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## SIMULATION OF THE THERMAL PROCESS OF GRINDING

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*This article describes a mathematical model that simulates the determination of the maximum heat on the surface of a metal part during grinding. This model features the ability to change the initial parameters so that the resulting temperature does not exceed the critical one.*

*У статті розкрито математичну модель, яка імітує визначення максимальної температури на поверхні металевої деталі під час шліфування. Її особливість полягає в можливості змінювати початкові параметри таким чином, щоб результуюча температура не перевищувала критичну.*

The key task in production is to create quality products. In industry, the quality of a product depends on the quality of its parts, which in turn depends on the machining of materials. Abrasive processing is widely used in factories to obtain increased accuracy and surface quality. For this purpose, special circles are used, the cutting elements of which are grains. Continuous improvement of machine tools and abrasive wheels has made this process a highly productive one. The workpieces can be processed with micron precision and excellent roughness, which can be achieved, for example, by grinding or polishing.

A common problem in abrasive metal working is an increase in temperature. Heat is generated when the abrasive grain is loaded. Thermal phenomena arise and are concentrated in rather small areas. The generated heat energy provides intensive heating of the part, which can lead to a decrease in quality or damage. Temperatures can rise so high that changes in the structural composition of the surface layer, local melting, deformation, and the formation of microcracks are possible. As a result, the quality of the workpiece decreases or it becomes unsuitable for further use. This is a significant problem for industry, especially in those industries that require a lot of cutting and grinding. Enterprises thus suffer substantial losses. There are known cases of manufacturer's recalls occurring for batches of already sold product due to the fact that the defect was detected during operation. The fact is that the human eye may not notice thermal damage to the metal. A defected part which becomes part of the final product may make it unusable before the end of the warranty period.

Knowing the temperature of not only the part but also the contact surfaces of the cutting grain is important, since thermal conductivity to the grains is possible. Moreover, the temperature of these surfaces determines the diffusion breakdown and wear of the grinding wheels themselves. Therefore, the temperature factor becomes the main limitation in this process.

Temperature can be found from the well-known differential heat equation. However, as a partial differential equation, it has an infinite number of solutions. To select the solution that describes the grinding process from this set, additional conditions must be imposed on the sought temperature function. These are called initial or boundary conditions. Due to the stochasticity of abrasive machining, this is a very difficult task. At the moment, the variety of mathematical descriptions available does not reflect all the nuances of the grinding process. However, this is not necessary if only the basic patterns are being studied. Therefore, scientists followed the path of rational systematization and used simplified models.

The creation of a model that is as close as possible to the real grinding process and the development on its basis of a computer program that calculates the temperature, speed, force, and other parameters of grinding and which gives appropriate practical recommendations will change the production of products around the world. In view of the importance of this model and without exaggeration, I note that the demand for such a program would be greater than that for the vaccine against COVID-19.

A general analysis of the literature of the 20th century makes it possible to conclude that initially the temperature of the part was judged by the nature and intensity of phase transformations in the surface layer during grinding. The dependence of the contact temperature on the grinding conditions was mainly determined experimentally. The theoretical calculation of grinding temperatures was carried out in accordance with the basic laws of heat transfer. Scientists, under certain conditions, determined the amount of heat in the grinding zone, established its distribution between the part and the wheel, or took into account coolants, etc. As a result, formulas and basic laws of thermal phenomena of the process under study were obtained from the differential heat equation, empirical results, the Fourier problem.

Features of the thermal model during grinding are disclosed in the article [1]. The model is studied under the assumption that the cutting grain has a cylindrical shape. Ellipses are obtained in their section when grinding.

Such a mathematical model provides the possibility for the given initial data to calculate the missing data and find the maximum temperature on the surface of the part in the grinding zone. Moreover, it allows one to analyze the effect on the maximum temperature on the surface of the part in the grinding zone of changes in the initial conditions. The use of coolants can also be attributed to the initial conditions. They have a smell and therefore affect the purity of the air. Their disposal pollutes soil and groundwater. In addition to environmental problems, there are other problems associated with their use. Therefore, in my research I have tried to solve the problem without using coolants. To meet the set research tasks, it became necessary to automate the implementation of the created mathematical model for determining the temperature on the surface of the part during grinding. Based on this model, a computer program has been developed for an approximate calculation of the maximum temperature on the workpiece surface and optimization of the grinding process in the thermal aspect. It is proved that the mathematical model is an acceptable substitute for the process under study.

**References;**

1. Oleksenko V. Optimization of the Thermal Process of Abrasive Metal Working / Viacheslav Oleksenko // Acta Metallurgica Slovaca. – Slovaca, 2021. – VOL. 27, NO. 2. – P. 94-98, https://doi.org.10.36547/ams.27.2.895.