Conference Proceedings of the Academy of Romanian Scientists
PRODUCTICA Scientific Session
ISSN 2067-9564 Volume **9**, Number **1**/**2017**

ASPECTS OF GRINDING LARGE PIECES OF RUBBER ROLLERS IN PAPER INDUSTRY

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Rezumat. *Lucrarea prezintă particularitățile de şlefuire a cauciucului în industria hârtiei. O analiză a variației rugozității obținută la finisarea stratului de cauciuc. Ea prezintă datele de tăiere folosite la maşina de şlefuit cu role.*

Abstract. *The paper presents the grinding rubber particularities in paper industry. An analysis of the variation of roughness obtained in the finishing of the rubber coat. It shows the cutting data used on the grinding roller machine.*

Keywords: grinding rubber; rollers with rubber coat; sheathed rubber; variation roughness; roll camber.

1. Introduction

In the paper industry roller presses from paper machines can be compared with some deformed grinders under their own weight and of the additional pressing tasks. The final product quality: the paper and also the normal operation of the paper machine can be negatively affected by the arrow which is formed by the rollers and which causes a patchy distribution of the pressing pressure on the width of the paper machine.

The problem was solved by the technologist specialists by eliminating the inconveniences caused by the deformation of the roller presses. The solution was the use of rollers with different diameters in length to exclude the arrow. These rolls are called bulging and the size of a camber roll is given by the relation:

$$k = D - D_0 \tag{1}$$

where: D is the diameter of the roll in the middle and
D_0 is the diameter at the ends of roller (see Fig. 1; Fig. 2) [2]

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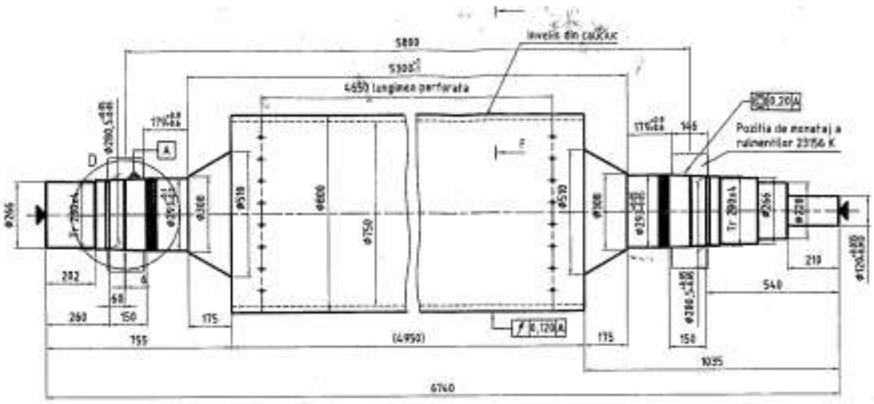


Fig. 1: Roller with rubber shell subjected to grind on the roll grinding machine

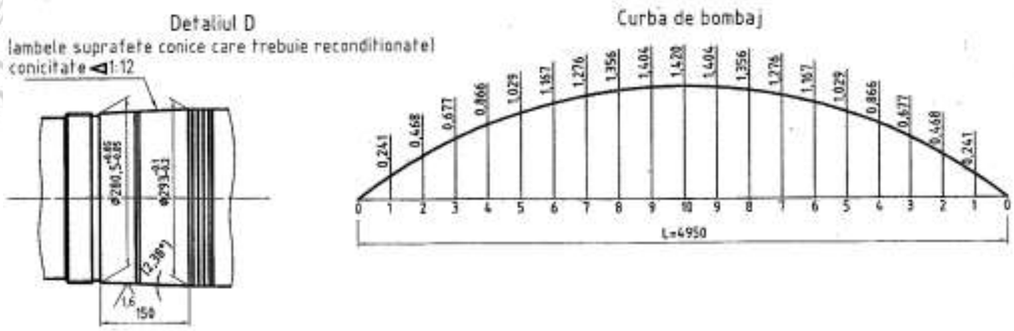


Fig. 2: The camber curve of the rubber roll

The roll with rubber shell that is analyzed must be made with a camber of 1.420 mm according to the technological requirements imposed on the grinding machine model XШ-193H8 Mosckba using linear copying mechanism of cutting by tilting the trolley grinding machine.

