ASPECTS CONCERNING THE ABSORBED POWER AT THE RECTIFICATION OF THE LARGE RUBBER PIECES IN THE PAPER INDUSTRY

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Abstract: *The paper work presents the particularities grinding rubber of paper industry. An analysis of variance cutting power at roller with rubber coat and presents cutting data used for processing by machine grinding rollers. It also present some directions to processing by grindig rubber with porous grinding wheel and cooling flow abundantly.*

Keywords: *grinding rubber; roller with rubber coat; roll camber; cutting power; absorbed power*

1. Introduction

Rollers presses from the paper machines can be compared with some deformed grinders under its 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 negative 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. [Poppel, 1979] The technical solution approached by the technologist specialists is to eliminate the inconveniences caused by the deformation of the roller presses is 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:

$$K = D - D_0 \quad (1)$$

where D is the diameter of the roll in the middle, and D_0 is the diameter at the ends (Figure 1) and (Figure 2)

At the rubber rollers (sheathed rubber) due to difficulties in measurement of the diameter, it's defined the notion of periphery camber [Poppel, 1979]:

$$k_{periferic} = \pi D - \pi D_0 = \pi (D - D_0)$$

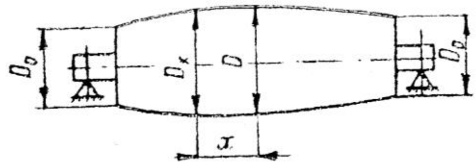


Figure 1: *The definition of sizes for the calculation of the roller's camber. [Poppel, 1979]*

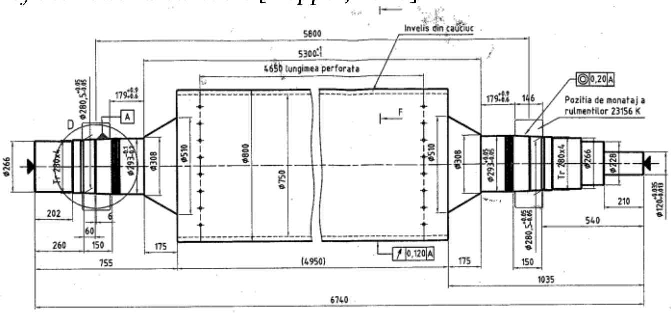


Figure 2: *Roller with rubber shell subjected to rectification on the roller griding machine*

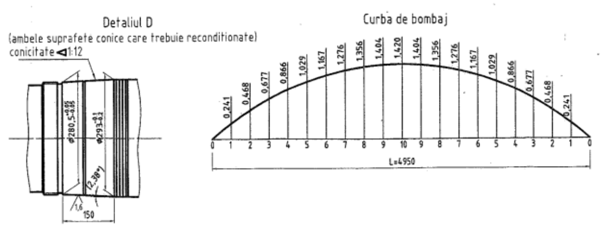


Figure 3: *The camber curve of the rubber roll*

The roll with rubber shell that is analyzed must be realized with a camber of 1,420 mm according to the technological requirements imposed on the griding machine model ХШ-193Н8 Mosckba using linear copying mechanism of cutting by tilting the trolley grinding machine.

2. Details the rectification of the rollers with rubber shell

From the camber theory for rolls presses paper machine results the importance of these cambers by cutting machining, in particular by the process of correcting the rubber sheath of the rollers, which are indispensable for the rollers of the paper machine, the correction is a process of utmost importance to obtain a high quality of the processed surface. Primary technological objectives to be attained after the correction are referring to obtain roughness, integrity of the processed surfaces (avoiding burnings, cracks, treads, remanent tensions; the rubber being a very sensitive material at mechanical processing) and also achieving the prescribed cambers.

The grinding of the rollers on the grinding machine (cylindrical and external) model ХШ-193Н8 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 discs 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); positioning 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). [Cartea tehnică ХШ-193Н8 Мосkba, 1978] [Machines a rectifier, 1982]

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 heat from the processed surface of 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 resharpening;
- 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. [Ștețiu, 1994]

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 ХШ-193Н8 Mosckba to the grinding of the rubber.

