ABOUT THE INCREASE OF SURFACE QUALITY BY VIBRO - HARDENING

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INTRODUCTION

Vibro-hardening is a processing of the surfaces with axes of rotations, of the planes or the frontals surfaces. The processing is make by vibration of the deform element (ball, role, diamond point) which is into casket and a certain force is pressing on the process surface. The result is hardening, polish or creates a new regular microrelief (MRR) of a certain type on the process surface. In the case of the cylindrical exterior surfaces processing the dynamic parameters are the force (*F*) and the dimension of the deform element (d_b for case when using the ball). The cinematic parameters are the number of rotation (*n*), the vibration frequency (n_{cd}), the advance feed (*f*) of the deform element and the oscillation amplitude (*2e*)

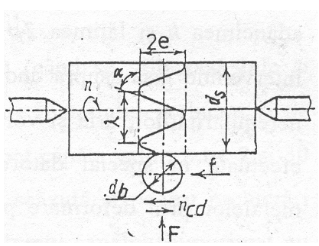


Figure 1. The vibro hardening parameters.

1. EXPERIMENTAL RESEARCH

This has been realized on testing above workpieces from different types of steel manufactured in Romania.

Studying the influence in every case the other parameters are maintaining constants. The surface roughness has been measured before the processing by vibro-rolling (after the fine turning) and after vibro – hardening, with the profilograph – profilometer Surtronic. The report between initial and final roughness has been noted with λand is named burnishing degree.

a) The influence of the number of rotations

For obtaining a type or another by *MRR* will chose with great attention the cinematic parameters process. Hove been identified variation limit of cinematic parameters for obtaining the MRR wished. Even in this limits, when MRR is completely new, the cinematic parameters exerts influence above the quality of process surface. The experimental values results of the research are related in the table 1.

Noticed the fact that when the number of rotations is raising, microrelief what results is with channel system (which is meeting or not) and only

Table 1. The experimental values regarding the rotation influence about the roughness and about burnishing degree.

n, rev/min	Constant parameters: F=400 N, f=0,048mm/rev; d_s=60mm; n_{cd}=470cd/min; 2e=1.6 mm, d_b=15.85 mm									
	OLC45, Rain=1.7μm		OLC35; Rain=1.6μm		OL60 Rain=1.5μm		18MnCr10, Rain=1.5μm		OLC15, Rain=1.4μm	
	Ra, μm	λ	Ra, μm	λ	Ra, μm	λ	Ra, μm	λ	Ra, μm	λ
25	0,23	7,39	0,21	7,6	0,19	7,89	0,16	9,37	0,12	11,66
31.5	0,24	7,08	0,22	7,27	0,2	7,5	0,18	8,33	0,14	10
50	0,27	6,29	0,25	6,4	0,23	6,5	0,20	7,5	0,16	8,75
100	0,38	6,47	0,36	4,32	0,26	5,76	0,23	6,52	0,18	7,77
125	0,47	3,61	0,41	3,90	0,30	5	0,26	5,76	0,20	7
200	0,55	3,09	0,43	2,72	0,35	4,05	0,29	7,17	0,21	6,36
250	0,62	2,74	0,48	3,33	0,37	3,66	0,31	4,83	0,23	6,08
400	0,70	2,42	0,53	3,02	0,47	3,19	0,40	3,75	0,26	5,38
500	0,73	2,32	0,63	2,58	0,49	3,06	0,43	3,48	0,30	4,66
630	0,75	2,26	0,66	2,42	0,54	2,77	0,47	3,2	0,33	4,24
800	0,77	2,20	0,68	2,33		2,63	0,50	0,57	0,36	3,88

using the advance working tiny and amplitude vibratory movement relatively diminished led to obtain the smoothly surfaces in such cases. In case which the practice is chosen correctly, can be obtained roughness raised after vibro – hardening than the initial surface (after cutting).