2. Particularities of rollers grinding machine

The correction of the rollers on the grinding machine (cylindrical and external) model XШ-193H8 Mosckba has the following characteristics: large dimensions of the work piece $D_{p\ max}$ = 1500 mm and of the grinding wheel, $D_{d\ max}$ = 900 mm; using grinding wheels with a step of soft medium or hard hardness; increased rigidity of the grinding machine and a strict specialization in rollers grinding, allowing the use of elevated values of the cutting depth (a_{pmax}= 0.8 mm) and of the longitudinal feed (fl, max = 300 mm/min); the positioning of the rolls on the grinding machine is made with the help of two half-bearing that supports the roller axis; the rotating of the roll is made by a drive group (engine P = 32 kW, n = 1500 r/min); range of rotations / min: 8-50 rev/min; the grinding machine is equipped with a linear device of copying with which is realized by copying the rollers camber (the maximum concavity and convexity which can be achieved is 2 mm). The maximum race of the tool holder saddle at the longitudinal rectification is 5000 mm. The grinding rock is driven by a continuous engine power with variable speed (engine P = 32 kW, n = 1500 r/min). Speed ranges 8-1500 rev/min) [9, 10].

3. Abrasive super porous corps used in the grinding of the rubber

In the process of grinding (abrasion) of the used rubber used as a shell for the rollers in the paper industry are successfully used abrasives super porous products which have a number of advantages:

- they heat very little the work piece (so-called cold grinding), where due to large pores, the air has the possibility to penetrate the disk and to form vortices which removes the heat from the processed surface from the work piece;
- not clogging pores;
- improve the processed surface;
- allow greater penetration advance;
- increase the grinding efficiency;
- have good self-sharpening and require an insignificant re-sharpening;
- the abrasive consumption is reduced;
- the cost of grinding is significantly reduced;
- have a low weight;
- have a good grinding for sensitive materials at heat (rubber, leather, felt) and high-alloy steels and stainless steels [6].

The super porous rock of dimension 600 X 304.5 X 80 (D X d X H) and the hardness H was used on the grinding machine XШ-193H8 Mosckba to the grinding of the rubber. The grinding rocks recommended to be used are: 33A46J10V for roughing and 22C80J10V for finishing [1, 10].

4. Grinding material

Hard rubber with the hardness Shore 92. In the conducted researches concerning the current stage of cutting processing or the abrasive preparations of the used materials as shells for the rollers of paper machines, but also for the rollers with rubber shell which are corrected periodically to adjust and reconfigure the technological combers imposed in the pressure systems where they fulfil the functional role of training the half-finished product (paper paste), given the high cost of a solider roller with its shell it can be concluded that the correct assessment of the cutting capacity or grinding the stones to be corrected it is a major challenge that must be respected in the optimization of the cutting process.

5. The dry grinding – the wet grinding with cooling liquid

We observed that in the dry grinding, the productivity is higher but the main disadvantages are: the trained dust from the little splinters and the fast clogging of the grinding rock and also the increased heating with a high risk of breaking the stone. In the analysis of the grinding process of the rubber shell without cooling liquid, were found some particles avulsions and binder from the grinding rock, forming small craters with a negative impact on the roughness of the rubber sheath (see Fig. 3 b).

The dry grinding was used only for the visual tracking of carrying out the grinding process of the rubber. The use of abrasive preparations fluids is necessary because in the grinding process takes place a high heat release which produces the local heating of the grinding rubber (the occurrence of local thermal stress), but also a chopper of the splinters which can cause pore filling of the grinding wheel (see Fig. 3 c and Fig. 5 a, b).

