The environmental and economic security of territorial communities is an integral part of sustainable development. It requires an integrated approach that includes environmental, economic and social aspects, as well as effective resource management and the introduction of modern technologies. Creating favorable conditions for the development of a green economy and environmental awareness of the population will help to improve the safety and well-being of communities.

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STUDY OF ENERGY EFFICIENCY OF PULSE HIGHT-SPEED MILLING CONSIDERING THE ATOMIC PROCESS

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Abstract. The pursuit of reducing energy consumption in metal milling leads to the modernization of mechanisms. These mechanisms utilize the energy released directly during the cutting process. A method for determining energy efficiency in high-speed pulse gear milling is presented, considering atomic-level processes. Understanding the physical interactions involved offers new directions for improving the energy efficiency of metal machining.
Keywords: Pulse milling, high-speed milling, atomic approach, oscillating milling, metalworking.

Introduction.

Topicality. Energy efficiency in modern manufacturing is one of the key factors in assessing profitability and competitiveness. The process of chip deformation and fracture during high-speed gear milling, has been considered in some recent publications [1]. However, the energy released as a result of breaking interatomic bonds has not been taken into account, and its utilization requires further in-depth study. Understanding the physical processes involved in the contact interaction between the chip and the tool opens up opportunities for improving the energy efficiency of metal machining.

The object of research is the process of high-speed metal milling

The subject of the study is the assessment of energy consumption during pulse milling in various operating modes and with different pulse frequencies of the milling cutter.

The purpose of the work is to compare the energy consumption of classical continuous gear hobbing and pulse hobbing. At the same time, trace the dependence of the energy consumed at different frequencies of cutter feeding in different processed materials.

The objectives of the study is to analyze the existing methods of high-speed milling, especially in the aspect of taking considering the atomic approach to the chip forming process. In high-speed gear milling with a blade tool, the process of plastic deformation is implemented according to the scheme of compression and simple shear [1] It has been proved that the resistance to plastic deformation of the cut layer depends on the type of crystal lattice of the processed material, its energy of the packaging defect and the presence of impurities at the grain boundaries. The purpose of the study is to investigate the possibility of using the energy that is released when interatomic bonds are broken in the further milling process.

The novelty of the research lies in the method of impulse milling itself. The analysis of existing publications has shown the use of either classical milling of gears, or oscillating, in which the milling cutter makes longitudinal movements relative to the surface during the cutting process.

Presentation of the main research material.

Consider the process of chip formation when cutting a cutting tool into a workpiece, focusing on the force that must be applied to break the interatomic bonds of the material being processed and the physical processes that occur in this case.

In the process of chip removal, deformation of the layers of the processed material occurs not only in the area of the chipping plane, but also in front of the cutter tooth and under the cutting plane. However, now we are interested in the plane of plastic shear. Plastic deformation can occur if not only dislocations pass through the crystal (the original structure already has a certain number of dislocations), but also newly formed ones. The stresses required for the initiation of plastic deformation (without dislocations), i.e. for the breaking of interatomic bonds, are about 10% of the shear modulus. For example, for iron, the interatomic distance is 2.48 Å, the dislocation energy at this distance is ~6 eV, and the strength of the Fe-Fe interatomic bond is 4.290

eV. The dislocation energy exceeds the strength of the Fe-Fe interatomic bonds, so the movement of the dislocations will be accompanied by the deformation of the crystal, that is, the breaking of the bonds. [1]

The tendency of processed materials to deformation hardening depends on their electronic and dislocation structure, the presence of impurities, the rate of deformation, temperature, type of crystal lattice, radius of rounding of the cutting edge ρ, as well as on the speed of the hardening processes. In carbon steels, the main impurity is carbon, which, located at the boundaries of grains, can contribute to their baptism. As the temperature increases, the diffusion mobility of carbon increases, which facilitates the slippage of grains, increases and changes the shape of the chips. [1]

Thus, there is a direct linear relationship between the cutting power and the constant coefficient Kr, which directly depends on the EDU (packaging defect energy). And as a result, the cutting power depends on the energy that needs to be applied to break the interatomic bonds. In turn, as a result of this break, the energy of interatomic bonds is released. Possible ways to use this energy in milling will be considered on the example of a dual-mass electromechanical system that carries out pulse milling by a predetermined program.

