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EXTREMELY SMALL VIBRATION AS A MEANS OF INCREASING THE EFFICIENCY MACHINING

The use of coatings with surfactants (SAS) in combination with nano-vibrations at machining is very promising direction that reveals wide control possibilities of physical and mechanical properties of contacting surfaces forming cutting efficiency by providing high accuracy and reducing costs. The operational reliability of machines is determined primarily by the quality of the state of the working surfaces of parts formed at the finish of the operations process (stress-strain state of the surface layer, the process to remain in suspense, the speaker load, the physical-mechanical properties of the material, macro – and micro-geometry, geometric accuracy).

The considered literature indicates that the term "vibration technology" has appeared relatively recently, in the 60s, as a result of processes that use vibratory influence. This notion appeared among professionals who work in the field of technological use of low-frequency oscillation spectrum. It discourages processes based on the use of vibrations, which affect the processing of an object, both directly or (more often) on the finishing media and tools of different characteristics [1, 2].

From earlier described achievements of scientists and engineers in researches of oscillation cutting methods and application of SAS it is possible to draw conclusion in the sphere of engineer, that they had worked in the main direction – improving the quality of the surface layer of machine parts, improving the process of machining by cutting, but were not considered the vibration in the nanometer amplitude of vibrations. Vibration cutting and the use of surfactants remain in the areas of advanced engineering, the possibilities and scope of which haven't been fully found out yet. Therefore, in this work these two methods were pointed to improve the physical and mechanical properties of the surface layer and the hardness of parts that are of relevance and urgent problem for production and operation of such products [3–5].

Review of literature points to the need to address the strengthening of the working surfaces of machine parts and machining process improvement. Formed problem affects the quality of engineering products, and therefore requires a process control. The necessity of finding solutions is also relevant because the methods used today are demanding machining, first of all, energy-intensive and time consuming. Due to the fact that in a market economy, one of the conditions for maintaining the competitiveness of products is the use of resource-saving production processes, one of the promising directions is the application of vibration to the manometric high-frequency oscillations in the mode in conjunction with the application of coatings of surfactants to increase the micro hardness of the surfaces of parts machinery, energy conservation, improve the quality and accuracy of machine parts [6–8].

Experimental studies are based on the assumption that the increase in micro hardness of the detail after the vibration cutting with application to the surface of the sample and the influence of surface-active substances during vibration cutting. The object of researches is the technological system of treatment on the lathe-screw-cutting machine-tools of details oscillation cutting with amplitude with application of active substances.

In this paper the study is the process of improving the accuracy of obtaining the size, reducing energy costs, improving surfaces and micro-hardness.

The experimental setting, created in conjunction with the student Starodubtsev I., is presented on pictures 1–2, that consists of standard that is processed 1, chisel 2, spools 3, head of UDM 4, cable 5, strengthener AND-5 6, block of microamperes of meters 7, and control a generator stand 8, generator of impulsive currents 9. On fig. 2 the shown chart of fixing and setting of purveyance. Standard 1 set and fastened in a cartridge 2, and cuddles a back rotator center 3 for trussing to the system. Chisel 4 it is set in the head of UDM -600 5.

The principle of operation of the experimental setup (fig. 6), pulsed current with certain parameters, which can be installed with a control panel 7 is fed from the pulse current generator 6, and from there to the coil 5, which in turn is mounted on the tool 4. Pulsed currents excite the electromagnetic field of the coil, the dolmens are developed along the lines of force of the tool holder and tool based on the effect of magnetostriction begins to decline, and elongated by a certain amount.

This creates an oscillation during cutting. Chisel 4 with a spool 5, which is installed in a measuring head of the UDM-600 8. In the process of cutting there are cutting forces that are fixed by this device. From a head a 8 signal acts on a strengthener 10, and from it on the block of microamperes of meters 9, that allows to register forces at cutting of standard 2, that is set and envisaged in a three-fist cartridge 1 and back rotator center 3.