In the tracking process of dry abrasive preparation a great friction between the abrasive grains and the processed rubber sheath has been found. Moreover, the dry grinding produces a lot of dust (due to the use of the grinding wheel) with harmful effects on the operator and the grinding machine must be equipped with a very effective exhaust system.

a b c

Fig. 3: Photos a) dry grinding of the rubber b) pulling the granules c) little rubber splinters

The use of abrasive preparations liquid in the grinding operation of the rubber on the grinding rollers machine model ХШ-193Н8 Mosckba was made with a jet of rich liquid at a rate of 100 l/min using water or emulsion. In the optimization processing, the pump flow rate of 80 l/min has been changed to a pump 100 l/min noticing an effective cooling in the grinding process. This change of pump is a contribution given by the author of this paper. Using pump flow with the rate of 100 l/min, the heat elimination in the grinding process of rubber is very efficient. Thus as the temperature of the liquid is low, it is considered that the cooling took place under favourable conditions. At the grinding with water, was chosen an abrasive tool with a harder grade than in the dry abrasive preparation.

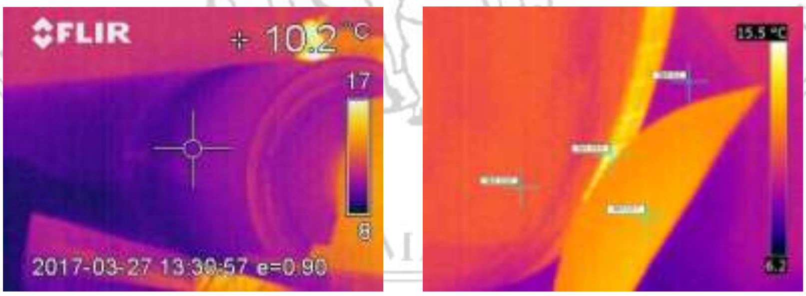
To increase the pressure and flow of the abrasive preparations a rougher grinding stone can be used because the cooling is more vigorous (abundant, constant and under pressure flow).

The liquid abrasive preparation most commonly used is the aqueous solution with small amount of soda ash, soap. At the finishing grinding, the liquid composition of the abrasive preparations may influence the surface quality grinding in a high proportion to the rest of the processing mechanism through cutting. We recommend keeping a clean coolant. The washing capacity of the coolant influences the finishing grinding; in this sense it is recommended to use liquids having a high washing capacity [4, 5, 7].

a b

Fig. 4: a) The grinding of the rubber shell with cooling liquid b) comparing the dry and the wet grinding

An effective indicator of an appropriate cooling in the process of abrasive preparation is the temperature occurred after the grinding, range 9^0-12^0C (see Fig. 5 a, b).



a b

Fig. 5: a) The temperature measured with the infrared camera for measuring the temperature on the grinding operation of the rubber (roughing); b) contact rubber sheath-grinding stone

6. The roughness, temperature and absorbed power analysis at the grinding of the rubber

In developing this current grinding research of the rubber appeared the necessity to determine the correlation between the different parameters of the cutting regime. For the roughness function, temperature and power were realized type polytropic equations:

$$R_a = C_R v_p^{\alpha_x} f_l^{\beta_x} a_p^{\gamma_x} \quad [3] \qquad (2)$$
$$T = C_T v_p^{\alpha_y} f_l^{\beta_y} a_p^{\gamma_y}$$
$$N = C_N v_p^{\alpha_z} f_l^{\beta_z} a_p^{\gamma_z}$$
$$R_a = f(v_p, f_l, a_p)$$
$$T = f(v_p, f_l, a_p)$$
$$N = f(v_p, f_l, a_p)$$

Number of conducted experiments $2^3 = 8$

Table 1: Factors of cutting data used at rubber grinding

Factor / Level	v_p [m/s]	**v** [m/s]	f_l [mm/min]	a_p [mm]
-1	0.33	25	111	0.025
+1	0.55	38	250	0.1

