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# MONITORING OF THE PROCESSED SURFACE QUALITY BY AN ACOUSTIC EMISSION APPLICATION

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*Abstract:* - The product quality is one of the basic aims of each modern production. An automatization of production processes implies a continual and automatic quality control being provided by an indirect method. Some results of the research of the following up the quality processes by applying acoustic mission made so far, have been presented in this paper. A part from an elementary given acoustic emission, a survey of an advanced system for acoustic signal mission following has been presented here. The signal is generated by means of the AE sensor, being transformed within a virtual instrument, i.e. the Lab View software. Monitoring of the processed surface quality has been chosen for the preliminary research presented in this paper.

*Key- Words:* - Acoustic emission, drilling, product quality

## 1 Introduction

Out of all machining procedures, drilling represents one of the most frequently used ones. This process, as it is known, occurs in very complex and difficult conditions accompanied by specific demands for a treatment quality. Having in mind the fact that more than 50% of drilling operations are final ones, there is a need for building an intelligent system for monitoring the drilling treatment process by means of acoustic emission. The main reason for studying acoustic emission (AE) lies in the fact that the greatest number of research efforts in monitoring the characteristics of machining process is focused to acoustic emission. [1]

Majority of the authors consider the problem of appliance of acoustics emissions from theoretical points of view. That is a general and non adequate approach [3], [5] and [6]. In order to use acoustics emission in real-time control it is necessary to investigate all relevant parameters in real work conditions at that from experimental point of view. Such experimental approach is a topic of this paper.

As it is known the machining process causes elastic deformations transmitted to a machine structure. This produces waves called acoustic emission and they are generated by different sources. Main sources, in machining process, of acoustic emission are: friction, plastic deformation in the cutting zone, creation and ship fracture, etc.

Aiming at comprehensive researches of the hole treatment processes with twist drills, the Faculty of Mechanical Engineering in Podgorica has been developing an intelligent system whose base is made up of AE-sensor supported by software Lab VIEW.

## 2 Experimental Researches

Experimental researches were carried out in the laboratory of the Faculty of Mechanical Engineering in Podgorica according to the established experiment plan. The main aim of research work is investigating the influence of sharpening twist drills on the quality of drilling treatment.

### 2.1 Treatment Quality

The quality of final piece, representing a transformed output material from working system, is a complex parameter, and a function of the quality of construction piece, quality of treatment system, projected treatment process, quality of input material, and similar. However, treatment quality is one of the condition for achievement of the needed quality of the final piece, and it includes:

a) treatment accuracy, and
b) quality of treated surfaces.

These two complex parameters of treatment quality are mutually dependent, differently for each treated system, and they are function of a great number of influencing factors.

Treatment accuracy means a degree of accordance of the treated pieces with previously determined die. The greater the accordance the greater the accuracy. Treatment accuracy includes:

- measure accuracy,
- accuracy of surface shapes, and
- accuracy of mutual relations of two or more surfaces.

The quality of a treated surface is determined by:

- roughness,

- undulation, and
- physical-mechanical properties of surface layer.

The results of preliminary researches of roughness of the treated surface by applying acoustic emission have been given in this paper.

Roughness is a microgeometrical irregularity, i.e. uneven surfaces on a small, reference length. Parameters of the treated surface profile (Fig. 1) are:

- greatest height of uneven surfaces $R_{max}$,
- furrow feed k,
- mean arithmetic distance of profile $R_a$,
- mean height of uneven surface $R_z$,
- percentage of profile carriage $p_{cn}$.

Basic criterion of roughness is $R_a$ whereas $R_{max}$, $R_z$ and $p_{cn}$ are additional criteria.