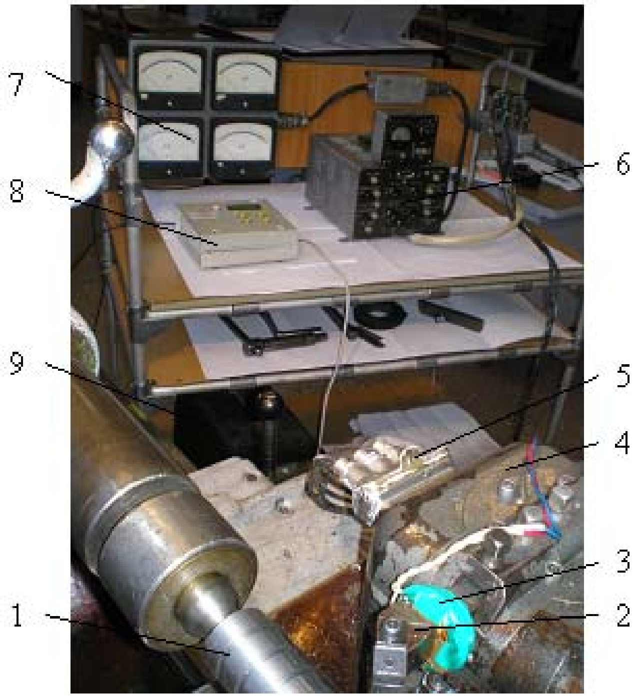

Fig. 1. General view of the experimental setting

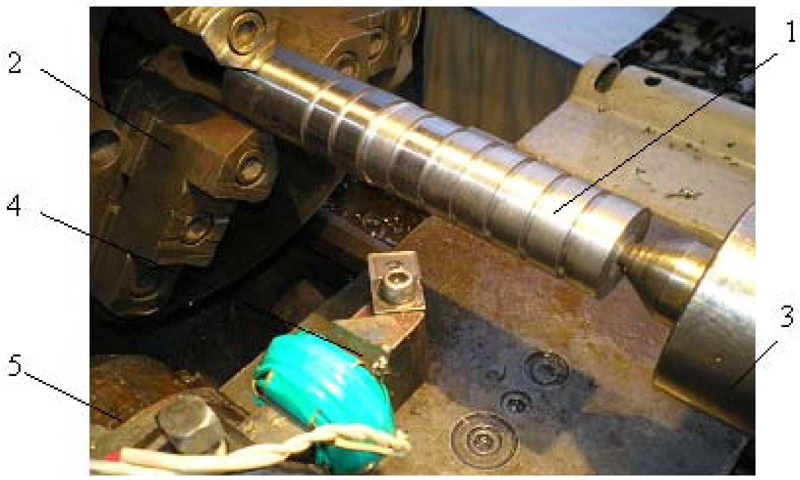

Fig. 2. View of the experimental setting

It also describes all the equipment that was used in the survey, developed plan of the experiment and for studying the machine parts after processing by vibration cutting.

Worked out model of initial indexes of quality and power consumption of shape-generating surface that shows by itself the group of constrained links.

On the basis of this model, formed by means of network modeling have been received and built graphic arts of size dependences that affect the quality and accuracy of the machined surface.

Analyzing the graphic dependences, we can conclude that the use of vibration cutting method actually leads to an increase in the microhardness of parts, reduces the cutting forces and improves surface quality, and post it to the method of surface-active substances gives even better results.

