

# MONITORING THE INTENSITY OF MECHANICAL VIBRATION DURING THE PROCESSING OF CHROME STEEL 14109

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Article deals with the examination of the effect of cutting parameters on the occurrence and size of mechanical vibration on three selected measured points during the processing of chrome steel. It also includes execution, experiment evaluation in this field and comparison of measured vibrations acceleration amplitude values according to the standards. The results of the measurement serve for early identification of a defect, which has great effect on the smoothness and efficiency of the machine. The article concludes with the proposed new findings from the measured values evaluation and formulated new recommendations for the operation in production system with lathe turning technology. The measured experimental values of the acceleration amplitude of mechanical vibrations were compared with theoretical values.

*Key words:* Processing of metals, cutting parameters, vibration acceleration amplitude, frequency spectrum

## INTRODUCTION

The processing of metals using the lathe technology is a complicated process, where the quality of the surface and the occurrence of vibration depends on a significant number of cutting parameters and tool equipment. Currently in order to prevent the occurrence of mechanical vibration, the standard procedure requires careful planning of the input technological and cutting parameters [1]. The occurrence of vibration caused by several sources, specifically the construction and rigidity of the machine, selection of tools and type of processed material. During the processing two types of vibration occur. Forced vibration is identified as processing vibration and is the result of some periodic forces occurring in the machine [2,3]. The sources of these forces are according to Gilla and Zghal [4,5] bad drives, imbalance of the processing machine and feed. Self-occurred vibration occurs due to the interaction during the removal of splinter [6,7]. After measuring the signals of the mechanical vibration during the lathe processing, measured data is processed using some of the techniques for the purpose of getting the amplitude and the vibration acceleration frequency. The traditional techniques of processing signals include the spectral analysis and time area analysis according to Braun [8], Santos [9] and Guimarães [10]. In an effort to reach the highest possible productivity during the lathe processing, bigger and bigger demands are placed on the removal of material and cutting parameters of the processing machines. This article is focused on closer ex-

amination of stated problem, measurement and subsequent evaluation of measured values on selected points of the lathe [11-13].

## MEASURING CONDITIONS

The experiments were realized on a machine LATHE SUI 40 at chosen 3 points.

Chosen three points – the chucking device, the gearbox and the work piece are shown in Figure 1. The processing was done using the standard carbide tool P30 and the inserted tool with a 25 mm square shank with a length of 15 cm without the use of cutting fluid. The feed was constant during the measurement. Details on the technical parameters used during the experiments are listed in Table 1.

The measurement of the vibration was performed using a contactless method, specifically using a laser interferometer Polytec PDV – 100.

Vibration acceleration amplitude measured in this way are recorded in the memory of the measuring device CompactDAQ NI 9233 (dynamic range 102 dB; maximum speed for each channel 50 kS/s) of the National Instruments Company.

Table 1 **Technological parameters of the experiments**

	1 exp.	2 exp.	3 exp.
measuring points on the lathe	chucking device gearbox work piece		
spindle rotation / rpms	355 560 900		
depth of the cut / mm	4		
feed / mm/rot	0,4		

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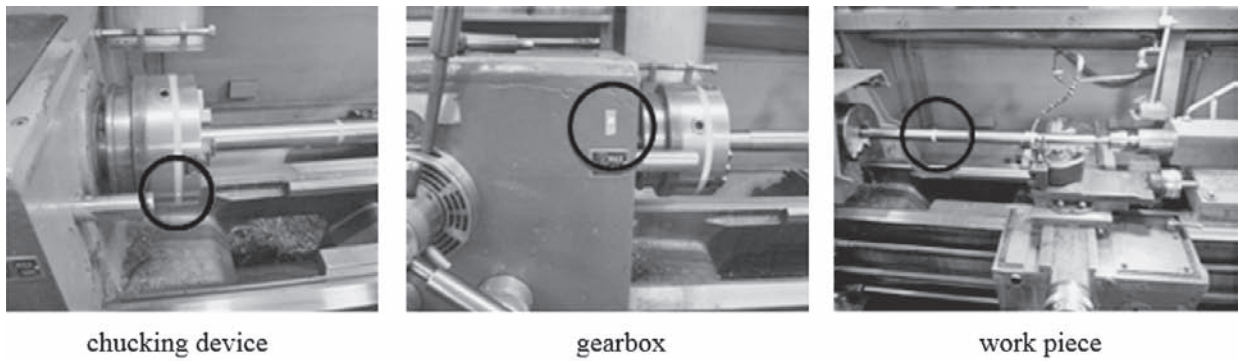


Figure 1 Measuring points of the lathe of the SUI 40 type

### MEASURING VALUES

Evaluation of measured values is based on creation of frequency spectrum using fast Fourier transformations ranging between 0 to 10 kHz. It enables determination of the number of harmonic frequencies in the observed signal. It is then possible to immediately observe the evaluated signal on a laptop with the SignalExpress software. SignalExpress program features several functions that are necessary for correct evaluation, recording of measurements and their analysis. Chart functionalities of change in the course of vibration acceleration amplitude at a frequency are evaluated jointly for engine revolution of 355, 560 and 900 rpm and individually for three checkpoints chosen in advance – a chuck, a gearbox and a workpiece.

