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Diagnosis Of Eating of Cutting Tools on The Basis of Analysis of Vibroacoustic Sounds in The Process of Mechanical Processing of Materials

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Annotation: The results of numerical modeling of Vibroacoustic Signal (VAS) in this article provide information on the use of vibroacoustic signal (VAS) parameters describing the dynamics of this process to determine the processing ability of metals by cutting, to determine the cause of the unstable process observed during cutting .

Basic phrases :. acoustic, vibroacoustic, milling, high- speed tool steels, metallo-ceramic hard alloys, mineral-ceramic materials, diamonds, bending , strength, viscosity.

Introduction

The development trend of domestic machinery is the widespread use of high-tech metal cutting RDB machines using high intelligent control and monitoring systems. Production experience in the use of RDB machines shows that their efficiency depends in many respects on the reliability of the operation of a complex technological system, where the cutting tool used is the weakest link in terms of reliability.

The standard way to ensure the reliability of multi-blade tools equipped with multi-sided indicator cutting attachments on machines is to determine the time before replacing the tool with a high probability of its failure. That's it for functional extractor by offer made recommendations based on cutting rites determined . As a result , the instrument change for cutting time har always his not working until which was average from time to time less that is _ esa cutting rhythms enough underestimate and valuable tool materials a lot eat due to of the instrument performance efficiency known degree loss take is coming .

That's right so in real time diagnostics systems use through torets milling cutters the work activities improve eng current is a task .

This In the article he prevailed sign (fault) criterion) _ of the instrument real - time status mode diagnostics to do offer This makes it tool of the resource more complete development provides , if necessary , as well If so , cut rites noticeable degree increase possible and that's it according to processing give efficiency increases .

Metal ceramics high hardness and heat endurance has which was tool of materials wide scattered groups is one. Current at the time new technology current reach with metal ceramics tools the work productivity increase and this with uni apply k death expand possible That 's it here high hardness parts milling for designed surfaces separately place takes over . Casting irons hardness (HB 360 ... 540).

However , the face milling process parameters components processing in giving his factors dependence on the RDB system installed diagnostics systems complete active to use opportunity does not give .

Carbon, alloy and high-speed tool steels, metal-ceramic hard alloys, mineral-ceramic materials, diamonds are used to make the working part of cutting tools.

Requirements for tool materials include:
- corrosion resistance;
-heat resistance;
-stability;
- viscosity;
-mechanical workability.

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Properties such as corrosion resistance and heat resistance are determined by the thermal conductivity of the material.

The requirements for the materials from which the cutting tools are made depend on the operating conditions of the cutting tool, its construction and the layers to be cut. S h The first requirement for the material from which the cutting tool is made is high hardness. The second requirement is resistance to corrosion.

Thermal resistance is characterized by a decrease in the hardness of the material after heating. Corrosion resistance is characterized by the fact that the cutting tool retains its shape and size during a certain mechanical processing.

The table shows the heat tolerance temperature and the grades of a number of tool steels.

Steel grade	U12	9HS	R9, R6M3	R18, R6MM5	R18K10	R9K10	R18K20
Heat resistance, ^{0}C	275	325	620	620	670	670	700

In addition to the listed qualities, tool materials must be technological, that is, have good mechanical performance. Durability, propensity to carbonation, plasticity in cold and hot conditions, the ability to work with sharp and abrasive cutting tools, etc. are technologically important indicators.

As a result of interaction with the material being processed, the shape and size of the cutting part of the cutting tool change and cause it to become impermeable. Failure of the cutting tool will reduce machining efficiency and accuracy, and will increase the cost of manufacturing and rebuilding the cutting tool. This has a sharp impact on the cost of production.

Reasons for failure of cutting tools occur in the following cases:

a) eating under the influence of friction;

b) plastic deformation of tool material;

c) fracture as a result of brittle decomposition.

Erosion under the influence of friction plays a key role in the impermeability of the cutting tool.

When cutting with tools made of tool steels, grinding of the cutting edge is very rare. Impermeability of hard alloy and mineraloceramic cutters (decomposition) events occur. The reason for the friction of the cutting edges is the attempt loads as a result of vibrations of the more tool-cutting tool-detail system.

Erosion can occur on the front and back surfaces of the cutting tool. These forms of eating are interrelated, but in most cases one of them is predominant. When eaten on the anterior surface, a groove or groove is formed at some distance from it along the main cutting edge. When eroded on the next surface, a thinned area or eroded bead is formed on the surfaces directly below the main and auxiliary cutting edges.