It's noticed that the roughness decreased (burnishing degree increasing) more and more accentuated once with the decreased hardness of the piece (figure 2). So that, for the steel OLC45 with the hardness HB213, the burnishing degree is between 2.2 and 7.39; at the steel OLC15 with

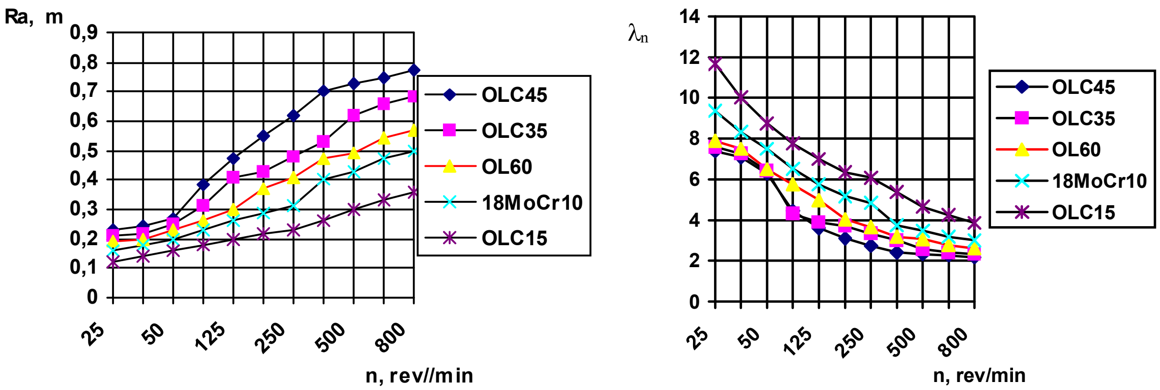


Figure 2. The roughness and the burnishing degree *vs* number of rotation

Table 2 Experimental results about the influence of feed by the burnishing degree

f, mm/rev	0,024	0,029	0,048	0,053	0,05	0,075	0,088	0,106	0,132	0,151
					Ra, µm					
OLC45	0,26	0,3	0,38	0,4	0,44	0,47	0,53	0,6	0,67	0,88
OLC35	0,23	0,28	0,33	0,36	0,41	0,45	0,5	0,57	0,63	0,75
OL60	0,2	0,22	0,26	0,29	0,33	0,38	0,45	0,53	0,59	0,7
18MnCr10	0,18	0,19	0,23	0,27	0,31	0,36	0,43	0,52	0,57	0,69
OLC15	0,16	0,18	0,21	0,25	0,29	0,33	0,39	0,48	0,53	0,65
					λ					
OLC45	6,53	5,6	4,47	4,25	3,86	3,61	3,2	2,83	2,53	1,93
OLC35	7,16	5,89	5	4,58	4,02	3,66	3,3	2,89	2,61	2,2
OL60	8	7,27	6,15	5,51	4,84	4,21	3,55	3,02	2,71	2,28
18MnCr10	8,8	8,42	6,95	5,92	5,16	4,44	3,72	3,07	2,81	2,31
OLC15	9,37	8,33	7,14	6	5,17	4,54	3,84	3,12	2,83	2,32

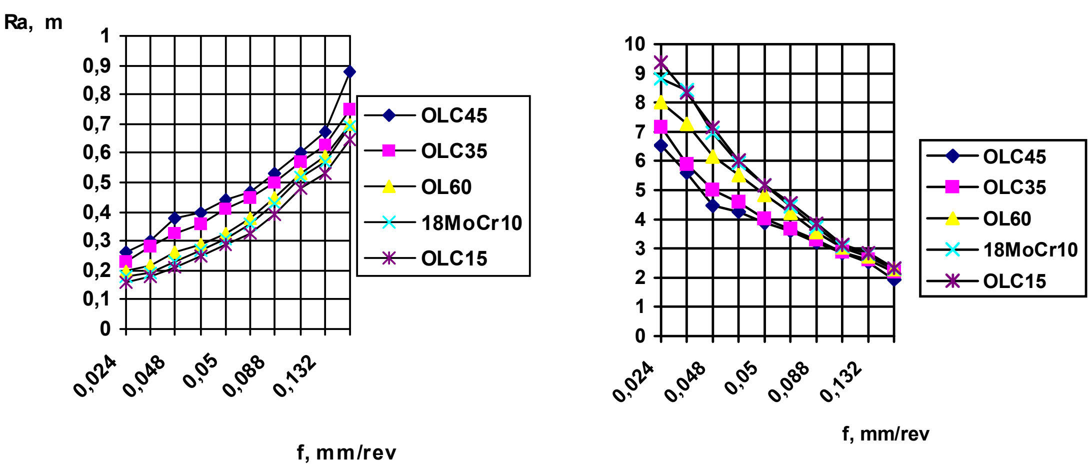


Figure 3. The roughness and burnishing degree *vs* feed.

