ENSURING THE ACCURACY OF GROUND BEDS OF HEAVY LATHE MACHINES USING THE METHOD OF VIBRATION STABILIZATION

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Abstract. The article considers the improvement of the grinding process for beds of heavy lathe machines using the method of vibration stabilization. A comprehensive analysis of the kinematic, mechanical, and thermal characteristics of the process is presented. Optimal grinding conditions are substantiated, allowing for increased machining accuracy and quality, reduced tool wear, and improved economic efficiency. The proposed solutions align with the principles of sustainable engineering and the New European Research Paradigm.
Keywords. Vibration stabilization; grinding; heavy lathe machines; machining accuracy; abrasive tool; wheel topography; system stiffness; energy efficiency

Introduction

Topicality. One of the most important tasks in modern mechanical engineering is the development of strategic industries such as heavy machine tool building, instrument making, energy, electrical, and electronic industries. The growth of these sectors depends on the supply of high-tech equipment, which requires high manufacturing precision.

Heavy machine tool building, as a fundamental industry, is concentrated in regions with developed research and production infrastructure.

Improving the accuracy and productivity of heavy lathe machines is a relevant scientific and technical issue that significantly impacts the quality of final products.

Object of the study. Ground beds of heavy lathe machines.

Subject of the study. Calculation of optimal grinding conditions.

Purpose of the study. To analyze and improve the technological features of grinding beds of heavy lathe machines to determine kinematic patterns, investigate the mechanisms of grinding wheel topography formation, and optimize machining modes to ensure high accuracy and productivity.

Research tasks:

1. To investigate the kinematics of the bed grinding process.
2. To study the mechanics of grinding wheel topography formation.
3. To model the interrupted grinding process.

4. To analyze the specifics of grinding with segmented wheels.

5. To determine the effect of system stiffness on tool wear, machining accuracy, and quality.

Scientific novelty. The application of vibration stabilization for increasing the accuracy of bed grinding in heavy lathe machines is proposed. The influence of oscillatory processes on tool wear, surface topography formation, and the stabilization of thermal and force loads is studied.

Methodology.

A kinematic analysis of the grinding process was carried out, and a computational model for cutting grain distribution was developed. The formation of grinding wheel topography and the influence of operating modes on tool wear were studied. Thermal and force analyses of interrupted grinding were conducted. The influence of the technological system's stiffness on machining accuracy was also considered.

Particular attention was paid to economic calculations: equipment cost, capital investments, working time fund, product cost, and net profit.

Discussion of results.

The results comply with the principles of the New European Research Paradigm:

• *Sustainable development (economic, environmental, social):*

Optimizing the grinding process reduces tool costs, energy consumption, and waste.

• *Human-centered focus:*

Improving machine quality enhances the reliability of products and meets the needs of end users in strategic industries.

• *Impact-oriented approach:*

The research results are interdisciplinary and applicable in related industrial sectors.

Conclusions:

1. The proposed approach to grinding beds of heavy lathe machines using vibration stabilization enables high machining accuracy.

2. Optimal grinding parameters have been determined, reducing tool wear and increasing productivity.

3. The patterns of system stiffness influence on machining accuracy and quality have been identified.

4. The developed model takes into account thermal, kinematic, and force characteristics, ensuring stable equipment operation.

5. Practical implementation of the research results allows for a 2–3 times reduction in abrasive tool costs, increased accuracy, and minimized errors in the production of large-sized parts.

6. The research contributes to the development of sustainable, human-oriented grinding technology and promotes interdisciplinary collaboration.

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APPROACHES TO MIGRANT INTEGRATION INTO LOCAL LABOR MARKETS

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