The circuit is implemented from a dependent rotation of 2 masses, in which the electric motor M rotates at a constant speed at rated power, and the electromagnetic coupling EM is controlled by an oscillating signal and has 2 positions. When the EM is closed, the mechanical transmission of torque from the motor to the cutter is blocked and the accumulation of torque occurs due to the rotation of the shaft in the elastic clutch. At the moment of opening the EM, the accumulated energy is transferred to the cutter F and used for its further advancement in the workpiece. Taking into account the fact that plastic deformation and breaking of interatomic bonds directly depends on the cutting power and torque, with pulse milling, it is possible to use an electric motor with a lower rated power than with classical continuous milling.

In the process of pulsed high-speed gear milling, the cutter moves with the occurrence of plastic deformations in the workpiece and with the rupture of interatomic bonds. As a result, a large number of atomic glide planes are shifted. [1] The energy released by the breaking of atomic bonds is partially converted into thermal energy and distributed in the elastic displacement zone of atoms. Taking into account the fact that in carbon steels, with increasing temperature, the diffusion mobility of carbon increases, which facilitates the slippage of grains, increases and changes the shape of the chips.

To study other aspects of pulsed high-speed gear hobbing and the possible use of the energy of breaking interatomic bonds, it is possible to build an experimental system. In this circuit, due to the wide possibility of adjusting the input signal (mc), and the ability to observe parameters such as the speed of rotation of the motor shaft, couplings and cutter (ω0, ω1, ω2 respectively) and the power on the drive shafts, it is possible to deeply study high-speed gear milling in a wide range of adjustments.

Discussion

This article is in line with the principles of the New European Research Paradigm, taking into account human-centered questions and promoting impact-oriented innovation.

Sustainability (economic-ecological-social):

Using the energy inherent in the processed material itself reduces the energy consumption for its processing. In turn, this saving affects the cost of production and this technology is advantageous in environmental terms. In turn, reducing energy consumption has a beneficial effect on the environment, reducing greenhouse gas emissions.

Human-centeredness - well-being:

Reduced energy consumption and automatic selection of milling conditions reduce the responsibility of the operator.

Impact-oriented - multi-agent/sectoral/disciplinary co-creation:

The technology allows for faster and higher-quality metal processing in all sectors of the economy. This includes mechanical engineering, automotive industry, astronautics, energy.

In summary, this research contributes to sustainable, human-centred and collaborative progress in production, in line with the goals of the New European Research Paradigm.

Conclusions. The application of the atomic approach opens up wide opportunities for improving high-speed pulsed gear milling, in particular, improving the energy efficiency of milling. Dependencies between physical parameters during high-speed gear milling have been determined: power, cutting speed, energy of breaking interatomic bonds in metal clusters. Two directions for increasing the energy efficiency of pulsed high-speed gear milling have been found: it is possible to reduce the power of the drive electric motor and use the energy of breaking interatomic bonds in further milling. Also, reducing energy consumption leads to improved ecology and reduced greenhouse gas emissions.

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STUDY OF THE INFLUENCE OF HYDRODYNAMIC LOADS ON THE PERFORMANCE OF HYDRAULIC TRANSMISSIONS

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Abstract. This research investigates the influence of hydrodynamic loads on the performance of hydraulic transmissions in order to increase their reliability and efficiency. There will be conducted an analysis of the operating modes that cause load changes and their influence on the wear and durability of system elements. The obtained results can be used for optimizing the designs and modes of use of hydrodynamic transmissions in various branches of engineering.
Keywords: hydraulic machines, hydraulic transmission, working fluid pressure, hydrodynamic loads, radial hydrovolume transmissions.

Introduction

Topicality. Currently, a promising direction in the design of transmissions for special-purpose vehicles is the installation of hydrostatic transmissions, which significantly increase the ease of driving the vehicle [2]. Before implementing the transmission, it is necessary to carry out a wide range of design and engineering work, which should include a detailed analysis of its operating conditions, mathematical modeling of physical and mechanical