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PECULIARITIES OF MECHANICAL WOOD PROCESSING AND WOODEN PRESSBOARD MATERIALS BY GRINDING METHOD

The article is dedicated to particularity of the processing wood and slabby material by method grinding. It is described theoretical base grinding wood and polishing instrument different scientist in this direction. In article are considered main schemes grinding wood. To he pertain grinding with flat zone of the contact, with band wheel by part (cylindrical), with free tape, with pressed (narrow and broad ironing). In work is described nature of the construction of the polishing instrument, material abrasive, ways bulding of abrasive grain.

Introduction. The most important tasks of the wood-working industry are:

1) electric power economy, application of rational energy saving types of cutting;

2) increase of productivity, quality and accuracy of the processed production;

3) rational use of wood and composite wood products.

At present a large number of different machines and lines on the basis of combination of ways of milling and grinding are widely used in the world practice in furniture and other industries. The main attention is given to the constructive improvement of the types of machines, creation of rational technological lines on their basis taking into account operation regimes. Every year wood-working industry increases the output of composite wood products.

Main part. Abrasive processing with cutting a detail surface with the purpose to make it flat and highly smooth is called grinding. We distinguish belt, cylinder and disk grinding .

The grinding skin can be considered as a multi blade tool with a large number of cutting elements – abrasive grains with cutting edges. Grains from manufactured corundum, silicone carbide or other abrasive materials are connected with each other and with a paper basis, fabric, fiber or a combination of these materials by means of a sheaf from animal glue, carbamide or phenol resins.

The number of granularity characterizes the size of grains of the main fraction (part) of grain structure: for polished grains and polished powders it corresponds to the size (in the 100-th of millimeter) of the parties of a sieve cell side on which grains of the main fraction are collected; for micropowders and thin micropowders it is equal to the greatest linear size (in micrometers) of grains in diameter.

Key parameters of grinding mode for the skin of chosen granularity are: pressure on a ground surface, direction of grinding concerning wood fibers, speed of cutting, movement speed, length of contact with wood.

Each abrasive grain influences wood with an elementary tangent and normal force (formula (1)). The sum of these elementary forces makes the general tangent force Fxi and normal Fzi (Fig. 1).

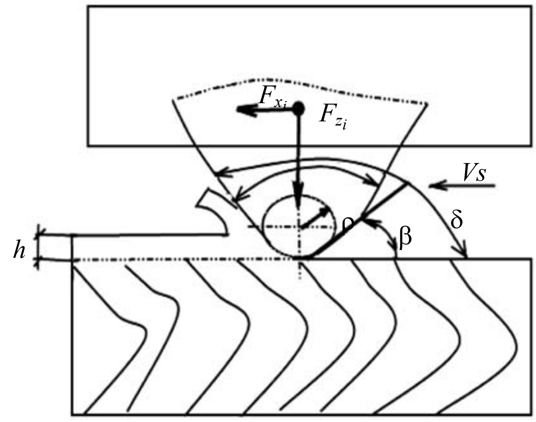

Fig.1. Diagram of cutting by abrasive grain

Taking into consideration that the process of grinding has no stable conditions of cutting, tangent force of Fx is considered as functional force of friction:

$$F_x = C \cdot q_i \cdot A,\ \text{H}, \quad (1)$$

where A – contact area: A = blk, sq. m; lk – length of contact of the grinding skin; b – width of the processed part of a detail; C – coefficient of coupling abrasives with wood [1].

Pressure in the zone of contact of the grinding tool with a processed material influences on the number of active cutting grains and on productivity of the tool.

The increase in pressure gives only little influence on the average thickness of cut-off chips and on roughness of the grinding surface. According to the experimental data, 50 times pressure increase leads to the increase in depth of roughness at only 5–14%. Practice and special researches show that at fair grinding the best quality of a surface is reached when grinding along fibers (the angle of the edge $\varphi_{with} = 0^o$). In fair grinding of a surface for high-quality furnish the angle of the edge not more than 15º is allowed.

At $\varphi > 15^o$, as, for example, when processing the boards lined in the firtree or in a rhombus, grinding of surfaces with microroughnesses of not more than 6–8 microns is required : only then the traces from the grains will be imperceptible.

Standard ratio of various manufacturing firms producing grinding materials (grain-oxide of silicon black)

Standard FEPA	GOST 3647-1980	Size of grains, micron	Standard FEPA	GOST 3647-1980	Size of grains, micron
P12	No. 160	1815	P220	No. 6	68
P16	No. 125	1324	P240	No. 5 and 4	58.5
P20	No. 100	1000	P260	No. M63	52.2
P22	No. 80	800	P280	No. M50	46.2
P24	No. 63	764	P320	No. M40	40.5
P30	–	642	P360	No. M28	35.0
P36	No. 50	538	P400	No. M20	18.3
P40	No. 40	425	P500	No. M14	15.3
P50	No. 32	336	P600	No. M10	12.6
P60	No. 25	269	P800	No. M7	8.4
P80	No. 20	201	P1200	No. M5	–
P100	No. 16	162	P1500	No. M3	–
P120	No. 12	125	P2000	No. Sq. m	–
P150	No. 10	100	P2500	No. M1	–
P180	No. 8	82			

Draft grinding of frame furniture and construction products with longitudinal and cross-section whetstones is recommended at $\varphi_{\text{with}} = 45^{\circ}$. We can find grinding with an edge angle of 90º, i.e. across fibers (processing of parquet boards).