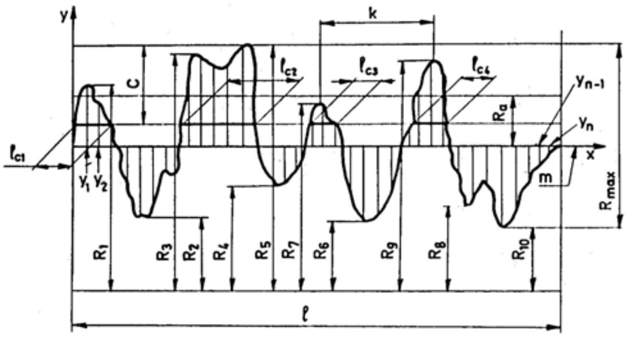

**Fig. 1 Parameters of treated surface profile**

A great number of factors influence on the quality of treated surface, among them the most important being:

- treatment method,
- treatment parameters,
- material of work piece and tool,
- tool geometry,
- dynamic behavior of treating system,
- application of means for cooling and lubrication,
- tool state (degree of bluntness),
- layer on the chest tool surface, etc.

## 2.2 Conditions for Carrying out the Experiment

### 2.2.1 Measurement Equipment

Roughness measurement has been done on the profilemeter HOMMEL-TESTER, P5Z type, firm HOMMEL. The value of the chosen parameter of roughness $R_{max}$, $R_z$, $R_a$ is read on the indicator.

Acoustic emission measurement has been done with AE-sensor of 8152B2 type, made by KISTLER, with the measurement range in the interval from 100 to 900 KHz, which, as recommended in the paper [3], meets the needs of conditions of the researches. The scheme of data acquisition at carrying out the experiment is illustrated in Fig. 2. [4]

### 2.2.2 Machine

A universal milling machine of FGU type. Added to the machine, by means of some adapters, are fixed sensors for measuring all relevant parameter of drilling process.

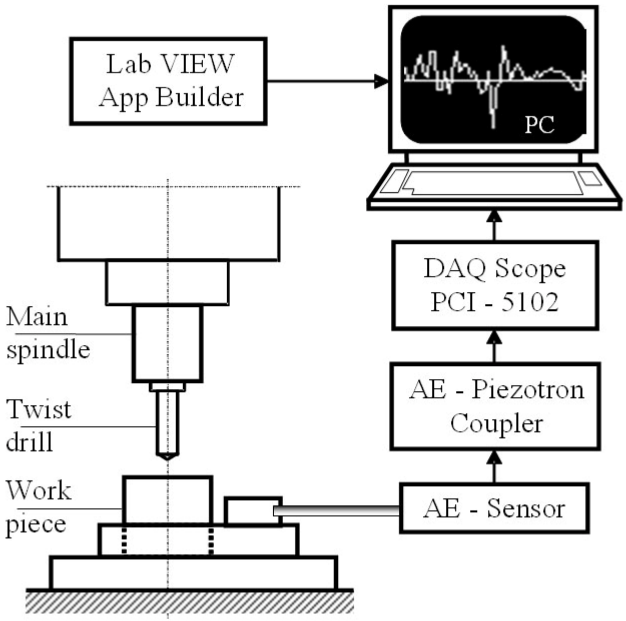


**Fig. 2 Scheme of carrying out experiments**

### 2.2.3 Tool

Normal twist drills with cillyndric hold of 8, 10 and 12[mm] in diameter. Way of sharpening: conical, two-plane, three-plane and cross sharpening. Making, sharpening and control of twist are made in accordance with prescribed standards.

a) Conical sharpening

At this method of sharpening, the back surface is a part of the surface of conical grinding, occuring with drill rotating around the grinding conus axis. Grinding is done by head surface of whetstone. Disadvantages of drill point geometry done by this method of sharpening are:

- improper character of changing chest angle and back angle along main cutting edges, and
- inadequate shape and improper geometry of secondary cutting edge.

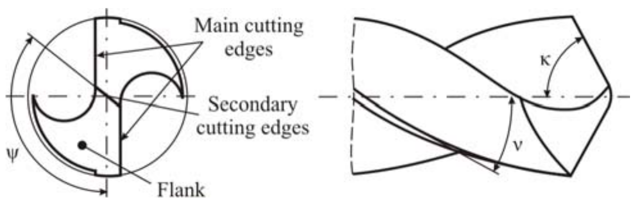


**Fig. 3 Conical sharpening**

b) Two-plane sharpening

At this method, back surface is a part of the plane. The secondary surface provides getting of back surface at wanted angle, by which the possibility of penetrating of back surface against cutting surface is avoided. At two-planes sharpening you achieve a more suitable geometry shape of secondary cutting edge, which gives a better self-guidance of the drill, and by this a less load and outer corners wear, this influencing much the very increase of tool life and accuracy of treatment.

