SECTION 2. MATERIALS SCIENCE

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ANALYSIS OF ADJUSTING PROCESSES TO HARDENING MODES BY PLASTIC DEFORMATION FOR AUTOMATED PRODUCTION

АНАЛІЗ ПРОЦЕСІВ КОРЕГУВАННЯ РЕЖИМІВ ЗМІЦНЕННЯ ПЛАСТИЧНИМ ДЕФОРМУВАННЯМ ДЛЯ АВТОМАТИЗОВАНОГО ВИРОБНИЦТВА

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The development of leading branches of technology is invariably associated with advances in the field of production and processing technologies of materials.

Modern branches of industry are characterized by a continuous increase in energy intensity with extreme and extremely intensive loading parameters during operation. Therefore, it is possible to ensure operational reliability and durability of machines, units and parts only by imparting special properties to the materials used. Ensuring the production of materials with high physical and mechanical characteristics dictates the need to use new processing methods that ensure high quality and productivity of product manufacturing.

Hardening by plastic deformation methods is widely used to increase the fatigue strength, hardness and wear resistance of the surface layer of metal, as well as to form directional internal stresses in this layer and change structural imperfections, crush blocks and create microstresses. Surface plastic deformation leads to the formation of shifts and elastic distortion of the crystal lattice, a change in the shape and size of the lattice. The greatest influence on the operational characteristics of the processed products is exerted by the hardening modes, physical and mechanical properties, structure and chemical composition of the material.

The optimal mode of surface plastic deformation, carried out for the purpose of strengthening, fatigue strength, wear resistance, is one that ensures the optimal increase in the ultimate strength $\Delta\sigma_B$ at certain plasticity indices, the maximum increase in the intensity of the endurance limit $\Delta\sigma_1$ [1], and the maximum reduction in the intensity of wear ΔI. The solution to the problem of increasing the operational characteristics of reliability and durability of machine parts and units is extremely important and promises a significant reduction in the costs of operation, repair and restoration of equipment.

The issues of determining the strength parameters of strengthening by plastic deformation methods have found a fundamental solution in a number of works [1–4]. As for the formation of the optimal physical state of the surface layer, there are practically no such recommendations. At present, it has been established that strain hardening is optimal at a deformation intensity equal to the ultimate uniform one [1]. However, the issue of determining them accurately enough for practice has not been fully resolved. Therefore, the aim of the research is to develop a theoretical and experimental method for determining ultimate uniform deformations.

Determining optimal strengthening modes by plastic deformation methods allows improving the technical and economic indicators of plastic deformation processes and determining the direction of searching for new technologies.

Among the diverse physical and chemical nature of the impact on the material, preference should be given to those that are improved in accordance with the objective laws of development of technical systems.

According to these laws, the development of technical systems and technologies is moving in the direction of transition from mechanical impacts to electromagnetic, thermal, wave, etc., increasing the degree of dispersion of the substance, the number of connections between elements and the responsiveness of the system; using molecules, atoms, ions, electrons as a working element and tool. The ways of improving and increasing the efficiency of the processes of wave, thermal, electromagnetic impact on the processed material or workpiece after systematization can be achieved in various ways:

– transitions from simple (elementary) physical effects to complex ones – chain and double;

– construction of a double physical effect by introducing an additional physical effect, including a wave effect, which is easy to control;

– replacement of an uncontrolled (poorly controlled) physical effect with a controlled one, for example, replacement of a mechanical effect with an electrical or electromagnetic one;

– by increasing the degree of dispersion or wave properties of the substance that plays the role of an instrument of the transmitting element or medium;

– transition from solid substances to porous, capillary-porous, two- and multi-component;

– increasing the degree of dynamism of the system, i.e. transition to a more flexible, rapidly changing system structure;

– transition from homogeneous wave effects or existing disordered nature of loading or structure to wave effects that are disordered or have a certain spatio-temporal structure;

– matching or mismatching the wave effect with the natural frequency of the workpiece or tool;

– periodic action of one pulse-wave action in pauses of another;

– interaction of an external electromagnetic field with contact-applied or non-contact-induced currents;

– use of electrorheological suspensions with controlled viscosity.

Fundamentally new directions in the development of products with high performance characteristics are the production of nanostructured structural materials and materials with a structure transformed to an ordered structure, and if the production of nanostructured structural materials is extremely labor-intensive and energy-consuming, then the production of materials with a structure transformed to an ordered structure is possible within the technological parameters of traditional processing processes. Such structures arise when there is a sufficiently intense flow of energy or matter under conditions of thermal, force, energy or deformation instability.

In the processes of processing workpieces by plastic deformation methods during shaping and strengthening, the flow stress depends on the temperature of the degree of deformation, the rate of deformation, the duration of deformation, the composition and structure of the material.

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