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INTERRELATION OF GEOMETRICAL PARAMETERS OF TECHNOLOGICAL CHIPSAND A DOUBLE-BLADE KNIFE IN LOG PROCESSING ON CHIPPER CANTER MACHINE TOOLS

Article contains results of researches on establishment of interrelation of geometrical parameter on chipper canter machines and technological chips and double blades knives when processing logs on milling of chipper canter machine. The analysis of graphic dependences of length of a slanted part technological chips, corner of a cut of an end face technological chips from size of shift of an axis of a log in relation to an axis of rotation of mills is presented. Expediency of equipment milling of chipper canter machines is confirmed with mechanisms of a vertical centering of logs.

Introduction. The problem of complex use of raw materials in the sawing industry deals with a number of questions, in particular with the optimization of timber cutting and trimming, with the decrease of power consumption in the process of processing, with the improvement of conditions of storing lumber [1], with means and methods of putting into processing waste products, with the creation of technological processes which exclude or reduce the quantity of waste but increase the quality of the received product [2].

Complex processing of wood by milling [3], widely adopted not only in the Republic of Belarus, but also in other countries is the essential contribution to the solution of this problem. It is accomplished by the use of expensive power-intensive modular equipment generally of foreign production: chipper canter machines (CCM) and lines on their basis.

On chipper canter machines modular processing of wood 8–18 cm in diameter with receiving a bar (square logs) and technological chips is the most effective. But the experience of exploitation of these machines in the Republic of Belarus and abroad shows that depending on the production technology logs with top diameter over 18 cm are processed on these machines. The use of CCM plays an important role for the Republic of Belarus.

Main part. The study of the peculiarities of a form formation of saw materials (sawn timber) and technological chips made possible to define the factors influencing the quality of the production received. They are defined most by geometry of the cutting tool of chipper canter machines.

Chipper canter machines are equipped with the special cutting tool – mills with a spiral arrangement of integral double blade knives.

Geometrical parameters of double blade knives with a spiral arrangement influence the process of receiving a bar (log) and technological chips on chipper canter machines and define the quality of the production received, power costs in wood processing process, and also the costs of cutting tools.

Double blade knifes are located on a conic surface of the mill case, and cut off wood layers of 5 mm thickness. Technological chips with a corner of a cut at an end face about 45º is formed.

Experimental process of cutting wood by double blade knives on FBS [4, 5] made possible to state that the surface roughness of a bar (log) layer depends on an angle of the entry of the knives i (i = 1, 2, 3 …) into wood and an angle at leaving it when processing logs. The angles are determined by the size of the vertical shift of a log axis in relation to an axis of the rotation of mills.

Angles of into and out entry of a i-knife from wood at the corresponding width to it a b_i layer of a bar vary because of the peculiarity of a milling tool design and transformation of the corners of cutting at rotation of the cutting tool.

Earlier it was determined that the length of the element l_e (mm) of technological chips represents the sum of chips length l_{ch} and the projections of its slanted part l_i and is determined by the following formula [6]:

$$l_{e,i} = l_{ch} + l_i = l_{ch} + \sqrt{R_i^2 - (a + \frac{b_i}{2})^2} - \sqrt{(R_i - \frac{S_{ch}}{\text{tg}\varphi})^2 - (a + \frac{b_i}{2})^2}, \quad i = 1, 2, ... \quad (1)$$

where l_{ch} – is the lengths of the chips, mm; l_i – the projection of the slanted part of the chips element, mm; R_i – the radius of cutting of i-m by the double blade knife of a milling tool; a – size of the shift of a log axis in relation to the axis of a milling tool rotation, mm; b_i – the width of a bar (log) layer which is formed by the i-double blade knife, mm; S_{ch} – the thickness of chips, mm; φ – the angle of the short blade knife's inclination in relation to a long edge.

From the expression (1) it is clear that the length of the element l_e of the technological chips changes only due to the projection l_i of its slanted part, as length of l_{ch} of the technological chips is a constant (i.e. 25 mm).

