ASPECTS CONCERNING THE SHARPENING OF MILLING CUTTERS USED FOR CUTTING THE WOOD

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Abstract
The milling represents the operation with the highest weight in the assembly of the processes of wood chipping, furniture and other finite products manufacture. As a consequence this is the subject of high importance both in research and especially in industrial application.

Key words: milling, kinematical parameters, kinematical parameters.

INTRODUCTION

At the operation of cutting the wood, the main factor of improvement of the splinting regime is represented by the quality of cut surfaces. This is determined by the kinematical parameters (cutting speed and advance speed – see the previous work) by the level of usage of the knives, by the characteristics of the wood, so on. The degree of usage of cuts, that is the quality of sharpening and the maintenance of the cutting capacity of knives, has a large influence on the cut surfaces [2]. A used blade does not cut the wood fibres anymore, instead it severs and wrests them, in such a manner that the cut surface presents severed, wrested fibres, as well as elements of burning» a well sharpened blade is considered when the rounding radius is of p_0 = 4 - 5 um and used, when the blade must be sharpened, if p_0 > 40 um (Câmpeanu M., et al.,2000)

MATERIALS AND METHODS

In order to emphasize the large influence of the usage degree of knives blade on the quality of cut surfaces, the next table is presented.

The influence of the usage degree of blade on the quality of cut surfaces

The degree of usage of blade, um	Longitudinal cutting		Transversal cutting	
	Quality of surface at:		Quality of surface at:	
	Mild resinous and deciduous trees	Hard deciduous trees	Mild resinous and deciduous trees	Hard deciduous
< 10	8-9	9-11	4	5
20	6-7	7-8	4	5
40	5-6	6-7	3	4

From the analysis of the data presented in the previous table it results that the usage of the knives has a large influence on the quality of cut surfaces. Thus, for the same regime of work, the quality class decreases, for example, from 9, corresponding to the sharpened blades, at 5, corresponding to the used blades, when the cutter is taken out of the equipment in order to be re-sharpened (Dogaru V. , 1981)

Influence of the usage of blades on the roughness of cut surfaces is bigger at:
- mild species (fibrous) which have the tendency to pile and wrest of fibres
- species with more knots or spinning fibres on the surfaces of wood

- cutting with the advance in the reverse sense of the direction of fibres.

At the transversal cutting, the influence of usage is more reduced, but here the roughness of cut surfaces is higher. Whereas the longitudinal cutting of hard deciduous with sharpened blades the class quality of surfaces is of 9 - 11, at the transversal one is of 5. As such, the degree of evenness of the cut surface varies a lot along the period between two sharpening procedures. It is imposed, as such, that the cutters should be taken from cutting equipments before the blades reach the maximum usage of 40 ***μm.***

For practitioners, it is necessary to define this moment through elements which are easy to notice (determined). These can be defined through:

-increase of cutting power with approximately 40 % in comparison to the initial value (easy to notice on a wattmeter – if the equipment has this kind of device)

- the cut surfaces present obvious bursts and avulsions of fibres, as well as elements of burns, especially at the mild species and at reduced advanced speed
- increase of noise and vibrations produced at cutting
- increase of regulation forces on the advance direction and of rejection of the piece by the tool on the direction perpendicular on the advance. These phenomena affect the functioning safety at the manual advance equipments.
- processing of a certain quantity of material. For example, the cutting of PAL covered with layers of melamine on both faces, the blades from K20 must be re-sharpened at the processing of approximately 900 m.l.

From those presented previously, it results that the usage of blades represents one of the "keys" for the improvement of cutting the wood, the following being imposed:

- blades with high resistance to usage
- re-sharpening in time of blades;
- improvement of the sharpening process and compulsory introduction of the three phases: roughing sharpening, finishing sharpening.

Currently, at the sharpening procedure, usually only the first phase is achieved (roughing sharpening), the blades resulting after sharpening with the rounding radius of approximately 20 μm. As follows, instead of being achieved at the beginning of cutting the 9th class of quality of the surface, only the 6-7 classes are obtained, which leads to a high increase of the percentage of the finishing operations, in order to reach the necessary quality class (the 9th class).

Main aspects of the sharpening technology

At the sharpening of knives, the following are pursued:

- preservation of the initial geometry of knives (profile, angles, so on)
- quality of blades (degree of sharpening)
- precision of positioning of blades in relation to the rotation axis (radius distance, axial distance, so on)
- preservation of the degree of maximum misbalance allowed (supposing that the cutters were initially balanced.

At the sharpening on the release face (cutters with backing off knives, cutters with cut or brazing, so on) the positioning of cutter in connection to the abrasive stone is usually made as in figure 1. The abrasive stone has a vertical position and the release face is positioned at the distance x in connection to its axis:

$$x = R \sin y$$

where R is the axis of the cutter, and y represents the release angle.