HB115, this degree is 3.88-11.66. So that is has raised over 50% degree of burnishing once with the half hardness of the process material, will have to take into account the variation number of rotation.

at smaller advances. It's noticed the importance which it bas the correctly selection of the cinematic process parameters in concordance with the purpose for the type of microrelief after the process. At big

Table 3. The oscillation amplitude influence about the surfaces roughness and about the burnishing degree.

Ra, μm										
2e, mm	0,6	0,8	1	1,4	1,8	2,2	2,6	3	3,4	3,8
OLC45	0,12	0,19	0,23	0,31	0,42	0,49	0,57	0,68	0,84	0,98
OLC35	0,11	0,14	0,2	0,28	0,36	0,45	0,51	0,63	0,78	0,93
OL60	0,1	0,12	0,18	0,25	0,34	0,4	0,5	0,6	0,75	0,9
18MnCr10	0,1	0,12	0,17	0,24	0,32	0,35	0,48	0,6	0,73	0,88
OLC15	0,08	0,11	0,14	0,21	0,27	0,32	0,4	0,51	0,63	0,8
λ										
OLC45	14,58	9,21	7,6	5,64	4,16	3,57	3,07	2,57	2,08	1,78
OLC35	15,45	12,14	8,5	6,07	4,74	3,77	3,33	2,69	2,17	1,82
OL60	16,5	13,75	9,16	6,6	4,83	4,12	3,3	2,75	2,2	1,83
18MnCr10	16,5	13,75	9,7	6,87	5,15	4,58	3,43	2,75	2,26	1,87
OLC15	20	14,54	11,42	7,61	5,92	5	4	3,13	2,53	2

b) The advance influence

For following the advance influence have been made research the results of this research are given in table 2 and in figure 3. It's noticed that once with the raised of advance, the roughness raised too. This raised is accentuated for big values of advance. Concerning the influence which is practiced by the hardness of the material, we can make the notice that at little advance shoes that the degree of burnishing raised once the increased of the hardness material.. This raised of the burnishing degree is less accentuated big advance, practical at this advance is not interesting essential the hardness material, the new microgeometry resulting owing to the cinematic process parameters. For little advance, the burnishing degree is about 50% once with double of hardness material, reaching the raised only with 20%

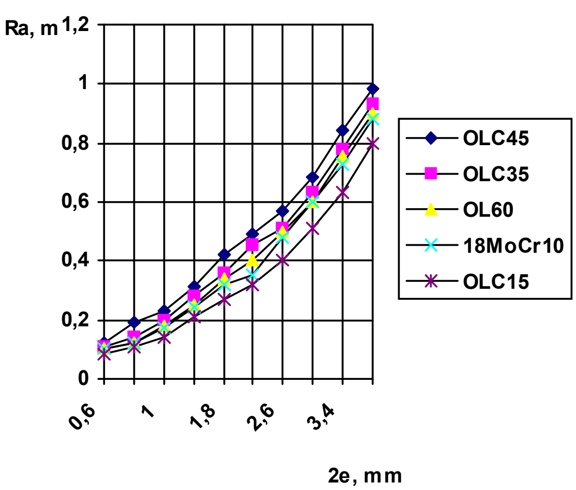
advance the deform element and at pressed forces bigger than the option value for the process material, on the proof appears delaminations of the superficial layer; this delaminations shows at little values of advance for materials with small hardness and at bigger values, for bigger hardness.

We can say that from the side of burnishing degree ideal we can used increased advance, which allowed us that on the some microirregulars to action more than a number of time, this solution is increased very much the process product.

c)The influence of the oscillation amplitude.

For showing the mode by influence of the vibration amplitude on the quality vibro hardening surfaces, will use the dates presented in figure 4.

