Measurement 110 (2017) 65–73

Contents lists available at ScienceDirect

Measurement

journal homepage: www.elsevier.com/locate/measurement

Research on operation determination of the functional condition of drill bits by means of the resistance method

Radoslav Krehel'

Technical University of Košice, Faculty of Manufacturing Technologies with a seat in Prešov, Department of Computer Aided Manufacturing Technologies, Štúrova 31, 080 01 Prešov, Slovak Republic

ARTICLE INFO

Article history:
Received 12 January 2017
Received in revised form 27 April 2017
Accepted 14 June 2017
Available online 19 June 2017

Keywords:
Lathe processing
Frequency spectrum
Vibration acceleration amplitude
Frequency
Mechanical vibration

ABSTRACT

The article deals with the identification of drill bit blunting. Blunting of a tool is considered to be a negative phenomenon which occurs by rubbing the tool against the machined material. The measuring procedure is based on the fact that the amplitude and frequency of vibration increases with the increased drill blunting at the moment of cutting the material. That causes harder cutting of the tool into the material and thus increase in the cutting force. This phenomenon has been transformed into the measuring method. According to the equation mentioned in the article it can be seen that the surface of the workpiece and tool changes its position by the means of the acting force. This change in position has its own size and frequency and is a measurable variable. The measurement can be performed indirectly, e.g. by measuring changes in electrical resistance between the workpiece and the drill bit at the moment of the touch. The size of the deviation of flexible deformation depends on the size of the acting force. The size of the acting force is in relation to the wear of the tool. The deviation of flexible deformation causes the change in the size of the contact surface of the workpiece and the drill bit at the time of the touch. This change constitutes the change in the cross section of the conductive way for the flowing electric current. The article describes the method selected for particular measuring. It's a resistance method by which the characteristics of the current flowing through the touching point of the machining tool with the surface of the workpiece is measured in the moment of the first contact of the tool with the workpiece at the beginning of machining. The electrical signal acquired in the moment of the first cutting of the machine tool into the workpiece carries the information on its functional condition. This piece of information is then processed and evaluated. The article contains conditions and the measuring procedure, comparison of the time pattern of the voltage of various degrees of the wear and by using various materials, which are recorded by the oscilloscope. Based on the values measured, the selected method for monitoring of the wear of drilling tools has been reviewed and evaluated.

1. Introduction

The history of the production processes can be described as a period of economic development, during which there was an active attempt to change the natural resources and raw materials for useful items, from which new characteristics were expected. The subject matter of these changes was the creation of tools used for realisation of process, during which a semi-finished product transforms to a final component or product. This process is called a production. In the early beginnings of the economic development the production was characterized by important parameters such as:

- production capacity,
- the product's effectiveness during their consumption or use,
- manufacturing labour productivity,
- rhythm and continuity of production,
- production costs.

These production parameters are directly related to the product quality. The level of quality and consumer satisfaction with products are in direct proportion, and therefore we try hard for the highest quality from the beginning of the production development. The level of quality can be detected by measurement technique. The higher efficiency measurement technique and concentration measurement technique in the manufacturing process, the higher quality level. The development of measurement technique has

E-mail address: radoslav.krehel@gmail.com

http://dx.doi.org/10.1016/j.measurement.2017.06.020
0263-2241/

been in close relation to the weight, volume and length measures development, which constituted the basis of developing market and related goods exchange.

The measuring technique is aimed to ensure the results' assessment of the components' testing and controlling process. The required level of production quality shall be done by elaboration of results of the control and that all by a means of the control of materials, semi-products, tools, cutting conditions, appliances, tests and components' measurements. The development of measuring technique is currently intense because the requirements for reliability, speed and quality of measurement processes have constantly grown [3].

Based on the experience and knowledge, a person involved in the technological process can solve tasks arising from the automated control in order to ensure failure-free operation, to reduce downtime, to ensure quality of production and to ensure the development of knowledge about the control of technological process. A high level of computer equipment and production technology enables us to solve these tasks with the high quality. Currently, we distinguish three phases of the process:

- controlling before the process - its task is to ensure failure-free work,
- controlling during the process - the task is to ensure failure-free process, identification of production quality, prognosis of defects, identification of tendencies in the development of production,
- controlling after the completion of the process - the task is to achieve the highest possible quality of products and ensure the solutions of the statistical and analytical tasks.