Because the knives are sharpened several times, it is necessary that the size of the angle y stays the same. In order to do that, the distance x has to remain constant, which is obtained by a slight turning of the cutter in the fixation device of the sharpening equipment, as in figure 1. In order to diminish the contact surface between the release face of the knife and the abrasive stone, it is necessary to be inclined with 1 - 3° in comparison to the surface which is sharpened.

The sharpening technology is established as follows:

- the thickness of the layer of material which has to be removed at one sharpening is established at g = 0,2 - 0,3 mm
- the features of the abrasive stone are chosen in connection to the nature of the material of blade

γ	$\sin\gamma$
15	0,25
20	0,342
22	0,375
25	0,423
26	0,438
28	0,469
30	0,50

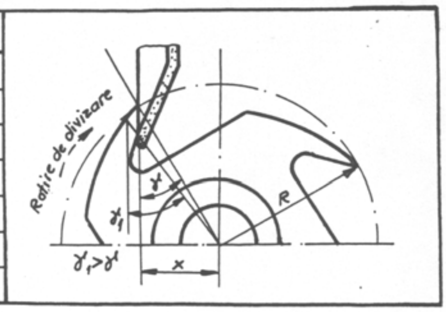


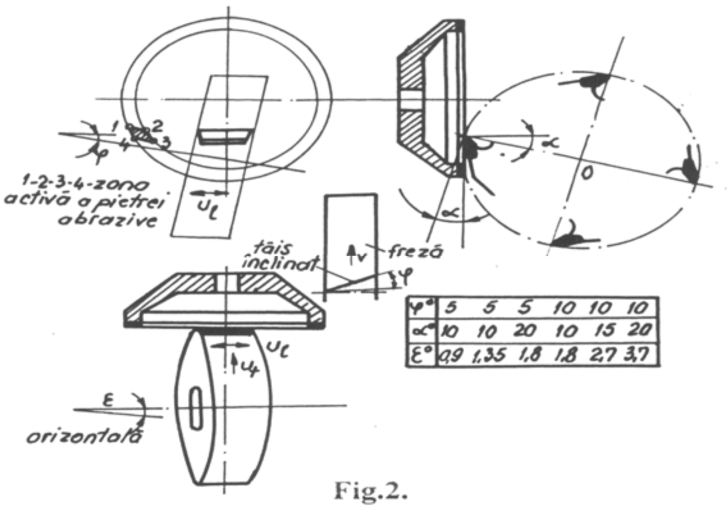
Fig.1.

- after all the knives were passed through the abrasive stone, the support is moved with transversal advance at the sharpening thickness fixed at a travel, and all the knives are passed again. The procedure is continued until all the travels for the roughing sharpening are done (usually 4-6 travels);
- in the same manner the finishing sharpening is done, using, usually, 2-3 travels of knives;
- it is recommended to do 1 - 2 travels in empty space (without transversal advance);

At this modality of sharpening (on the roughing face) the following aspects are noticed:

- the radial distance of blades, which represent the basic factor which characterizes the quality of sharpening – this being of maximum 0,01 mm – usually exceeds 0,05 mm. The value of radial distance depends on the class of precision of the distribution system, this being of $(360°: z)^{\pm 3°}$. This is done by the modern sharpening equipments. Also, the sharpening equipments must have a maximum functioning duration of 5 years. At the old sharpening equipments, you must first verify the precision of the index system (distribution). Also, you must verify the precision of the transversal advance, this ensuring deviations of maximum ±0,003 mm towards the nominal value of the transversal advance established at the sharpening regime.

<u>At the sharpening of knives on the positioning face</u>, the positioning of cutter in connection to the abrasive stone is done as in figure 2. If the blade is oblique, the tap of the fixing device is inclined in compliance to the angle of the blade. Thus, in figure 2 the vertical plan with the angle is presented (p and in horizontal plan with the angle £. In this way, the sharpened blade will describe at the cutting a cylindrical surface (D = ct.)



$\varphi°$	5	5	5	10	10	10
$\alpha°$	10	10	20	10	15	20
$\varepsilon°$	0,9	1,35	1,8	1,8	2,7	3,7

Fig.2.

The sharpening after this process is done with the same technology presented previously. We can also notice that, finally, the blades of knives have a smaller radial distance than the sharpening on the release face, values of maximum 0,01 mm being possibly achieved. This is because at this sharpening procedure also a "cylindering" of blades is done.