At belt grinding an optimum length of skin contact in the direction of wood can be seen and measured. Grains of skin can cut off and carry away from the surface only that amount of shaving which can be located in intergrain air space. At excessive length of contact the shaving gradually fills all the free space between grains and pushes the skin from the product aside, because of what grinding becomes difficult and may stop. The optimum length of contact does not depend on speed of grinding, it slightly depends on pressure and kind of wood, but it greatly depends on granularity of the skin [2]. The standard ratio of foreign and domestic grinding materials is given in the Table.

It is very difficult to predict in advance the geometry of grinding surface since distribution of abrasive grains in the tool is casual and irregular.

In industrial practice the supposed depth of roughnesses on a polished surface, micron, is determined by the empirical formula (2):

$$R_{m_{\max}} = (110 \pm 20) \cdot (d_i / \rho), \qquad (2)$$

where d_i – size of grains of the main fraction of granularity, mm; ρ – density of wood, g/cm³; the sign "plus" – for a sharp skin, "minus" – for the blunt.

Speed of cutting when grinding wood is calculated according to the schemes of the process as surface footage on the surface of the pulley actuating the belt or the disk of the cylinder. The depth of grinding done (thickness of the removed layer) for one pass is presented in formula (3):

$$t_i = (\frac{2}{3})\left[R_{m_{\max(i-1)}} - R_{m_{\max(i)}} \right], \text{ mm}, \qquad (3)$$

where $R_{m_{\max(i)}}$ – the average size of the maximum roughness after processing, micron; $R_{m_{\max(i-1)}}$ – and the same before processing, micron. For preservation of high efficiency of the process details are grinded in two-three steps, reducing the granularity of the skin from step to step.

To calculate advance speed of the detail for given conditions of grinding, it is necessary to know the grinding rate of the tool (skin). Grinding rate of skin $a_{\text{ш}}$ – is the nominal volume, cm^3,of the material taken away from 1 cm^2 of the processed surface at moving of the tool along the surface in 1cm. Therefore, $a_{\text{ш}}$ has the dimension cm (³/ß¼ ² ß¼)·.

Specific productivity of the skin a_g is determined by the impiric formula (4):

$$a_g = 1{,}12 \cdot 10^{-6} \frac{q}{\rho} \sqrt{d_i} \cdot a_m a_p a_{\rho n}, \qquad (4)$$

where q – pressure, ka; ρ – density of wood, g/cm³; d_i – grain size of the main fraction of the given number of granularity, mm; a_m – correction factor on the kind of the abrasive material (electrocorundum) – 1; flint – 1.3; a_p –correction factor haracterizing the way of putting abrasive grains on a basis (gravitational (–1); the electrostatic – 1.25); $a_{\rho n}$ –correction factor considering the sharpness of the skin (sharp – 1.4; of average sharpness – 1; blunt– 0.7).

On the known a_g speed of movement is determined by the formula (5):

$$\vartheta_s = 6 \cdot 10^4 a_g \vartheta (l_k / t_i), \text{ m/min} \qquad (5)$$

When grinding we distinguish general tangent F_x, normal F_z and axial F_y (for example, at a tool oscillation forces received by summering corresponding forces of all cutting abrasive grains. Axial force because of its little power usually is not considered.

In design formulas tangent force is defined similar to the force of friction because of the defining role of the process of friction, as the normal force of cutting F_z, formula (6), practically, is set by the grinding regime as the total force of normal pressure on the area of contact f_k. thus,

$$F_x = F_z f_g; \ F_z = 0{,}1 q f_k, \text{ N}, \qquad (6)$$

where f_g – factor of grinding, size dimensionless; q–pressure on the area of contact, kPa; $f_c = Bl_k$ – area of contact, cm^2.

According to the belt, and the type of contact between the wood and the grinding belt narrow-belt machines are divided into groups [3].

On wide belt machines for surfacing and wiping local roughness (to 300 mm on the surface and to 0.2 … 0.4 mm in height) is taken away and reduced from the processed surface.