Let's define limit values of a and b_i. Ranges of change of the values a and b_i entering into dependence , we can find according to the technical characteristics of the chipper canter machines, for example PSP 500 (SAB manufacturing firm, Germany), scheme of log processing and milling is presented in Fig. 1.

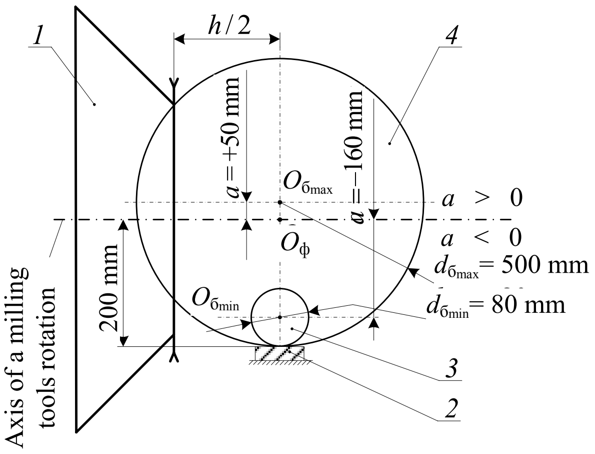

Fig. 1. The scheme of log processing on chipper canter machine PSP 500 (SAB, Germany):
1 – the left mill with double blade knives; *2* – support;
3 – log with the minimum diameter;
4 – log with the maximum diameter

In the course of milling machine work the axis of rotation of O_m of a mill *1* does not change it's position in the vertical plane and is at 200 mm distance from the surface of the support *2* on which logs *3* and *4* are based for processing in a range of diameters from $d_{б\,min} = 80$ mm to $d_{б\,max} = 500$ mm. In Fig. 1 right mill *1* which is symmetrically located in the relation to the support *2* is not shown. Axes of logs ($O_{l\,min}$, $O_{l\,max}$) can be displaced on size a above the axis of rotation of mill *1* ($a > 0$), and below ($a < 0$) or to coincide ($a = 0$) with the axis of rotation of mills depending on diameter of the processed log. The distance from the axis of rotation of the mill *1* to the axis of the log *3* of the minimum diameter is $a = –160$ mm, the distance from the axis of rotation of the mill *1* to the axis of the log *4* of a maximum diameter is $a = +50$ mm. The radius of cutting R_1 by the first double blade knife of the mill *1*, that lies near the surface of a bar layer is 225 мм. Double blade knives on the mill cut off wood layers about $S_{ch} = 5$ mm, and the tilt angle of the knife blades $\varphi = 45°$. If the layer width of the bar $b_{i\,min} = 0$ мм (i. e. the process of cutting is not carried out and the double blade knife does not form the layer of the wood); $b_{i\,max} = 0.7 d_{l\,max} = 350$ mm. Let's make a diagram of the dependence of l from a in the given ranges of change of dimensionless variable b_i ($0 \le b_i \le 350$ mm).

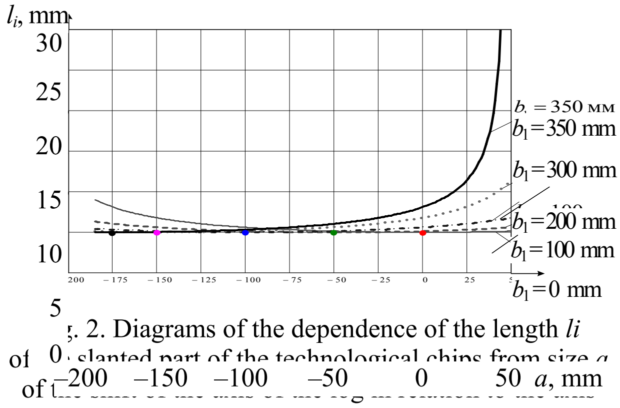

Fig. 2. Diagrams of the dependence of the length l_i of the slanted part of the technological chips from size a of [illegible] of mill rotation (• – minima of the dependence of l_i from a at different b_1)

Five diagrams of the dependence of the length l_i from a in the interval $–160 < a < +50$ mm at different meanings of b_1 ($0 \le a \le 350$ mm) are presented as an example on Fig. 2. It is clear (from the picture) that the minimum length of the slanted part of the technological chips does not exceed $l_{min} = 5$ mm. The greatest value of length of the slanted part of the technological chips in the range of change of variables a and b_i is equal to 47.17 mm for $b_1 = 350$ mm and $a = 50$ mm.