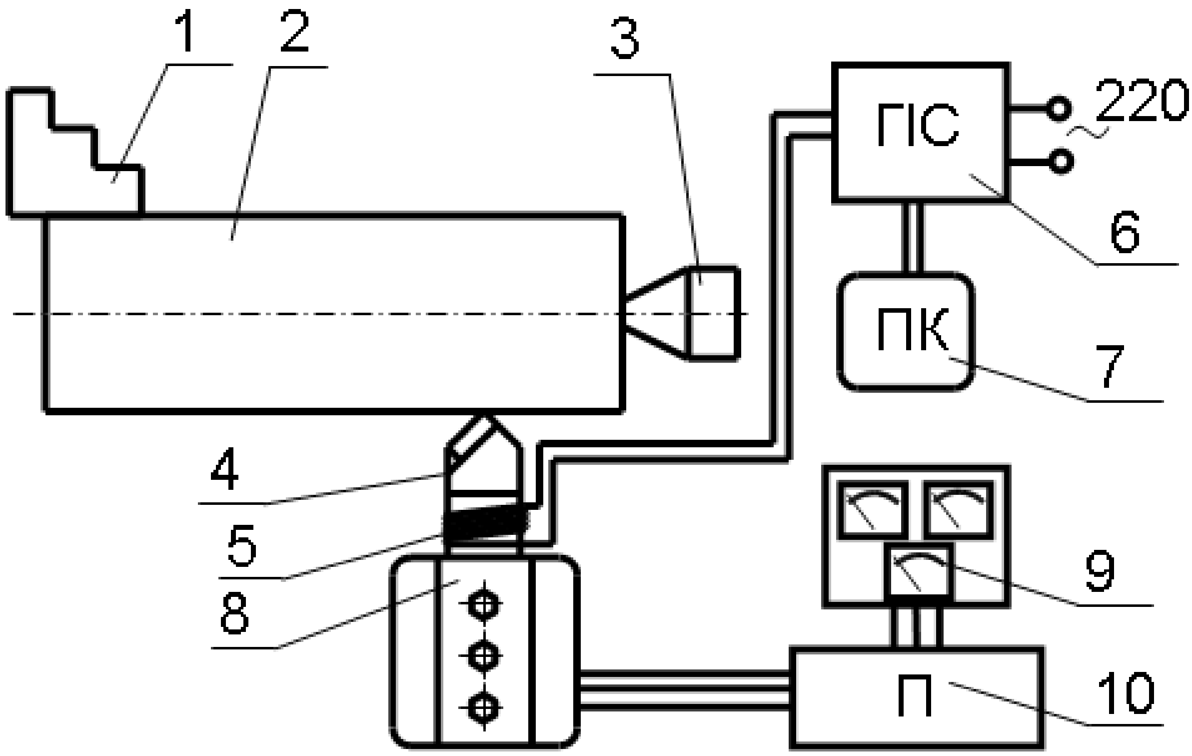

Fig. 3. Flow diagram of the experimental setting

From the constructed relationships, we see that the greatest influence on the samples obtained by cutting all modes at a current frequency of 5000 Hz or near this value.

The graphical dependence (fig. 4, a) shows that the greatest influence on the micro hardness has a current frequency and flow, at a frequency of 4–5 kHz and maximum values of micro hardness were obtained with the minimum filing. If we compare these methods, the use of surfactants produced the greatest results.

The constructed dependency (fig. 4, b) shows that the greatest influence on surface roughness has a feed, cutting speed and frequency, at the current frequency 3,5–4,5 kHz, the maximum cutting speed and feed rates at the lowest (0,1–0,2 mm/a) were obtained the best results of roughness, but it is significantly affected by the use of surfactants.

The graphical dependences (fig. 4, c) show that the greatest impact on reducing the cutting force has a maximum supply current frequency, and then it would be at the highest vibrations of the cutting edge. The effect increases with the use of surfactants.

If we analyze, the experiment gave a good performance to reduce roughness, increase in micro hardness, which has a significant effect on the wear resistance. Force in the cutting goes down too, and this makes it possible to talk about saving energy costs for processing as a whole cutting power decreases. Processing was carried out with the use of surfactants and without the use of surfactants, the analysis shows that the use of surfactants in the individual modes gives very good performance in all the studied parameters.