It's observed that once the increased amplitude value, the surface roughness increases too



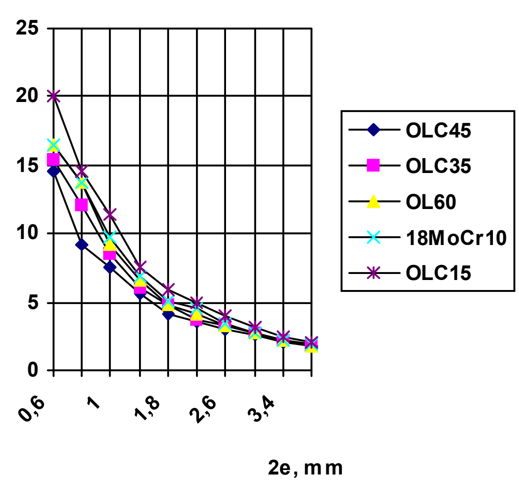


Figure 4. The roughness and the burnishing degree *vs* oscillation amplitude.

and the surface degree of smoothly decreases, for each of the five materials explored. The difference between quality coefficients of surface is significant at the small amplitudes, when at the materials with small hardness it's derived degrees of smoothly very big. This degree of smoothly have the tendency to reach a common value for all materials at the increased of oscillations amplitude, that is explaining through the microgeometry structure of surface only on the basis of the cinematic parameters.

d) The oscillation frequency influence

It's observed that once with the increased of the oscillations frequency (the number of double courses on minute and the oscillations frequency are direct proportional), the process pieces roughness decreases and the surfaces burnishing degree increases. Bigger increases of the burnishing degree are for mild materials and bigger values of the frequencies. Also, it's observed that the increase of the burnishing degree is quite fast until values about 700 cd/min, while, the increased is slower after this value. Though, it is apparent that the achievement of some devices who allowed the process with bigger frequency can bead further to an improvement of the surfaces quality.

The process of the experimental dates through statistical mathematics models, choosing the optimum form of the function after the Gauss criterion, led to obtain some mathematical models who indicate the dependence manner of the surfaces roughness and burnishing degree for a parameter of the vibro-hardening regimen, then when the other entry parameters are keeping invariable. It's obtained thus the models (1) and (2).

$$Ra = \sum_{0}^{n} C_{di} \cdot \frac{1}{d_b^{\,i}}; \quad Ra = \sum_{0}^{n} C_{n} \cdot \frac{1}{n^{i}}$$

$$Ra = \sum_{0}^{n} C_{fi} \cdot f^{i}; \quad Ra = \exp^{\sum_{0}^{n} C_{2ei}\cdot(2e)^{i}} \tag{1}$$

$$Ra = \sum_{0}^{n} C_{ncdi} \cdot \frac{1}{ncd^{i}}$$

For the burnishing degree it's obtained next relation:

$$\lambda_h = \frac{d_b}{C_{di} \cdot d_b + C_{2di}}; \quad \lambda_h = \sum_{0}^{n} C_{ni} \cdot n^{i}; \quad \lambda_h = C_{fi} \sum_{0}^{n} C_{fi} \cdot \frac{1}{f^{i}}$$

$$\lambda_h = C_i + \frac{C_{2i}}{2e}; \quad \lambda_h = \frac{n_{cd}}{C_1 \cdot n_{cd} + C_2} \tag{2}$$

The values of models coefficient (1) and (2) depend of the nature of the processed material and on the constant values of the other process parameters.

2. CONCLUSIONS

We can state that upon the obtaining a completely new microrelief surfaces by vibrohardening the cinematics of the process is essential. So that we are able to say that:

- The processing by vibrohardening ensures a high burnishing degree, which can lead to the values increase from 2-3 times to some tens of times, under special processing conditions, that is when the process parameters are established at values which have the most beneficial effect on the finish piece.
- The running parameters exert an influence on the degree of burnishing and roughness. The increase in motion speed, feed and range have negative effect and the increase of the ball diameter, of the oscillation frequency values and until a certain point of the pressure force is accompanied by beneficial effects on the surface roughness;
- The cinematic parameters must be chosen considering both the surface roughness after processing and the vibro-hardening yield;
- Before starting the processing, the cinematic process parameters must be chosen reasonably, as their wrong choice may lead to the formation of a channeled microrelief, whose burnishing degree possibly subunitarily shows that the surface roughness is greater that with the former processing;
- The type of microrelief and the special mode of operation where the roughness characteristics are easy to handle on the processing;
- The mathematical models are easy to handle on the stage when the parameters of the vibro-hardening are chosen and these models are included in computer programs that enable the choise of the mode of operation depending on the wished geometrical parameters.

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