Erosion, which is dominated by the formation of a large groove on the front surface, is mainly due to the high cutting speed and large thrust for these tool materials. The formation of pits can also be associated with adhesion and diffusion phenomena. The main dimension that characterizes the level of wear of the cutter per unit time is the $_{depth}$ of the pit. This hardness can be achieved by sharpening steels with black cutters (without cooling) to dimensions of 0.6-0.8 mm and higher. With cutters provided with VK group alloys in the direction of the steel a r are formed pits of size h_{front} = 0.2-0.3mm.

Because tungsten cobalt (VK) and titanium cobalt (TK) group alloys are resistant to high temperatures, they do not corrode rapidly on the front surface. It separates the groove from the main cutting edge by approximately m_0= 03-06 mm, and as a result of corrosion, the edge of the groove continues to approach the cutting edge.

The approach of the groove to the cutting edge provides a simultaneous wear on the back surface, and in the case of f = 0, it causes rapid cutting of the cutting edge.

next surface b , ie the impermeability of the cutting tool, is caused by mechanical abrasion. It is mainly eaten in the processing of cast irons, in the cutting of steels without cooling or with small thrust, in the cutting with frequent breaks, in the processing of steels with high temperature-resistant hard alloys. Subsequent surface wear is also subject to milling, grinding, and grinding .

The measure of the impermeability of the cutting tool on the next surface is the height of the eating $_{area}$. It usually starts directly under the cutting edge.

When the cutting thickness is greater than 0.10-0.15 mm and at a small or medium cutting speed, the cutting tools are eaten along the back and front surfaces.

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When working with such corrosive coolants, it applies to clean machining cutters made of reverse steels, all cutters equipped with hard alloys, surface and disc cutters, drills, hammers and so on. Such corrosion also occurs when cutting and processing materials that are difficult to process.

When hard-alloy cutting tools are machined, the groove formed on the front surface merges very quickly with the erosion shaft on the back surface. This creates a new cutting edge that is continuously restored.

The ability to diagnose cutting conditions is usually determined by the informativeness of a particular registered parameter, i.e., the value of its change is determined by the change in the controlled cutting parameter:

$K = D\,P_r / (D\,P_K)$

or in other words, by the following formula;

$K = d\,P_R / d\,P_k$

Here K-coefficient informativeness; $D\,P_r$ = (i-1) - Addition of the registered parameter when P_r (i) changes the controlled parameter

$D\,P_k = (i + 1) - P_k(i)$.

$D\,P_r$ associated with diagnostics by the VAS method refers to some features of radiation: amplitude, signal activity, criteria calculated according to formula (1) or (2), and some technological parameter under $D\,P_k$ in replacement processing: time, processing speed, tool wear, etc.

Instead of adding parameters (3) and (4) in formulas, you can use their relative variation:

$$\Delta P(i) = \frac{P(i-1) - P(i)}{P(i)} \times 100\%$$

Later, the data becomes dimensionless, which increases their usability. According to the figure. 4 cutting methods AE signals were recorded as grimer when cutting a T15K6 (a = 12, g = ph, = ph $_{1\text{ - }45°}$) with a steel 40x cutter with S = 0.5 mm / rpm ; t = 1 mm; v = 0.5-0.3 m / s and the method of processing the obtained results is shown. Measurement range Df = 200-1200 kGz.

The diagnostic coefficient for the relevant parameters in terms of velocity is: K_A = 40%; K_N = 200%, i.e. the parameter that provides the most information in this case is the intensity of VAS. However, in each specific processing instance, there may be the most informative parameter or their complex, and usually the amplitude and intensity of the signal are closely related.

VAS activity should take into account the continuous nature of most mechanical processing operations VAS of materials. Therefore, special attention should be paid to the correct selection of the signal attenuation limit "because it can change several times even with a small change in the amplitude of the small value of VAS activity" explained by the specificity of ziga. In practice, the discrimination limit should only allow the recording of individual changes in the signal, i.e., close to the amplitude of the maximum signal.

In this case, the individual signal diagrams, which are approximately proportional to these cutting speed conditions responsible for increasing the VAS activity compared to the signal amplitude, are explained by the following frequency increase and are one of the strongest VAS sources in the cut-off zone. (Figure 1) .

