ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VII (XVII), 2008

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

Ionel – Gabriel CHIRCULESCU
S.C. Complexul Energetic Rovinari S.A., doctoru21@yahoo.com

Key words: lapping, acoustic concentrator, lapping tool

Summary: In this paper are presented general notions regarding the ultra acoustic system used at lapping in ultra sound filed, which is composed by ultra acoustic transducer, acoustic concentrator and lapping tool, as well as technological characteristics of the lapping process in ultrasound field.

1. GENERAL NOTIONS REGARDING ULTRA ACOUSTIC SYSTEM USED AT LAPPING IN ULTRA SOUND FIELD

Lapping is the technological process of processing by cutting with granules or abrasive powder in suspension between processed surface and active surfaces of the tool in relative movement. Due to pressing pressure a part of abrasive will be imprinted on the surface of the lapping tool and by free movement of helical knots will be obtained a piece of very good quality of the surface.

Lapping in comparison with the other finishing processes in ultra sound field presents some particularities which reside in:

- refinement process will be realized with weak regimes of chipping;
- on the processed surface there are pits, scratches without a preferential direction;
- material assay on the processing surface will be realized mainly from chipping elements of the abrasive granules fixed temporary on the surface of the tool or in free status of the processing area;
- the processing surface it is submitted in the same time to mechanical actions but also chemical with the purpose of alienation of material particles.

In figure 1 is presented the principle scheme of an ultra acoustic system used at lapping in ultrasound filed.

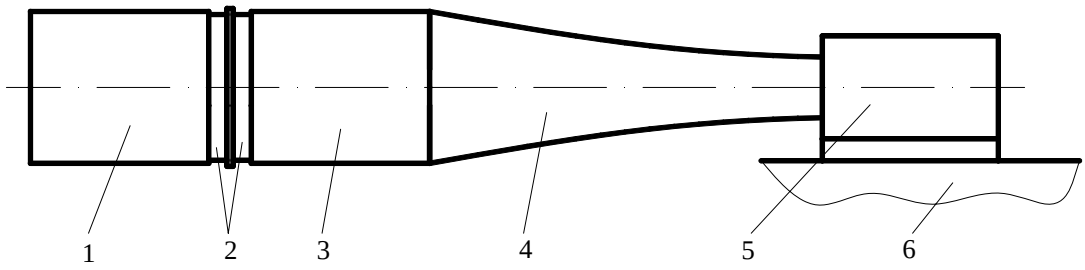

Figure 1 The principle scheme of an ultra acoustic system used at lapping in ultrasound filed
1 – reflector element; 2 – active element; 3 – radiant element; 4 – acoustic concentrator; 5 – lapping tool; 6 – processing tool;

Ultrasonic system used at lapping in ultra sound field is formed by:

- ultra sonic transducer formed of: - reflector element (1);
  - radiant element (3);
  - active element (2);
- acoustic concentrator (4);
- lapping tool (5);
- processing tool (6).

Active elements of the ultra acoustic system is the electromechanical transducer, which based on piezoelectric effect (which resides in apparition of electrical assignments induced on a surface of a body submitted to mechanical pressures, the size of electrical burden is proportional with applied mechanical tension, and the sign will change in rapport with deformation), transforms electrical oscillations applied by electronic generator in elastically oscillations. These oscillations are transmitted, concentrated and focused through the agency of acoustic concentrator in processing environment. All elements of the ultra acoustic system are rigorously calculated, designed and executed in perfect coordination of the acoustic, mechanical and constructive parameters.

High frequency electronically generator, used as energy source, transforms electric current of industrial frequency in high frequency current. The frequency of the generator is granted by main frequency or the first harmonica of the converter of ultra sound energy, named resonance frequency.

Ultrasound generators are characterized by the following electrical measures: frequency or scale of work frequency, exit power, effective power, stability and precision of regulation of the frequency etc and by non electrical measures which refers especially to simplified construction, gauge, mass, cooling modality, noise level, etc.

The stability and precision of regulation of the frequency are especially important in case of chipping assisted by ultrasounds. These two characteristics should not depend on variation of burden, which is variation of parameters of the chipping regime.

It is necessary that the generator ensures the maximal approach of its frequency ν_g by the resonance frequency ν_0 of the transducer, and the difference $\Delta\nu = \nu_g - \nu_0$ should not get out from the resonance the ultra acoustic system. In case of using ultrasounds for the activation of classical procedures of processing through chipping it is very important the rapport in which is situated the amplitude of the oscillations of the transducer A_t, at resonance frequency, in comparison with its admissible value A_a, given by relationship:

$$K_a = \frac{A_a}{A_t} = \frac{1}{\sqrt{1+\left(\frac{2\Delta\nu_a Q}{\nu_0}\right)^2}} \qquad (1)$$

where:

Q is quality factor of mechanical system;

$\Delta\nu_a$ - is admissible difference of frequency between the frequency of the generator and the resonance frequency of the transducer.

Transducer is the element that transforms with an imposed effective power the electrical energy in acoustic energy.