4. Grinding material

Hard rubber with the hardness Shore 85. 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 fulfill the functional role of training the halffinished 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

The preparation through cutting or abrasive preparation of the rollers with rubber shell presents distinctive features both in the dry grinding (no cooling liquid) and also in the grinding wet cooling liquid. In the dry rectification, 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, there 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. 4 b)

The dry grinding (without cooling liquid) was used only for 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 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.

a ***b*** ***c***

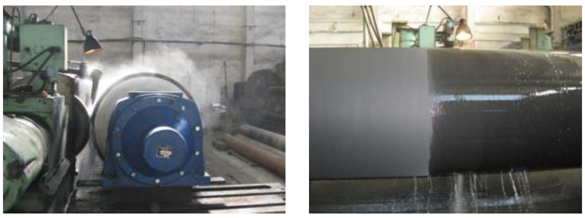
Figure 4: *Photo a) dry grinding of the rubber b) pulling the granules c) little rubber splinters*

In the tracking process of dry abrasive preparation it has been found a great friction between the abrasive grains and the processed rubber sheath. More over, 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 an exhaust system very effective.

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 a very effective cooling in the grinding process. [Catalog Carbochim, 2009]

Thus as the temperature of the liquid is low, it is considered that the cooling took place under favorable 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 can be used a grinding stone rougher 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. [Stefănescu, 2011]. 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. [Stefănescu, 2011] [Ștețiu, 1994]



a ***b***

Figure 5: *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 9^0-12^0 C (see fig. 6).

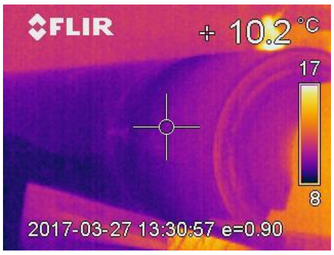


Figure 6: *The temperature measured with the infrared camera for measuring the temperature on the grinding operation of the rubber (roughing) with an abundant cooling, flow 100 l/min.*

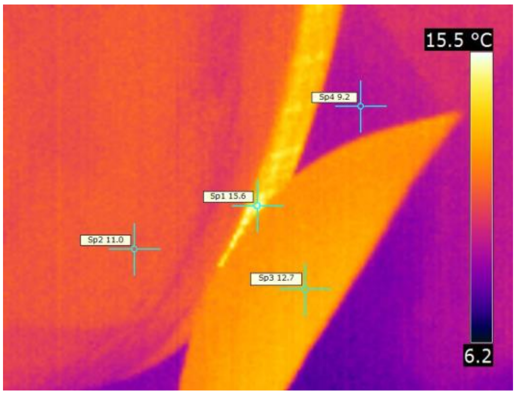


Figure 7 *The temperature measured in zone contact (disk-rubber)*

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

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

$$R_a=C_R v_p^{\alpha_x} f_l^{\beta_x} a_p^{\gamma_x}$$ [Străjescu, 2004]

$$T=C_t v_p^{\alpha_y} f_l^{\beta_y} a_p^{\gamma_y}$$

$$N=C_N v_p^{\alpha_z} f_l^{\beta_z} a_p^{\gamma_z}$$

$$R_a = f(v_p, f_l, a_p)$$

$$T = f(v_p, f_l, a_p)$$

$$N = f(v_p, f_l, a_p)$$

Number of realized experiments $2^3= 8$

Table 1: *Factors of cutting data* [Vlase, 2011]

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

Table 2: *Measurements*

No. exp	Input factors: v_P [m/s]	f_l [mm/min]	a_p [mm]	Ra [µm] V_d=25 [m/s]	Ra [µm] V_d=38 [m/s]	T [^{0}C]	N [kW]
1	+1 / 0,50	+1 / 250	+1 / 0,1	1,6	1,2	12	5,5
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

7. Conclusions and reasearch directions

For the considered functions:

$R_a = f(v_p, f_l, a_p)$

$T = f(v_p, f_l, a_p)$

$N = f(v_p, f_l, a_p)$

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

a) Roughness

R_a=0,9819*v_p^0,5909*fl^0,1837*ap^0,0563 (roughing)

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.

b) Temperature

T=5,6444*v_p^0,8021*fl^0,3250*ap^0,1614

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

c) The cutting power

N=9,9438*v_p^-0,2876*fl^-0,2963*ap^-0,1889

Taking into account the fact that the rubber grinding is a demanding operation (concerning the sensibility of the processed material) is required further reasearch at higher cutting speeds with high low for the cooling liquid, the use of grinding stones showing cooling channels, thus completing the synergistic effect of the cutting fluid in the grinding process. An additional cooling in the researched cutting process was performed with an aditional spraying with air unde pressure by choosing a suitable angle to avoid random splashing of the liquid jet. It was observed a better cooling and the increase of production.

