

THEORETICAL AND EXPERIMENTAL CONSIDERATIONS REGARDING LAPPING IN ULTRASOUND FIELD - PART II -

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Summary: In this work are presented the main aspects of ultrasound activation of lapping process, as well as the influence of the amplitude of oscillations on rugosity, deviation from plan character and on productivity.

3. ULTRA SOUND ACTIVATION OF LAPPING PROCESS

In case of ultra sonic lapping, micro inaccuracies of the surface will be modified continuously as result of successive change of movement direction of the abrasive granules, their trajectories becoming unpredictable, aleatory.

At the application of low and high frequency oscillations will be ensured a better quality of the surfaces and will be reduced several times the consumption of energy through chipping and for friction of the bearing of main shaft. This thing will be explained by the fact that superposition of a ultrasonic field modifies the cinematic of chipping with abrasive granules, so will be activated the mechanism of formation of micro inaccuracies of the surface, facilitating material sampling and chip formation, improvement of self-sharpening and cleaning of the abrasive bars, will be decreased friction forces and evolution of heat in area of contact half- finished.

In the process of lapping within ultrasonic field, the ultrasonic activation intensifies the grains movement as a result of ultrasonic oscillations action (figure 2).

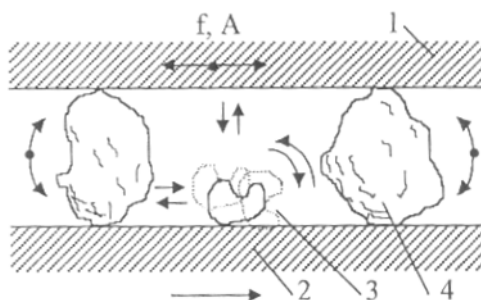


Figure 2 Simplified model of abrasive grains action in the process of ultrasonic lapping
1 – Working piece; 2 – lapping tool; 3,4 – small and big dimension abrasive grain

During processing, large grains perform active rotation movements, and small grains execute oscillation movements. A bigger load is applied on large grains between the lapping tool and processing surface than on the remaining abrasive, which conducts to their breaking and crumbling, the grains diameter would fast become uniform, the profiling effect of knife-edges would rapidly result.

Due to superposition, aggregation and destruction of abrasive grains, the external load shall be uniformly distributed all over the grains alignment with uniform diameters, which allows the increase of processing accuracy, surface flatness and homogeneity and avoidance of deep cuts on the processing surface.

The oscillation of small particles is executed in parallel, analogical phenomena to abrasive cleaning would appear. The processes connected to micro channels formation is thus activated, the improvement of surface roughness but also the emergence of some compression bottoming tension.

Also in the case of ultrasonic lapping activation, due to large grains rotation, their cutting-edges are rapidly following one another and the cutting capacity of abrasive is augmented.]

The processing should be directed so that dynamic behaviour of abrasive grains, their movement and profiling effect of knife-edges should be activated upon the application of ultrasonic oscillations. The formation of micro-channels is being accelerated, the material sampling process is improving, and consequently the productivity could be increased. A better recycling of abrasive material is performed, the facility for its supply, diminution of grains dimension in parallel with the emergence of new knife-edges; particles migration could result in a decrease of abrasive consumption and for roughness decrease and augmentation of processed surface quality the exchange of abrasive for a much finer one shall no longer be needed.

Material sampling at ultrasonic activated lapping takes place due to the following phenomena:

- percussion and displacement of the abrasive granules on the processing surface;
- percussion of the abrasive granules in the space between tool and piece;
- acoustic cavitations;
- chemical corrosion.

Cavitation phenomena have a relatively small gravity, especially at lapping with abrasive pastes, due to higher viscosity of the bearer liquid. Chemical corrosion can have significant gravity in case that in the composition of the lapping paste will be introduced elements that are chemical active.

At ultrasound lapping the volume of material alienated by an abrasive granule is the volume of a trigonal pyramid given by relation:

$$V_1 = \frac{\sqrt{3}}{6} a^2 h_p \quad (2)$$

where: a is the side of the pyramid;

H_p – depth of penetration in the piece.

Considering $a \cong 2h_p$ the relation (2) becomes:

$$V_1 = \frac{\sqrt{3}}{6} h_p^3 \quad (3)$$

Researches showed that ultrasonic oscillation might significantly intensify lapping processes, by removing most of negative emerging phenomena and satisfactorily influencing the quality conditions imposed on the processed piece surface.

The figure no 3 presents the influence of oscillations amplitude on roughness and circularity deviation in the process of internal cylindrical lapping, ultrasonically activated.