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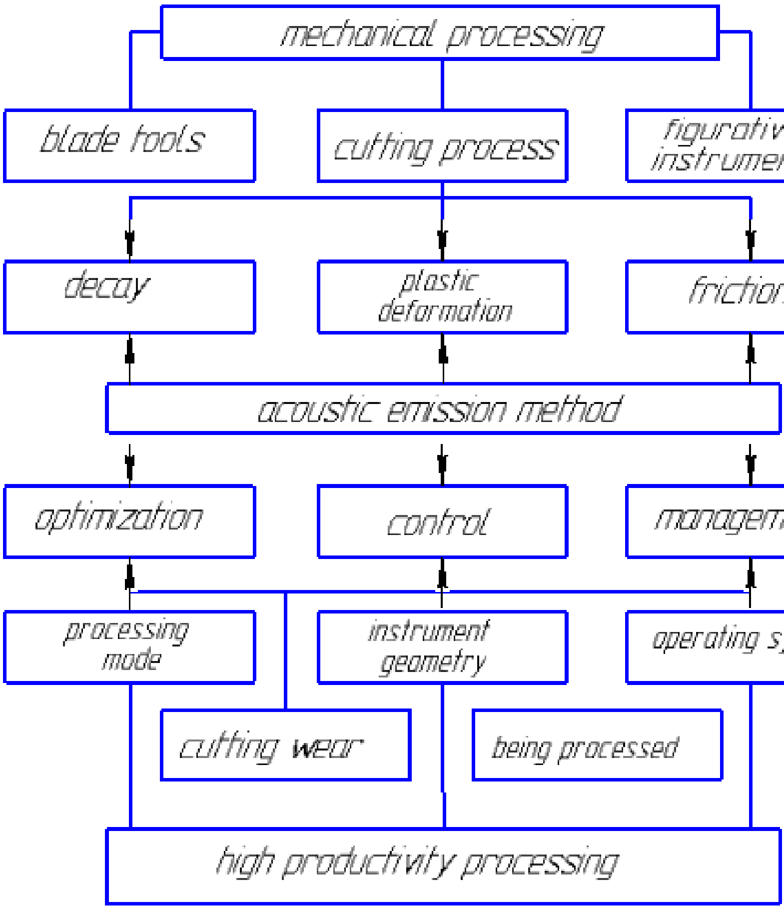

Figure 1. As shown in the diagram , mechanical processing using acoustic emission (VAS).

From the VAS method structural diagram of use in the processing of changes in cutting conditions. Because VAS is produced by basic physical processing processes, experiments have shown that any change in their energy capacity leads to a change in acoustic radiation parameters.

The main treatment factors diagnosed with this method are: chip formation and collapse. The onset of chip crushing is usually accompanied by a characteristic increase in signal

VAS, which can be used to control vibration sharpening, drilling, especially the recording process; sharpening geometry and brand of tool materials, as well as the effect of wear-resistant coating; rigidity of process system elements; the effect of physical and mechanical properties of materials on processing; the type of technological environment used, its concentration; surface quality and the presence of a recyclable structure material; knife and abrasive tool wear; surface depth and pre-processing methods.

Thus, the VAS method allows the identification of all important processing properties and, especially valuable ones, to determine their interactions. This predetermines the possibility of using VAS signals to control the intersection. A block diagram of the application of the VAS method in machining operations is shown.

In the technological system, the workpiece during machining of the machine tool generates high-frequency elastic waves, and at the same time their parameters and appearance are manifested in the stresses that occur when the dynamic local processing. Their main source is the cutting zone, where plastic deformation and destruction of recycled material occur and cracking of friction bonds on the contact surfaces of the tool. These processes inevitably result in the discharge of a rigid body, such as a cutter, with varying degrees of permanent and temporary localization, and the technological waves of forces propagating in an elastic medium (i.e. across the elements of the technological system carries certain information).

Note that if low-frequency oscillations are caused by the unevenness of the machining process and are caused by many external factors, primarily due to the stiffness and inertial properties of the technological system elements, then VAS waves during cutting is formed as a result of dominant physical processes (friction,

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plastic is deformed). This is their parameter by analyzing the dependence of the apparatus on the processing conditions for technological cutting diagnostics namayon will be .

For example, the modification, processing, and recording of received power waves is called the vibro acoustic method. VAS sources can be conditionally divided into external and internal components . The first includes sources located on the surface of an object, such as friction, collisions, or voltage waves generated by the turbulent flow of a liquid or gas. creates certain advantages. These dynamic processes are related to the redistribution of mechanical stress fields in the main part of the material to the internal sources of the VAS (e.g., plastic deformation, micro and macrofractionation, phase transformations). From these positions, it can be concluded that there are a number of VAS sources in the sound output zone, and in the case of voltage waves of different power and spectral density.

