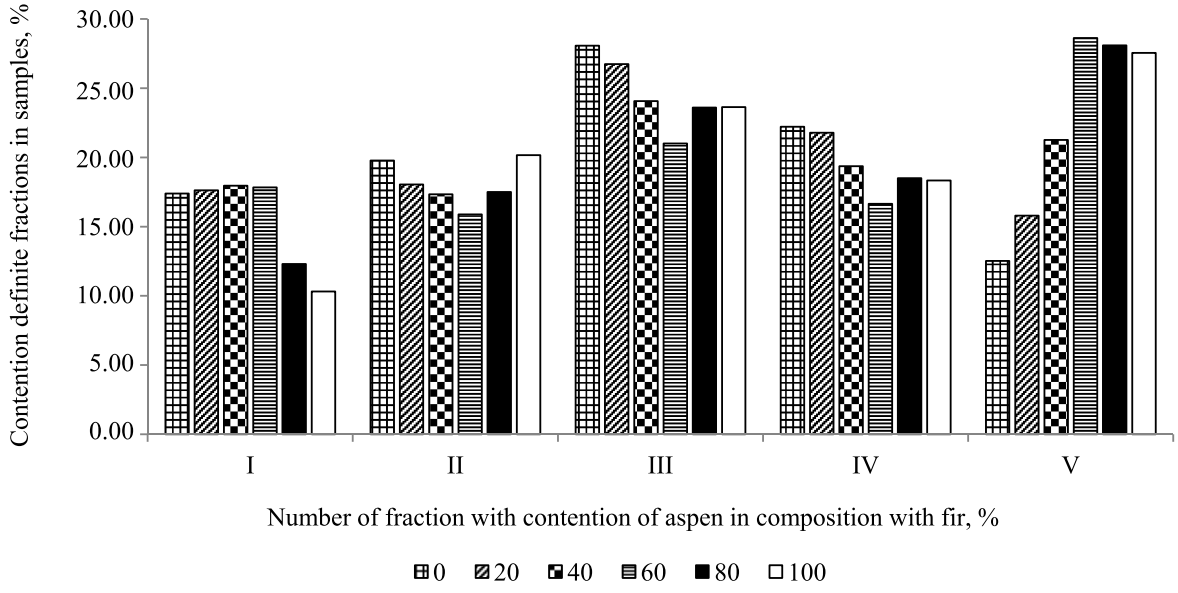

Fig. 3. Fractional composition of the thermal-mechanical pulp

Dependency of specific energy consumption and breaking length of newsprint from sodium sulfite consumption

Wood type	Sodium sulfite consumption, %	Specific electric energy consumption, kWh/t	Breaking length, m
Fir tree	0	1,240	4,640
	2.5	1,150	5,690
	5.0	1,020	5,750
	7.5	980	6,330
	10.0	960	6,980
Aspen	0	820	2,650
	2.5	780	5,370
	5.0	640	5,830
	7.5	550	5,640
	10.0	500	9,300

From the data provided in the table you can see that if chipped woo is treated with sodium sulfite prior to chip disintegration both fir tree and aspen wood become more prone to be milled, thus reducing specific energy consumption by 280 and 320 kWh/t respectively. We must point out that the degree of the effect of sodium sulfite consumption on aspen wood was more significant when compared to that of fir tree.

Conclusion. The research results demonstrated that:

1) the substitution of some part of fir tree wood for aspen wood in TMP composition in the production of newsprint reduces specific energy consumption for high-frequency chip disintegration in the range of 10–25%;

2) the treatment of chipped wood with sodium sulfite solution prior to its high-frequency milling reduces energy consumption for the production of TMP with the simultaneous increase in the strength of newsprint.

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