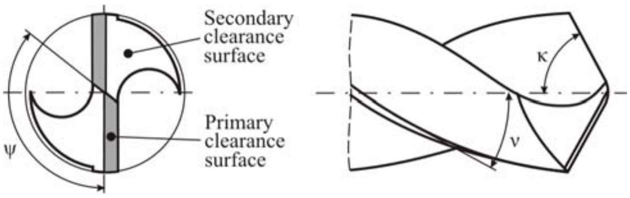


**Fig. 4 Two-plane sharpening**

c) Three-plane sharpening

This sharpening method consists of correcting the secondary cutting edge of the two-plane sharpened drill. This correction is made by undergrinding secondary cutting edge with two flat surfaces elongating, in this way, both main primary cutting edges to the very centre of the drill, forming at this a sharp secondary cutting edge.

Drills sharpened by the procedure are characterized by a higher durability, greater feed, a more precise treatment, a better self-centering of the twist tip.

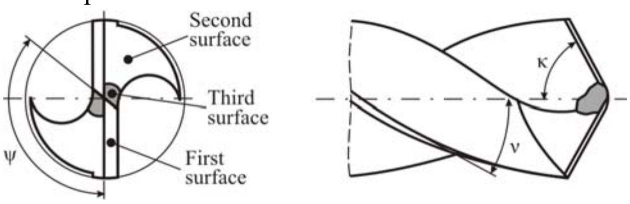


**Fig. 5 Three-plane sharpening**

d) Cross-like sharpening

This form of sharpening is achieved in a way it is the back conical surface of drill point (primary flank, Fig. 6) an angle of $30^0$ to $40^0$ is grinded. By this sharpening a negative chest angle of main cutting edge is transformed into a positive angle, at which the length of secondary cutting edge is decreased to its minimum, this being of great importance in quality of cutting. For an adequate performance of cross-like sharpening it is necessary to have a greater core thickness of drill point in relation to standard one, thus this element makes drill resistant to torsion load and decreases its vibrations during work.

By a correct usage and over-sharpening of these drills, it is possible to achieve a greater durability, and in more difficult work conditions it is far greater. Advantages of these drills in the relation to conventional drills is reflected through several factors:

– improving cutting ability of drill by achieving better drill point geometry,
– decreasing axial cutting force by eliminating secondary cutting edge,
– increasing positioning accuracy of drilled holes by decreasing secondary cutting edge's size
– a strengthtened core decreases vibration of drill in the course of work, thus giving more accurate holes made, drills may undergo greater axial forces and torsion moments, this contributing to decrease of drill fracture in the work process.

Cross-likely sharpened drills especially improve the cutting process at treating materials that are difficult to be treated, materials of great hardness, as well as at making great holes in steel and aluminium alloys.

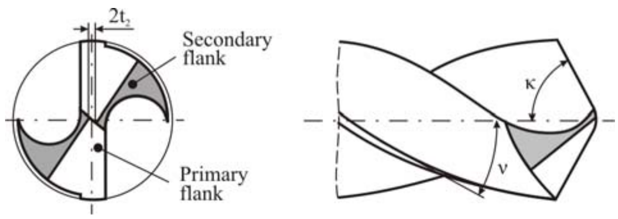


**Fig. 6 Cross-like sharpening**

### 2.2.4 Cutting regime

Spindle speed 500; 710; 1000[rpm]; feedrate 26.66; 53.33 and 105[mm/min]; drilling depth l=25[mm].

### 2.2.5 Material

Testing samples of dimensions ∅30x40[mm] made of steel Č.1530 have been used for research. Hole drilling is carried out by using means for cooling.