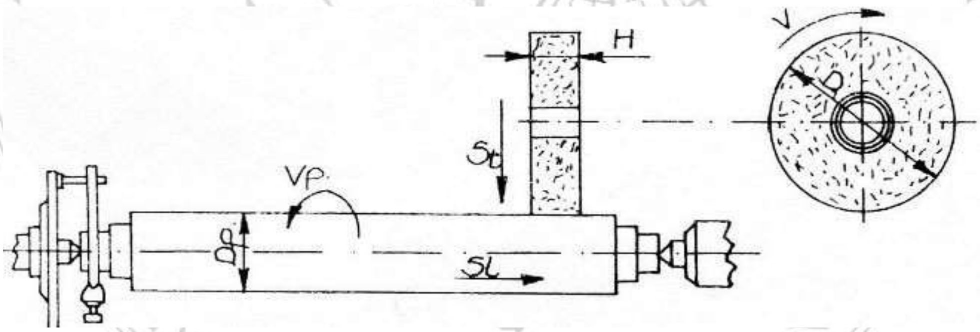


Fig.6 The plot of cylindrical external grinding for roller with rubber cover [1]

Table 2: Measurements

No. exp.	**Input factors**			Ra [µm]		Temperature T [^{0}C]	Power N [kW]
	v_p [m/s]	f_l [mm/min]	a_p [mm]	V_d=25 [m/s]	V_d=38 [m/s]		
1	+1	+1	+1	1,6	1,2	12	5,5

	0.50	250	0.1				
2	+1 / 0.50	+1 / 250	-1 / 0.025	1.50	1.1	11	5
3	+1 / 0.50	-1 / 111	+1 / 0.10	1.30	0.8	10.5	4.8
4	+1 / 0.50	-1 / 111	-1 / 0.025	1.25	0.75	10	4.6
5	-1 / 0.33	+1 / 250	+1 / 0.10	1.20	0.70	9.8	4
6	-1 / 0.33	+1 / 250	-1 / 0.025	1.10	0.60	9.6	3.95
7	-1 / 0.33	-1 / 111	+1 / 0.10	1.15	0.65	9.5	3.90
8	-1 / 0.33	-1 / 111	-1 / 0.025	1.10	0.50	9	3.85

For the considered functions:

$$R_a = f(v_p, f_l, a_p) \quad (3)$$
$$T = f(v_p, f_l, a_p)$$
$$N = f(v_p, f_l, a_p)$$

as a result of the processing the experimental data with the program DATA FIT version free 9.1.32 the following variation laws resulted:

a) Roughness

$Ra = 0.9819*v_p$^0.5909*fl^0.1837*ap^0.0563 (roughing) (4)
$Ra = 0.3642*v_p$^1.1292*fl^0.3886*ap^0.08100 (finishing)

The influence of the piece speed is manifested most on roughness versus longitudinal feed processing and the depth processing.

a) Temperature

$T = 5.6444*v_p$^0.8021*fl^0.3250*ap^0.1614 (5)

The influence of the piece speed is manifested more on the temperature versus the longitudinal feed of processing and of depth processing.

b) The cutting power

$$N=9.9438*v_p\hat{}-0.2876*fl\hat{}-0.2963*ap\hat{}-0.1889 \quad (6)$$

Using the program MINITAB 16 was drawn the graph of roughness variation taking into account the longitudinal advance f [mm/min] and the piece speed v [m/s] (see Fig.7 and Fig. 8).

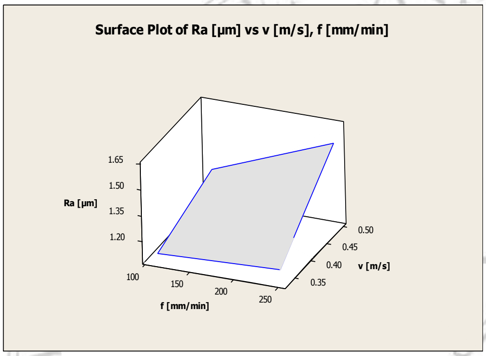


Fig. 7: The roughness variation of roughing according to the longitudinal advance f [mm/min], and the roller speed v [m/s]

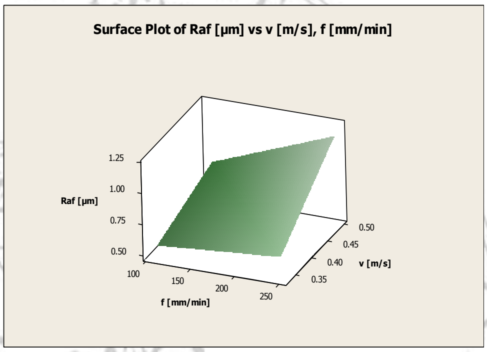


Fig. 8: The roughness variation of finishing according to the longitudinal advance f [mm/min], and the roller speed v [m/s]