Using the program MINITAB 16 was drawn the graph of power and cutting variation taking into account the longitudinal advance f [mm/min] and the processing depth a_p [mm]. It was observed a power increase with the depth increasing of processing and longitudinal feed (fig. 8). Also, it present another graphs with power cutting variation (fig. 9 and fig.10).

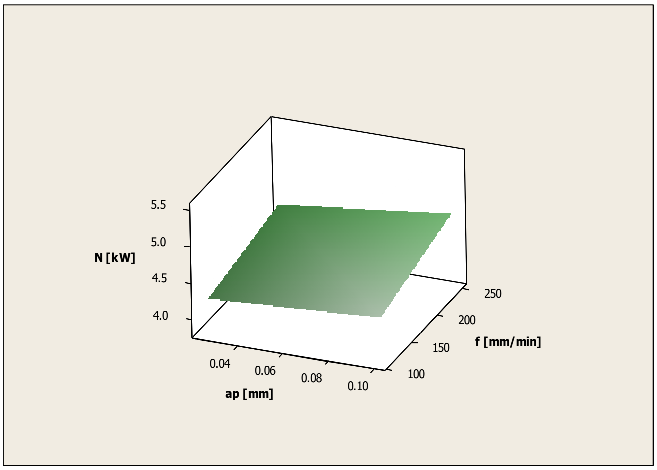


Figure 8: *The power variation of cutting according to the longitudinal advance f [mm / min], and the processing depth a_p [mm].*

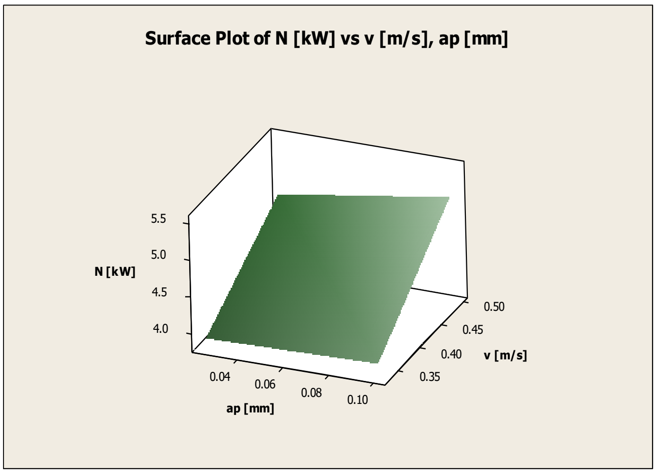


Figure 9: *The power variation of cutting according to the speed piece v [m / s], and the processing depth a_p [mm].*

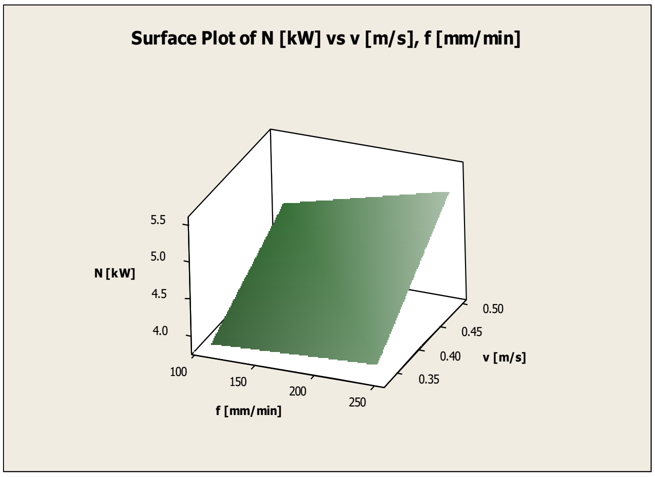


Figure 10: *The power variation of cutting according to the speed piece v [m / s], and the longitudinal advance f [mm / min].*

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