ACOUSTIC EMISSION MONITORING OF CUTTING PROCESS

V.E. WAINBERG, L.I. DEKHTYAR and V.K. ANDREYCHUK
Agricultural University, Kishinev, Moldova

ABSTRACT

In this article the authors offer methods and equipment for monitoring of cutting process and preventing of cutting tool break-doun and change of processing quality. The operation of the device is based on the analysis of acoustic emission (AE) signals parameters, appearing during cutting. It is also offered to conduct inspection of cutting toolsalignment basing on AE signals, appearing in the course of article's processing.

KEYWORDS

Acoustic emission, cutting, cutting tool, break, eccentricity.

AE parameter signals, generated during dynamic restructuring of processed material in cutting zone, are very sensitive to alternation of its initial physical and mechanic characteristic (Poduraev, 1988). They depend on the structure of processed material (Barzov, 1980). Alternation of the processed material's hardness also influences on the AE character (Tutnov, 1981). Besides it provides possibility to define the value of optimal cutting speed, providing maximal stability of tool. Therefore AE method provides possibility to conduct current inspection of the blanks' material.

If AE signals are received by piezoelectric transducer, installes on the cutting-tool or tool-holder, the information about the material values in the cutting point will come to analysing part of the apparatus with certain delay, therefor changing of optimal cutting modes will be also delayed, worsening the processing quality and bringing to tool breakage in case of sudden alternation of material properties. For exclude this we offer to install an indenter in front of cutting tool, supplied with a pressing device and AE signals receiver.

During the operation, the indenter sratches the processed surface, generated signals characterises physical and mechanic properties of the processed material (Wainberg, 1977; Boyarskaya, 1986). In case inadmissible rise of the material hardness AE signals parameters rise correspondingly, which proves necessity to change cutting mode and even to stop it. Indentor breakage and, as the result, breakage of the system are impossible due to small depth of indentor penetration.

To realise this method the device (Fig. 1) was designed. It consist from AE signals receiver 1, installed on the indentor 2 wich is attached in front of the cutting-tool 3 in the distance L and is pressed to the processed surface by the pressing device 4, preamplifier 6 with the set of filters, AE signals analysing unit 7, registration unit 8 wich has a communication unit for connection with executing device. Cutting mode control units 9 receive control signals from registration unit, depending on the properties of the material.

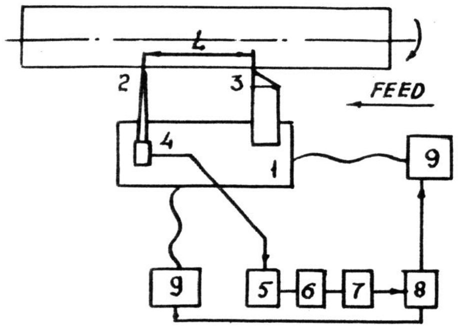

Fig.1

The device operates in the following way. Pressing device presses indentor to the processed surface (0.1 N). During treatment of the article the indenter scratches its surface. Parameters of generated AE signals characterise physical and mechanic properties of the processed surface. These signals are received by signals receiver, then through amplifiers 5,6 come to units 7,8, where they are analysed and registerd for getting information about cutting mode control units 9, which prevent tool breakage, by stopping the feed or change of cutting depth.

Distance L between the indentor´s point and the tool´s cutting edge (in accordance with maximal feed speed) provides reliable operation of the lathe´s control system. Indenter breakage is impossible because scratching depth is only (1-5) mkm. Besides the pressing device operates as dampfer and indenter´s point is manufactured from superhard materials.

We conducted testing of the device during processing of cylindrical samples of ste el 40. In the central part of the sampl´s surface a 10-mm-wide harder band was created by mechanic (rolling) and thermic processing.

As informational AE parameters we took amplitude (A) and AE event count speed ($\dot{N}$). Changing of this parameters depending on the coordinate of processed surfuce in comparison with hardness is shown in Fig.2. Changing of the processed surface leads to substantial growth of AE parameters, which gives possibility to use them for the control of the lathe.