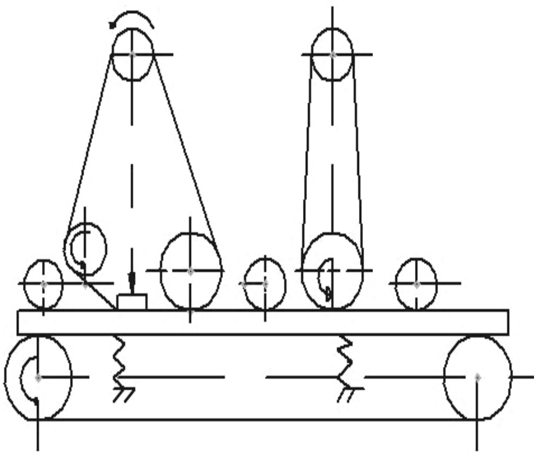

Fig. 2. Function scheme of wide belt grinders

Schemes of narrow belt grinding machines: a) with a pulley part of the belt; б) motionless table; в) contact clip by the wide iron; г) the same with the narrow iron (Fig. 3).

Machines with a free belt are applied to grinding of curvilinear details.

Machines with the contact clip are divided into two groups: with the clip by iron and the pulley part.

Among the first are the machines with the narrow iron in size less than the processed detail established on the carriage, and machines with the length of iron more than the detail on the conveyor.

The abrasive material can be of natural (pomegranate, sandpaper) or of artificial origin (silicon carbide), manufactured corundum – silicon oxide), the grinding belt is presented in Fig. 4.

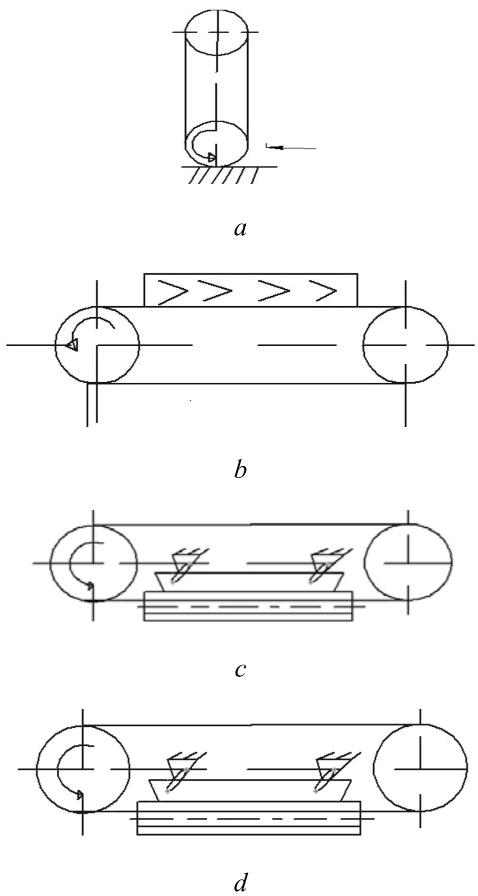

Fig. 3. Diagrams of narrow belt grinders:
a – with a pulley part of the belt;
b– motionless table;
c – a contact clip by wide iron;
d – the same with a narrow iron

Pouring of abrasive material on a basis can be carried out by mechanical (gravitation fields) or by electrostatic field (action of Kulonov forces).

We distinguish 100%, 75% and 50% – (rare) types of pouring [4].

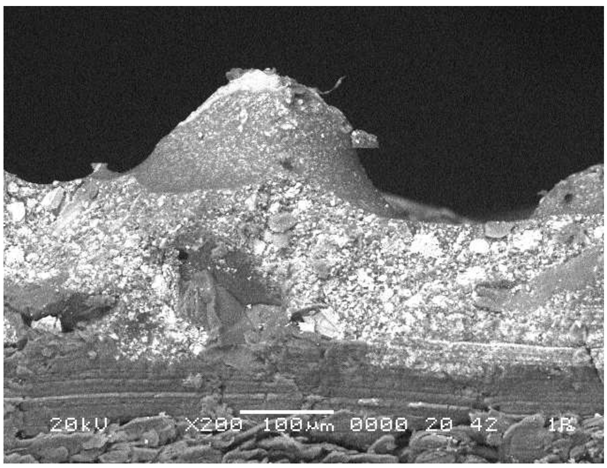

Fig. 4. Grinding belt P80 under the microscope

Thus, it is necessary to carry out grinding in consecutive cycles, beginning with a large abrasive grain, and at each other cycle it is necessary to apply more fine abrasive grain to achieve better polishing.

Many scientists in our country and abroad achieved great success in the study of methods of the mechanical processing of wood and composite wood materials by the method of grinding. Our native researchers V. V.Amalitsky, N. V. Makovsky, V. I. Lyubchenko, A.A. Pizhurin and many others paid also great attention to the problem of wood grinding.

Conclusion. By the results of the carried-out literary review and by the study of practical experience it is possible to do the following conclusions.

1) There is an expediency to carry out research work to study the dynamics of the process of grinding wood materials.

2) There is a great necessity to ascertain physics-mechanical regularities of energy expenditure during the process of grinding with obtaining needed quality (roughness) of the processed surface and taking into account the expense of the abrasive tool and its productivity.

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