## 3 Experimental Results

Mean arithmetic distance of $R_a$ profile, as a mean arithmetic size of absolute values distance of all the points of effective profile within the limits of reference length is given in Table 1.

| Type of sharpening | $R_a$ [μm] |
|---|---|
| Cross-like | 6.21 |
| Conical | 6.82 |
| Two-plane | 7.65 |
| Three-plane | 8.08 |

**Table 1 $R_a$ values for the central point of experiment**

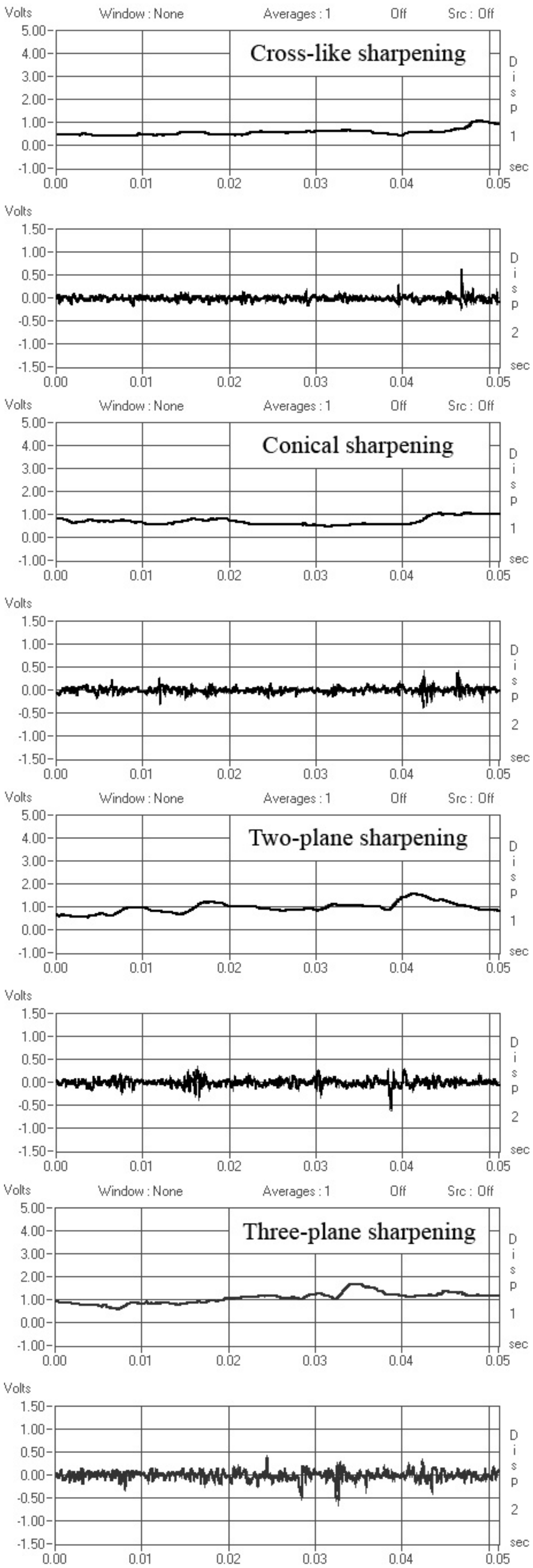


**Fig. 7 AE signals for different types of sharpening**

AE signals for differently sharpened twist drills and central point of experiment are illustrated in Fig. 7.

## 4 Conclusion

Based on the shown results, it may be concluded that there is a certain dependence between type of sharpening of twisted drills and AE signal intensity. Namely, mean value of AE signals (Display 1 in Fig. 7) is lowest for cross-like sharpening, and increasing over conical, two-plane, towards three-plane way of sharpening.

Reasons for above said lie in the fact that at cross-like sharpening if compared to conical one, there is far greater thickness of the core, this making drill more resistant to torsion load and decreasing its vibrations in the course of operation. Also, by undergrinding of the core, it weakens, this favoring vibrations and trembling of the drill point.

Based on the data given in Table 1, it is evident that roughness parameter of treated surface $R_a$, in relation to type of sharpening, behaves as AE signal intensity.

To establish an accurate dependence and define limit values of the parameters observed (AE and $R_a$), it is necessary to continue researches of monitoring the quality of treated surface by acoustic emission.

Initial researches should be a base for quality and tool monitoring or process control.

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