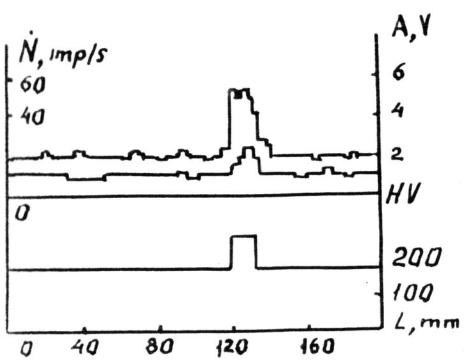

Fig.2.

Besides cutting control the AE method gives possibility to align cutting tools. Cutting-tools alignment takes much time and the bigger part of procedures is manual. To automatize alignment we offer to use AE signals, generated during processing of articles. The essence of the methodology lies in distinguishing of the envelope of AE signals and in additional distinguishing of low-frequency component with measured amplitude. The amplitude´s value characterises the aliment of tools in relation to the processed surface.

Block diagram of the divace for realization of the methodology during turning is in Fig.3a. In Fig.3b there is a part of

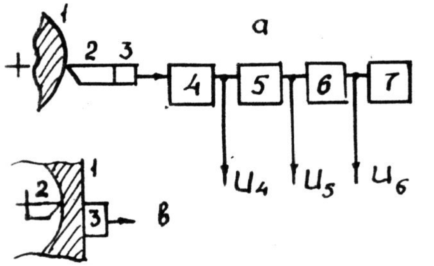

Fig.3.

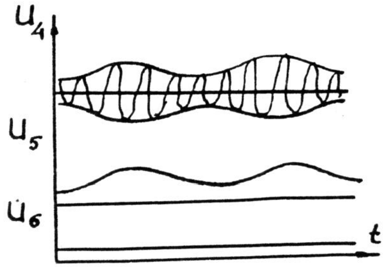

Fig.4.

the device for hole boring. Initial alignment of the tool 2 is made on coordinate system of the machine before processing of the article 1. The AE signals generated during turning are received by the converter 3, amplified in unit 4 and processed by the envelope amplitude detector 5. The form of signal U_4 after unit 4 in case of operation with insufficient alignment of the tool in relation to the processed surface is shown in Fig.4. The detector 5 distinguishes the signal´s envelope U_5 and filter 6 distinguishes the low-frequency component U_6 of the envelope. The meter 7 registers its amplitude. The amplitude shows the quality of cutting-tool alignment. Changing the position of the cutting-tool and the article and monitoring the amplitude of variable of AE signals envelope component, it is necessery to find its minimum, which corresponds the best alignment of the cutting-tool.

During experiments we bored hole with the diameter 94 mm. Initial alignment was made before boring on coordinate system of the machine. The component´s amplitude (after the meter 7) was registered by the recorder. Changing eccentrisity (its value was measured by micrometer in relation to basic hole) it is possible to build the dependence of low-frequency component´s amplitude from the degree of cutting-tool´s alignment fault (Fig.5). Therefore it is possible to conduct optimal alignment of the tools, reaching the closest to zero value of this amplitude, wich corresponds minimal eccentricity of cutting edge in relation to processed surface.

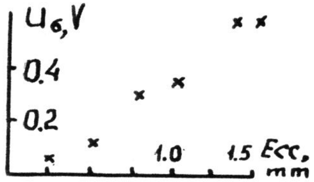

Fig.5.

REFERENCES

1. Barzov A.A. (1980), Improvement of cutting tools operation effectivity. NIIMash, Moscow.
2. Boyarskaya Yu.S. (1986),Physics of microindenting processes Stiinta, Kishinev.
3. Poduraev V.N. (1988), Technological diagnostics of cutting by AE method. Mashinostroenie, Moscow.
4. Tutnov I.A. (1981), . Application of AE for improvement of nuclear machine-building technology. IAE, Moscow.
5. Wainberg V.E. (1977), Investigation of AE during definition of microhardness. Plant´s laboratory, 8, 992-994.