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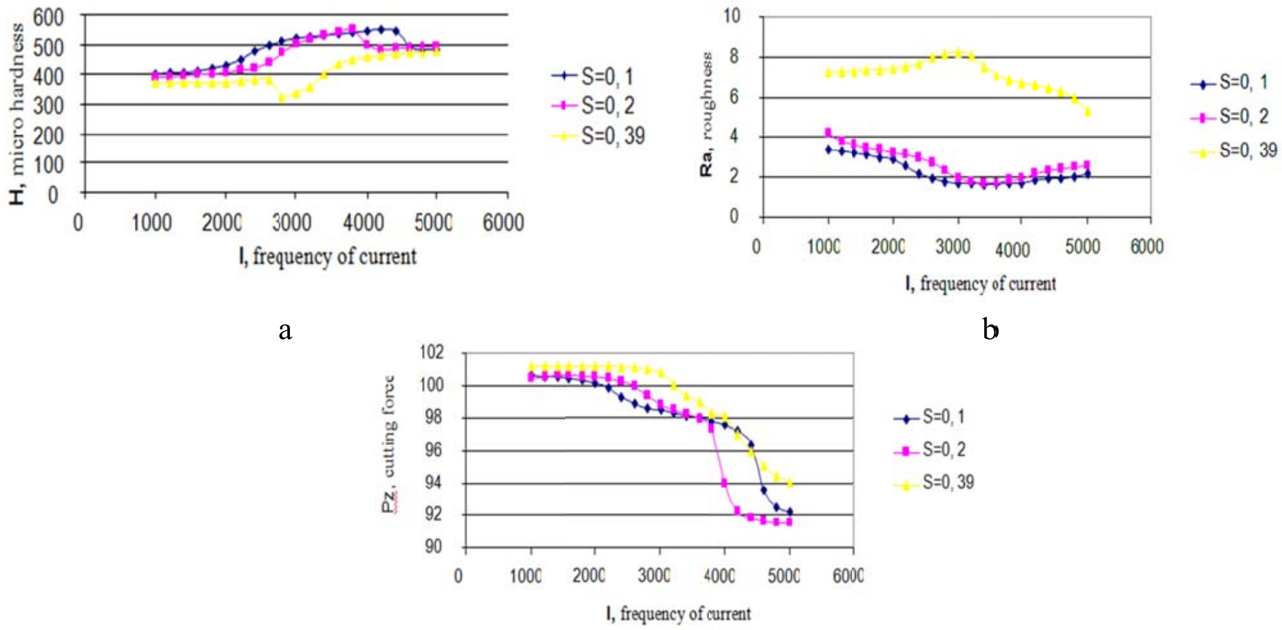

c

Fig. 4. Charts of dependence:

a) micro hardness of material from current frequency; b) roughness from current frequency; c) got force of cutting from current frequency from using of SAS with the speed of 199 m/min

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When we compare with the process of machining without vibration and the use of surfactants, this method gives very good performance, but also an important factor as grinding chips during cutting. The figure shows that the elemental chips were obtained, and not drain so it does not damage the part and does not preclude the process of cutting.

Analyzing the vibration cutting method with nanometer amplitude using SAS provides an exemption on the basis of finishing operations to reduce costs and obtain quality indicators, such as in the finishing operations, but economically more advantageous.

Cost effectiveness, when implementing new technology and the operation of a new method of machining – cutting vibration using surfactants is due to:

– It is a reduction in complexity (due to the replacement of grinding operation details into the operation of cutting vibration using SAS), and, consequently, reducing workers' wages;

– Savings on the part of that change, the overhead (due to accounting overhead cost percentage, and transportation costs, because there is no need to transport parts to the operation of grinding);

– Savings on energy costs (because the processing of the work piece surface by vibration cutting with surface-active substances requires less charges, and machining process lasts less in comparison with the process of grinding);

– It is an economy of charges on an instrument, because this method allows to increase the period of instrument firmness through diminishing the cutting power.

CONCLUSION

The new technique of experimental studies was developed and experimental studies were conducted to determine the effect of vibration cutting techniques and surface-active agents on the micro hardness, power, and surface roughness of machine parts.

As a result of the conducted researches an important scientific and technical task was passed and it includes the transition to the processing technology of machine parts using vibratory cutting with nanovibrations with the use of surfactants. Performed theoretical analysis of studies conducted in the field of vibration cutting techniques and surface-active substances showed that the direction of the vibration amplitude of the cutting with a nanometer is relevant, promising way;

The process of metal vibration cutting from surfactants showed very good results, namely: reducing the cutting forces by 20 % decrease in the roughness 35 % increase of the micro hardness of 1,5 times. The conditions of change in microhardness, power, surface roughness of machine parts according to the resulting vibrational frequencies for processing were investigated. If the current frequency of 4–5 kHz and the minimum feed rates have the maximum effect;

The effect of vibration treatment and surface-active agents on the physico-mechanical properties of the metal were investigated. The process of metal vibration cutting showed very good results, namely: reducing the cutting forces, reducing roughness, improving the surface layer of machine parts. The changes of micro hardness, roughness of machine details were investigated after application of vibration cutting and under influence of superficially – active substances.

The mathematical model for determining the change in surface hardness of machine parts under the influence of vibration cutting and surface-active substances were developed.

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