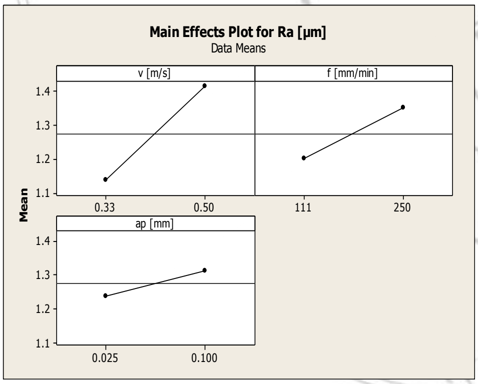


Fig. 9: Main effects plot for R_a [μm] (roughing)

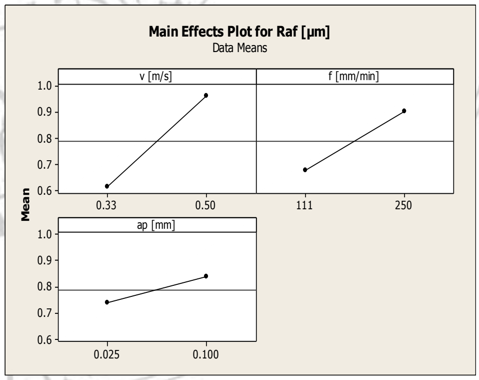


Fig. 10: Main effects plot for R_a [μm] (finishing)

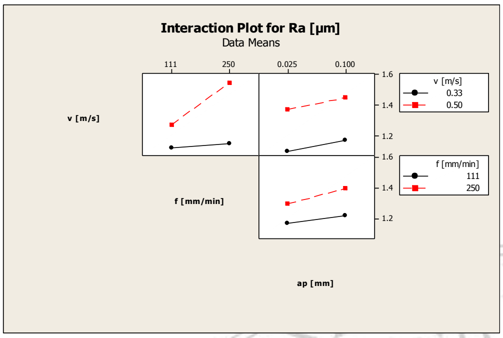


Fig. 11: Interaction plot for R_a [µm] (roughing)

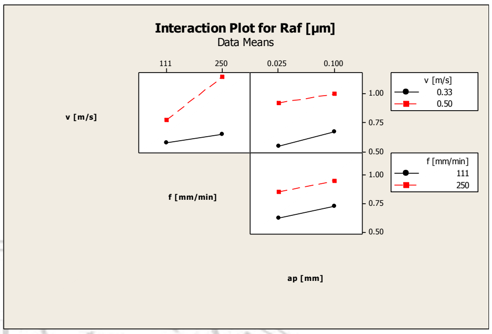


Fig. 12: Interaction plot for R_a [µm] (finishing)

7. Conclusions and directions to research

It was observed that the roughness increases with the roller (piece) speed v_p [m/s] and longitudinal feed f_l [mm/min] (Fig. 8 and Fig. 9).

For directions to research, it is also to study the influence of the material of mantle (rubber, stonit, micronit, diamantit), of the abrasive material and of the parameters of the cutting regime on the roughness of the manufactured surface, all thing considered the importance of roughness on the behaviour of the roller to avoid the appearance of fault of grinding.

The paper presents the results of the research regarding the rubber grinding, a material very sensitive to the thermal regime of the chopping. Personal contributions in the research concern the increase of the cooling flow (80 l/min to 100 l/min); the synergic use of a cooling air stream and the choice of an optimal regime for avoiding vibrations and processing defects on the surface of the rubber sheath (ricks, spirals, spots, burns). In other specialized references the aspects presented in the paper are less treated.

Notations and / or **Abbreviations**

f_l [mm min]= longitudinal advance
v_p [m/s]= roller (piece) speed
v_d [m/s]= disk speed
a_p [mm] = depth processing
N [kW] = power
R_a[µm] = roughness

R E F E R E N C E S

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