From (1) it follows that the length of the slanted part of the technological chip element depends on the thickness of S_{ch} chips received and the tilt angle φ of the short knife blade in relation to the long edge. The calculation (according to the expression *1*) with taking into account $l_{ch} = 25$ mm shows that the relation $l_{e\,max}/l_{e\,min}$ reaches 2.41.

Quality of the cut end surface of the technological chips depends on the angle φ_{ch} of it's cut end [7] therefore let's analyze the dependence of φ_{ch} from a at the given b_i meaning.

The tangent of the angle φ_{ch} of the cut end of the technological chips at the given thickness of S_{ch} is inversely proportional to the length l_i of it's slanted part. Taking into account formula (1), we receive:

$$tg\varphi_{ch} = \frac{S_{ch}}{l_i} = \frac{S_{ch}}{\sqrt{R_i^2 - \left(a + \frac{b_i}{2}\right)^2} - \sqrt{\left(R_i - \frac{S_{ch}}{\text{tg}\,\varphi}\right)^2 - \left(a + \frac{b_i}{2}\right)^2}} \quad (2)$$

In Fig. 3 the dependence diagrams of φ_{ch} from a in the set ranges of change of dimensionless variable b_i ($0 \le b_i \le 350$ mm) are represented.

In Fig. 3 five diagrams of the dependence of φ_{ch} from a in the range from $–160 < a < +50$ mm at different values b_1 ($0 \le a \le 350$ мм) are presented as an example. From Fig. 3 it is clear that for $b_1 = 350$ mm the angle of the cut end of the technological chips has the least value $\varphi_{ch} = 6°$ at the arrangement of the axis of the processed log above the axis of rotation of mills on the size $a = 45$ mm, and the maximum corner of the cut $\varphi_{ch\,max} = 45°$ is reached for all b_i at $a = –$

$b_i / 2$ (as it should be, as at $a = -b_i / 2$ the length of l_i accepts the minimum value).

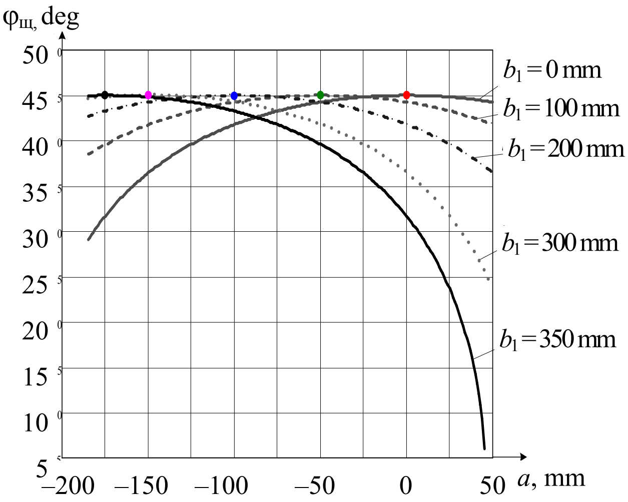

Fig. 3. The dependence diagrams of the angle φ_{ch} of the cut end of the technological chips from the size a of the shift of the axis of the log in relation to the axis of mill rotation

Conclusion. The presented analytical dependences (1), (2) establish the connection of technological chips parameters and a double blade knife (length, thickness, angle of cutting fibers). They influence the productivity of wood processing by mills with a spiral arrangement of knives, and also the quality of the production received and that's why it is necessary to take them into consideration while calculating the types of cutting and the design of mills. It should be noted that the presented analytical dependences do not consider the wedge angle of the long and short knife blades (β_l, β_s) and the back angle (α).

The carried-out theoretical research with the analysis of the regularities establishing the interrelation of technological chips geometrical parameters and a double blade knife, proves the expediency of the equipment of chipper canter machines with mechanisms of vertical centering of logs.

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