This study was aimed at:

- developing and describing a method of the exact identification of the drill bit wear,
- development of the principle of detecting drill bit wear,
- development of detecting method based on this principle,
- verification of the developed device on the bases of the particular case of measuring the dimensional tool wear.

At present, we can find metal machining in every industry. The basic procedures of metal processing include cutting, drilling, lathing, etc. The selection of the right machining tool and its monitoring in the process of the withdrawal of splinters is important for the economic and effective use of these methods, as it is presented in publications [1–12]. The wear of the tool affects the productivity of the machining and product quality. The basic precondition for the increase of productivity is the determination of an optimum strategy of tool exchange. By short time intervals between the tool exchange, longer downtimes occur and also the tool potential doesn't have to be used sufficiently, as the tool is not so worn out that it is really necessary to exchange it. This leads to higher costs for tools or the overall production process, as presented in theses [13–22]. By a late exchange of the tool, the time required for machining extends, what can lead to lower quality of the machined surface, as it is presented in the thesis of LÜ 2014 [6]. The mission of the monitoring is to determine the rate of the tool wear, and, based on this, to determine the right time for tool exchange. Reasons presented are the driving mechanism of the research and development of modern monitoring systems for processes of cutting and observing the tool condition, as it was stated in publications by LAURO 2014, PRASANNA 2014 [8,9]. The objective of the research was to determine the functional condition of drill bits during operation. The importance of this study is based on the development of this new method, the main advantages of which over other methods lies in the simplicity of the construction, resistibility to the external disruptive influences, easy maintenance, low demands on the consumption of the electrical energy, minimal possible interference into the production process and low production cost. The relevance of this study is based on the increase in the production effectiveness with the regard to the optimization of the drill bit exchanges and that all based on the effective determination of the technical conditions that this new method enables. This study has contributed to the development of the current state in this field and particularly by a means of the improvement of the application of spectral diagnostics in the frequency field of mechanical vibrations. This research significantly contributes to optimizing electronic and mechanical part of the device, especially by adaptation of the filtering coefficients for the correct settings of the bandpass of the frequency signal. For example, compared to work of GUTHY 2013 [11] where the author evaluates temperature as an authoritative variable, the use of vibration is more favourable in case of my survey. That is because of the fact that the temperature has a large time coefficient of change in the transient performance and the changes are not evaluated in real time. The vibrations show without delay. The work of EATON 2014 [4] deals with the identification of the tool status in terms of acoustic emission. This method enables to carry out the analysis but only in compliance with ideal working conditions and elimination of the outer interference impacts such as the effects of noise from other sources that would significantly affect the identification result of the tool status.

The article contains the description of the oscilloscope used for measuring, as well as other equipment used for the monitoring of the tool condition. The final part deals with the processing and evaluation of the parameters measured.

2. Analysis of the present state

From the point of view of the acting force, we can picture the machining process as a flexible system (SNOP-system – S – machine, N – tool, O – workpiece, P – fixture) shown in Fig. 1.

The key to Fig. 1:

V - rate of feed [m···s−1],
F_y - the force between the workpiece and the tool, [N],
j_y - coefficient of elasticity of the tool, [N···m−1],
δ - vibration amplitude of the tool, [m],
f_s - acting force to the tool, [N],
m_y - weight of the tool, [kg],
h_y - the thickness of the splinter, [m],
y - deviation of flexible deformation, [m].

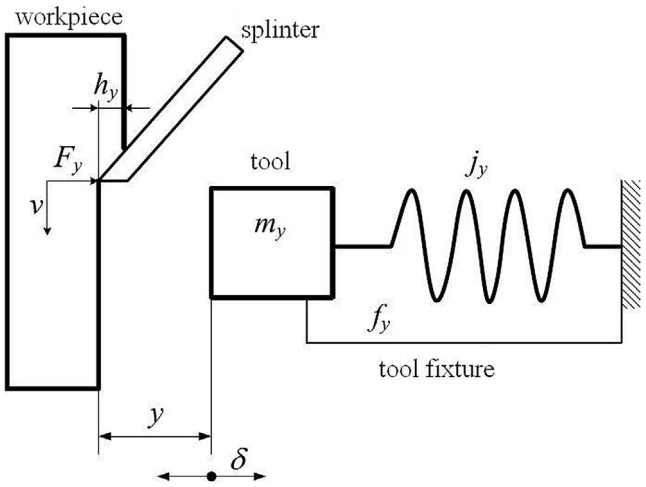

Fig. 1. Description of the flexible model of SNOP system [8].