

## CUTTING AND PROCESSING OF SOLID POLYMER MATERIALS

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### Abstract:

The article discusses the most widely used hard-to-machine materials in mechanical engineering - high-strength steels and titanium alloys, as well as the main directions for improving the machinability of these materials by cutting. The most promising direction from the point of view of minimum costs is indicated. A variant of controlling the processing process by choosing cutting modes according to the criterion of the efficiency of energy dissipation is proposed.

**Keywords:** machining, high-strength steels, titanium alloys, improved machinability, energy dissipation efficiency coefficient.

One of the ways to create competitive marine technology is to reduce the weight of the structure. This is achieved by using metal alloys with high specific strength. Significant indicators of strength characteristics are the reason for the tangible abrasion ability of the material being processed and considerable contact temperatures in the cutting zone during machining. These factors are the main reasons for the significant wear of metal-cutting tools when machining high-strength steels and titanium alloys. For these reasons, alloys with a high specific strength are generally referred to as difficult to machine materials. Also worth noting is the group of austenitic stainless steels used in shipbuilding and shipbuilding for the manufacture of a wide range of products operating in aggressive environments. A feature of the behavior of these materials during cutting is the formation of a build-up on the front surface of the cutting tool. Despite the different nature of the difficulties encountered in the processing of the above groups of materials by cutting, the main measures to improve their machinability can be combined in the following directions:

- improvement of the design of cutting tools, including the creation of new tool materials, coatings and geometry;
- the use of innovative lubricating and cooling technological media;
- control of the properties of the processed material using heat treatment, or through the use of additional energy sources.

The purpose of all of the above measures is to improve processing productivity by increasing the life of the cutting tool. However, the amount of capital investment in the implementation of each direction in production is significantly different. The first direction requires the cost of purchasing a modern expensive cutting tool, which can significantly affect

the cost of manufacturing a part in a single or small-scale production. The second in cost of investments can vary in a wide range, since if it is only about changing the cutting fluid (coolant) with the best performance, then this is one amount, and if, in addition to changing the coolant, it is necessary to purchase special modern systems for its supply, as well as to install them on the existing equipment, the amount can be much higher. Material property management is the most cost effective a way to improve machinability. Especially when it comes to the regulation of cutting conditions, which leads to the most favorable combination of the physical and mechanical properties of the processed material for chip formation. Therefore, this direction is the most promising at machine-building enterprises specializing in the manufacture of complex equipment in small volumes.

If we dwell on the latter direction in more detail, it should be noted that the machinability by cutting of a particular metal material is not so much a feature of the process of its processing as an internal generalized property of the material itself, its tendency to resist plastic deformation and fracture under specific technological conditions of shaping. That is, the machinability is the flexibility of the material to the specific effect of the cutting wedge of the tool. The specificity of the impact is understood as the inhomogeneity of the acting load over the pressure area, high degrees and rates of deformation, the need to exhaust the plasticity of the processed material and bring it to destruction. The main parameters of the material that affect its workability include:

- type of crystal lattice and interatomic bond;
- chemical composition;
- structure, that is, the presence of phase and structural changes that are observed at the macro level;
- substructure, that is, the number, dispersion and distribution of the strengthening phases, the type and density of dislocations, their mobility, as well as the size of grains and blocks, their degree of micro orientation, the state of inter granular and inter block boundaries;
- the stability of the strengthening phases and the structure as a whole to the action of stresses and temperatures in the time interval of the cutting process with the concomitant development of adhesion and diffusion phenomena.

It is impossible to trace the influence of each of such a huge number of internal factors on the behavior of the processed material during cutting. Therefore, an indicator should be used that can assess the total effect of all processes occurring in a material undergoing severe plastic deformation. By the numerical value of this indicator, one can judge the degree of efficiency of the cutting process. The technological system of cutting should be presented as a dynamic dissipative system by analogy with how the author of considered the process of hot forging. The power source in the case of cutting will be a metal cutting machine. Energy, accumulating on the tool, will be transferred through it to the workpiece, which, in turn, will convert one part of it into heat, and the second will be spent on changing the microstructure of

the material. That is, the processes taking place in the thermodynamic cutting system are far from equilibrium. Thus, energy indicators should be used as criteria evaluating the degree of efficiency of the application of certain cutting modes. In particular, it is possible to apply the coefficient of energy dissipation efficiency, which is the ability of a material to dissipate energy at a given temperature-rate conditions of deformation. This indicator has a number of advantages, including: invariance with respect to the type of deformation, as well as taking into account the joint action of all simultaneously acting dissipative processes.

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