RESULTS:

Sharpening regimes. The sharpening regimes will be presented in short in connection to the material of the blade of knives. A. Blades from allied steel

1. Roughing
- abrasive material:
  - white or pink electrocorundum (96 - 98% AI2O3)
  - ceramic connection
  - granulation in metric system 60
  - hardness K,L
- sharpening regime:
  - sharpening speed v = 20 - 30 m/s
  - transversal advance at a double travel 0,04 - 0,08 mm/c.d
  - longitudinal advance 4-6 mm/min
  - abundant cooling 20 l/min

2. Finishing
- abrasive material: - white or pink electrocorundum (96 - 98% $A1_20_3$)
  - ceramic connection
  - granulation in metric system16-25
  - hardness L
- sharpening regime:
  - sharpening speed v = 30 - 40 m/s
  - transversal advance at a double travel 0,03 - 0,04 mm/c.d
  - abundant cooling 20 l/mm

B. Blades from rapid steels

1.1. Roughing (for blades from R_{p5} and R_{p9} which have a good processing at sharpening)
- abrasive material:
  - white electrocorundum (96 - 98% $A1_20_3$)

- granulation in metric system 25 - 40
- hardness H, I, J, K
- structure 6-7
- ceramic connection
- sharpening regime:
- sharpening speed v = 20 - 25 m/s
- longitudinal advance3-6 m/min
- sharpening depth at a double travel 0,04 - 0,06 mm/c.d.
- with abundant cooling 40 1/**mVrv**

1.2. Roughing (for blades from $R_{p]}$ and R_{p2} with have a weak processing capacity at sharpening)

- abrasive material:
  - white electrocorundum with superior qualities
  - granulation 25 - 40
  - hardness F, G
  - structure 6-7
  - ceramic connection
    - sharpening regime:
    - sharpening speed v=16-18m/s
    - longitudinal advance 3-6 m/min

4. Finishing

- abrasive material:
  - bakelite or ceramic binding
  - sharpening regime:
  - sharpening speed 25 -30 m/s
  - longitudinal advance 1-2 m/min
  - sharpening depth at a double travel 0,02 - 0,03 mm/c.d.
  - with abundant cooling

C. <u>Blades from sintered metal carbides (CMS)</u>

The work regimes for sharpening the blades from sintered metal carbides are presented in short in tables 1 and 2.

Table 1

Technical and work features at the sharpening of the positioning face of cutters

Technical values	Allowed values and work regimes
Verification at radial distance: allowed deviation – cylindering	0,01 mm
Roughing sharpening: abrasive stone	Diamond stone 0 100... 0 125 mm granulation D 91-D125, concentration 50, synthetic connection
Work regime, splintering depth on a travel	0,01...0,02 mm
Finishing sharpening: abrasive stone	Diamond stone 0 100... 0 125 mm granulation D 64-D35, concentration 75, synthetic connection
Work regime, splintering regime at a travel	0,005...0,008 mm
Verification at the radial distance: allowed deviation – cylindering	0,01 mm
Roughing sharpening: abrasive stone	
- work regime - splintering depth at a travel	Diamond stone 0 100... 0 125 mm granulation D 100-D180, granulation D 100...Dl80, concentration 30, metallic connection
Finishing sharpening: abrasive stone	0,01...0,03 mm

Work regime: - splintering depth at a travel	Diamond stone 0 100... 0 125 mm, granulation D 30- D15, concentration 30, synthetic connection 0,005 mm...0,008 mm

DISCUSSIONS AND CONCLUSIONS

Obs: If the same abrasive stone is used at the roughing, as well as at the finishing a stone with concentration of 50% is used and also synthetic connection

After the finishing a sharpening, the super-finishing (evenness) is performed with the help of pastes applied on a rotative disk from cast iron. The disk has a diameter of 250 - 300 mm and a peripheral speed of 1,5 - 2,5 m/s.

As abrasive past we recommend the composition: 60 - 70% boron carbide powder or silicon carbide powder with the granulation of 270 - 325 and paraffin 15 - 30%. The paste may also contain wax or castor oil plant.

The useful part of the evenness disk is grased with petrol and then the shining paste is applied, which is levelled with a rod. The evenness surface must be pushed on the surface of the cast iron disk and simultaneously moved along this. The sense of rotation of the disk must be the reverse of the sharpening stone. We recommend that the levelling should be done not on the entire face of the plate from metallic carbides, but only on the narrow stripe with the width of 2 - 4 mm and under an additional angle of 2 - 3° in comparison to the nominal positioning angle.

The pressure between the levelling disk and the surface of the knives must be of 1,5 -2,0 N/cm^2, and the longitudinal advance of 0,5 - 1,0 m/min.

After the levelling, a roughness of the processed surface is obtained, corresponding to the 10th class.

The operation of levelling may be done also with special diamond stones with granulation 400, soft concentration and synthetic connection.

Irrespective of the shape and material of knives, the operation of sharpening of cutters starts with their cleaning. This is because the cutting edges gather a crust of dirt, resulted from dust, tannin, wood resin, clays or lacquers which deposit and dry, due to the heating of the metal of the knife during the cutting. The cleaning is represented by the removal of these deposits, operations which is done with various diluting agents: petrol, carbon tetrachloride or hot water. In no case this operation will not be done with the help of metallic bodies, which may deteriorate the blade. Only cloths will be used, and also soft brushes or wood sticks.

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