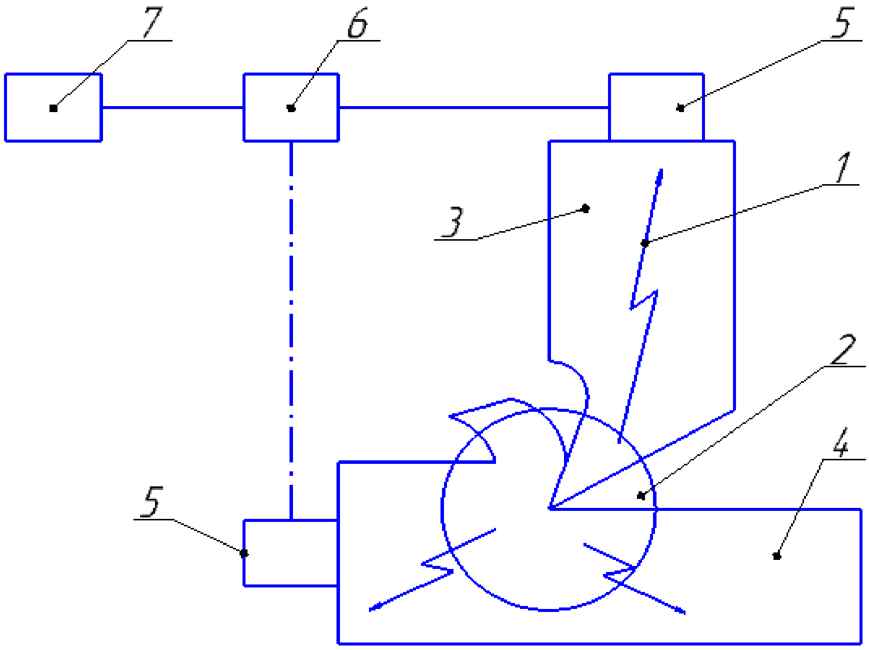

Figure 2 View of the vibroacoustic signal (VAS) cutting process .

The change in the parameters of the vibroacoustic signal (VAS) is shown in Fig. The desired signal is processed and transmitted to the 7th control device.

The processing of the AE signal can be different, it is related to the informativeness of acoustic radiation, the parameters of which are determined by the cutting conditions, primarily the rate of deformation of the processed material - the intensity of its destruction and plastic deformation, as well as friction and is the wear of the contact points of the device

In addition to spectral density, VAS signals have a number of information parameters, the analysis of which allows to create a table of correlations between the flow conditions of the processing under study and the nature of the VAS.

GOST 25.002-80 provides basic concepts in the field of AE. Therefore, on the basis of this GOST and work [4], we determine the most characteristic parameters of VAS used in solving technological diagnostic problems. VAS activity is the ratio of the number of acoustic emission pulses to the observation time. At the maximum value of the VAS signal at the amplitude and e-selected time interval , the aplitude distribution is distributed over the time interval under study of the amplitude-Le.

It should be noted that the degree of correlation between different VAS parameters and the cut characteristics studied can vary within very wide limits. However, these sound output conditions, if any, are recorded very reliably because the parameters are usually interrelated. Therefore, when conducting experiments, it is advisable to record several parameters of the VAS, such as amplitude (energy characteristic) and activity (spectral characteristic).

Experiments have shown that the construction of the dependence of VAS parameters on the cutting conditions includes not only VAS parameters, but also their combination, for example, the technological characteristics of the signal output:

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$$W_m = A^2 N_S / (P_z v_{rez}),$$

Here: $A^2 N_S$ acoustic signal propagation; A-signal amplitude VAS ; N_S -thermodynamic signal VAS, $P_z v_{rez}$ - shear force. Good results are obtained by acoustic signals during processing.

$$W_I = AN_S / v_{rez.}$$

Physically, when we look at it, it is the pulse of elastic waves that are simultaneously generated in the exit zone of the sound during processing. Most acoustic measurements are comparative in nature, so the graphical parameters of the VAS or technological criteria expressed by formulas (1) "(2) are usually expressed in relative or conditional units, such as the millimeter of the tip of a pen. Sometimes the VAS parameters lead to the input of the sensor; for this, the electrical signal received from the recording equipment is divided by the total gain factor of the measuring instruments.

General Conclusions.

1. In conclusion, it can be said that from the above analysis it is possible to control the process of formation of vibroacoustic signals during cutting, ie to diagnose.

2. Vibroacoustic signal (VAS) numerical modeling results confirmed that vibroacoustic signal (VAS) parameters describing the dynamics of this process can be used to determine the cause of the unstable process observed after cutting, to determine the workability of metals by cutting.

3. Increased labor productivity is achieved by reducing the auxiliary and main technological (machine) time. The reduction of auxiliary time is achieved, firstly, by automating the working bodies of the machine, secondly, by using fast-moving machine tools, and thirdly, by improving the machining process.

4. Thus, the VAS method allows to reduce the volume of resistance experiments in determining the processing capacity of new materials, and can also be useful for controlling the input and flow of processed material for processing in factory and laboratory conditions.

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