For the process of ultrasonically activated lapping, the increase of oscillations amplitude would also imply an insignificant increase of processed surface roughness value.

The circularity deviation decreases commensurate with the increase of vibrations amplitude until it reaches an amplitude value of 10 μm , after that an accelerated increase of roughness value takes place together with the increase of amplitude value.

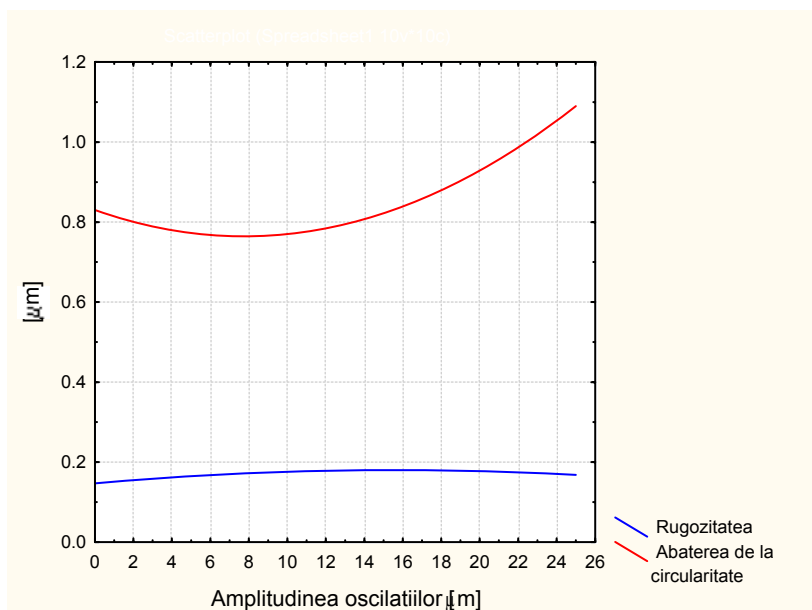


Figure 3 The influence of oscillations amplitude on roughness and circularity deviation

Operating productivity for the ultrasonic activated lapping is also affected by the amount of oscillations amplitude. The increase of oscillations amplitude would result in an increase of operating productivity (figure 4).

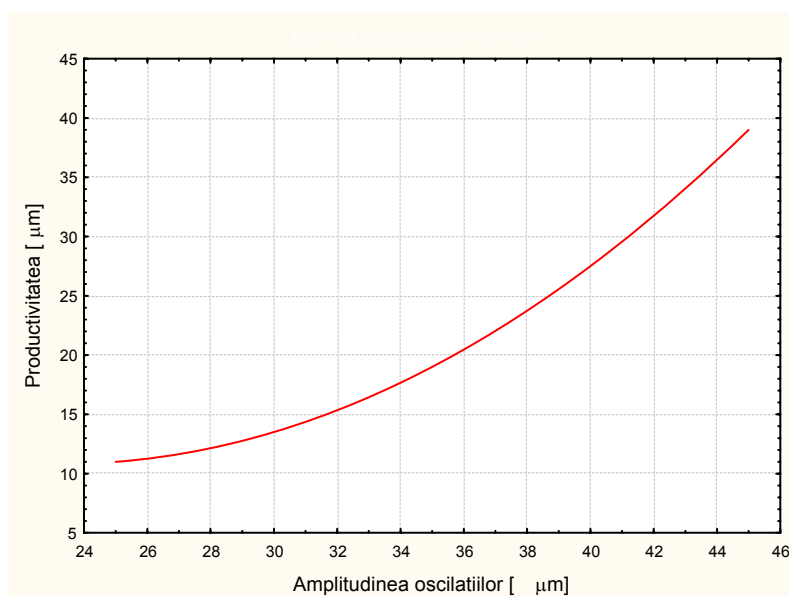


Figure 4 The influence of oscillations amplitude on productivity

4. CONCLUSIONS

Ultrasonic energy activation of processing lapping operation determines a range of positive aspects, such as:

- Better quality of processed piece surface, the correction of shape deviations within a short period of time;
- Better supply with abrasive material, improvement of accessing conditions for working liquid within the active processing area;
- Reduction of abrasive consumption by a decrease in abrasive grains dimension and an increase of active grains number.

Lapping ultrasound activated can be applied to pieces of relatively small dimensions, the gauge of the processing piece being limited by fixation in the concentrator ultrasonic system.

Ultrasonic lapping being less studied will be imposed the global evaluation of the performances of the procedure, of the application limits as well as perspectives of industrial application. Opened are problems connected to the modality of introduction of the ultrasonic oscillations in processing hearth, of designing and construction of the necessary dispositive, of perfection and optimization of this procedure.

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