The ultrasound concentrator allows that the acoustic energy is concentrated in a smaller volume and to obtain ultrasound waves with increased intensity. Ultrasound concentrator makes connection between transducer and the transfer object with the purpose to increase the amplitude of oscillation and to ensure an impedances accord between transducer and the burden of working space. Concentrator has the form of a bar with variable transversal section and generator is exponential.

Chipping tool makes connection between concentrator and work surface, being many times the effective work tool, supplying the useful amplitude, in conditions of minimal loss of better energy and a wear and tiredness resistance.

To realize the unity and stability of an ultrasound system to accomplish the functional role are also necessary:

- adaption elements and of acoustic coupling which realizes an efficient mechanical - acoustic connection for an optimal transfer of energy between the elements of the installation;

- systems of mechanical and acoustic fixation refers to fixation modalities of different elements of the ultra sound system and its fixation in the resistance structure. From energetically considerations and of dynamic stability their assembly will be realized in a node of oscillation of the element of acoustic adaptation.

There are, however, a series of common requirements, technological and acoustic that any acoustic system has to comply with. The technological requests should be observed by the final part of the system – the acoustic transformers; they are linked to calculation and making accuracy, wear resistance and fatigue, the system's hardness, operation stability, the quality of junction with the transducer, etc. The acoustic requirements are determined by the need to create within the entire oscillator system of an oscillation regime that would allow the efficient conveyance of the ultrasonic energy from transducer to medium. They could be formulated as follows:

- minimum energy losses in transducer and transformer;
- the maximum concentration of the ultrasonic energy;
- the stability of the resonance regime for the oscillator system;
- the optimum adaptation of the system to the electric oscillations generator;
- uniformity of acoustic energy radiation throughout all the utility domain;
- maximum efficiency;
- maximum acoustic responsiveness;
- maximum directivity;
- steady-state conditions for the oscillator system functioning within a certain time-limit;
- the possibility to control the main operational parameters at any time during the operation;
- technological and constructive simplicity of the component parts and of the entire oscillator system as a whole;
- increased reliability.

2. TEHNOLOGICAL CHARACTERISTICS OF THE LAPPING PROCESS IN ULTRA SOUND FIELD

Lapping tool is the support of the lapping abrasive environment and is bearer of the geometrical form that must be imprinted to processing tool. While lapping, the tools will be realised from materials which are softer than the piece. For paste made of micrometrical powders it is recommended the use of tough supports, and for pastes from under micrometrical granules, soft supports. Tough supports involve between the abrasive granules in rotation movement and soft supports helps at abrasion movement. To select supports there must be taken into account:

- nature of the material of processing piece;
- configuration of the processing piece;
- way of processing;
- degree of mechanization of processing;
- prescribed quality of the surface.

The abrasive material is composed from abrasive granules and lapping liquid, determining in an essential manner, material sampling in lapping process.

The abrasive used depends on the material from which are manufactured the processing pieces.

- electrocorindon: for soft iron, cast iron, easy metals, non- ferrous poly metals;
- silicon carbide: improvements steel and alloy
- boron carbide: metallic carbides, ceramics;
- diamond: metallic carbide and for polishing

The bearer liquid must:

- ensure a homogenous mixture with abrasive material;
- ensure transportation and alienation of the eroded material from working area;
- have a certain consistency (refers to the degree of viscosity at ambient temperature):
- be resistant at increased temperatures;
- should not exceed a certain percentage of impurities, avoiding its stuffing;
- not to allow agglomeration, immediate deposits;
- be water, alcohol, oil or universal soluble.

To respond to these requirements the bearer liquid must contain lubricant substances, spreading agents, dilution and anticorrosion agents. In the same time they have a soiling and cooling role.

In correlation with the granulation size and the nature of the support, the third determining factor in obtaining an imposed quality of the processed surface, is an abrasive concentration - liquid bearer. This can be expressed in volume or mass. There is an optimal concentration of abrasive granules in liquid, over which the quantity of sample material will not increase, appearing a damaging of the processes surface. At increasing concentration over optimal level, once with increasing the number of abrasive granules, decreases the specific loading on each granule, having as effect the increasing of the translation and rolling speed, diminishing their lapping effect.

The character of material sampling at lapping depends on corresponding choice of the parameters of work regime.

Processing supplements at lapping has values between limits: 0,004 ÷ 0,05 mm.

Chipping speeds at manual lapping are of 10 ÷ 30 m/min, and at mechanical one are of 100 ÷ 200 m/min. Material sampling increases with increasing speed, but is limited by the centrifugal force which alienates the abrasive granules to the periphery of the active area between tool and processing piece.

Contract pressure between lapping tool and piece is an average of 0,1 ÷ 3,5 MPa and has the greatest influence of sampling.

BIBLIOGRAPHY:

[1] Amza, Gh., Ultrasunetele – aplicații active – Editura AGIR, Bucureşti, 2006;

[2] E., Bădărău, ş.a., Ultraacustica fizică şi tehnică, Editura Tehnică, Bucureşti, 1967;

[3] Chirculescu, G., Utilizarea ultrasunetelor în creşterea calității suprafețelor prelucrate prin aşchiere, referat nr. 3.