The chart in Figure 2 is an example of the change in course of the vibration acceleration amplitude at frequencies for engine revelation of 355 rpm respectively and reduction of 4 mm in workpiece material. By analogy, charts have been drawn for functionalities of vibration acceleration amplitude and frequencies of vibrations in analysed engine revolutions at measured checkpoints, which were the chuck and the gearbox. Comparative charts of vibration frequency spectra were made from the functionalities chart - separate ones for measured checkpoints and a joint one for selected engine revolutions of the lathe. Figure 3 shows a comparative diagram of frequency spectra envelopes common

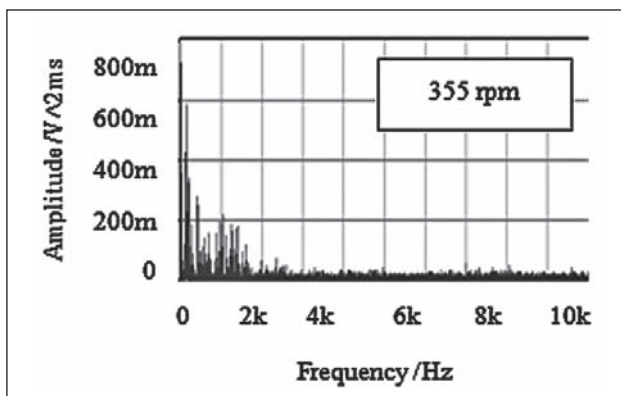


Figure 2 Chart functionality of the vibration acceleration amplitude dependent on frequency for the workpiece and three analysed lathe engine revolutions

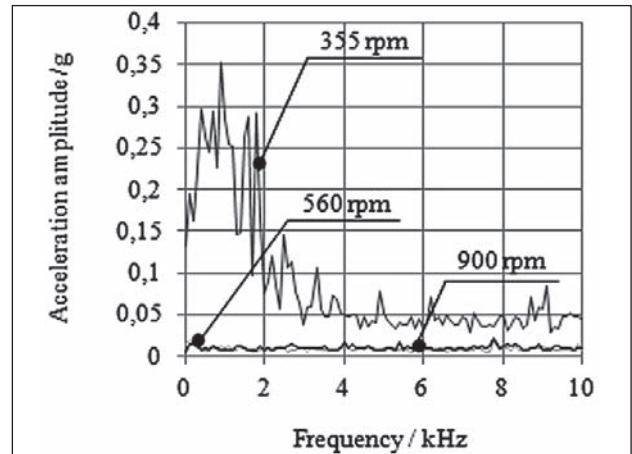


Figure 3 Comparative chart of frequency spectra envelopes in the chuck

for the selected engine revolutions of 355, 560, and 900 rpm respectively, used in measurements on the chuck. Comparative diagram of frequency spectra envelopes for analysed engine revolutions at the gearbox checkpoint is shown in Figure 4 and Figure 5 shows the same for the workpiece.

It is possible to conclude from the frequency spectrum envelope that at 355 rpm, the highest value of amplitude of vibration acceleration was reached compared to other selected revolutions of 566 and 900 rpm respectively. Maximum value of 0,352 g was reached at 355

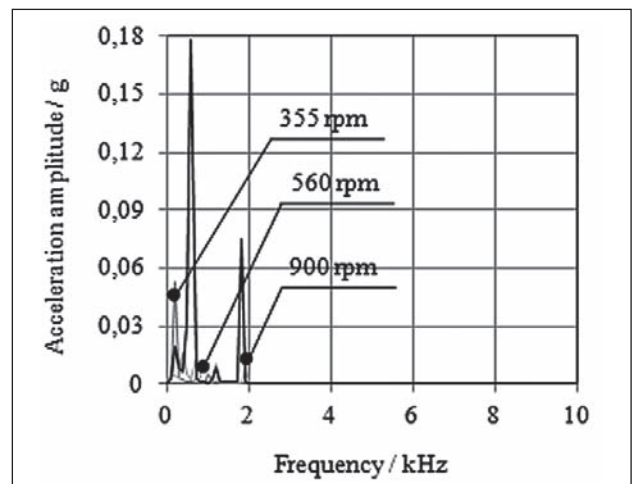
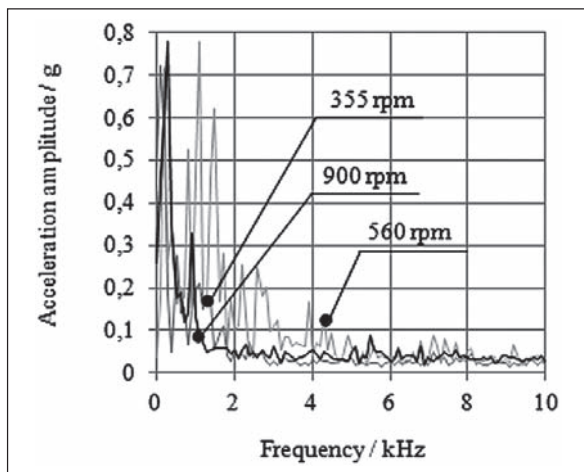


Figure 4 Comparative chart of frequency spectra envelopes in the gearbox



**Figure 5** Comparative chart of frequency spectra envelopes in the workpiece

rpm and at the frequency of 900 Hz; at the revolutions of 560 and the frequency of 7,8 kHz, the maximum value reached was that of 0,011 g and the value of 0,014 g is the maximum measured value at 900 rpm and at the same frequency of 7,8 kHz. Difference between the minimum and the maximum value represents growth as significant as 95,85 %.

It is possible to conclude from the comparative chart of envelopes that at 900 rpm, the maximum value of vibration acceleration amplitude was reached compared to other selected revolutions of 355 and 560 rpm. The maximum value of 0,052 g was reached at 355 rpm and the frequency of 200 Hz. At 560 rpm and the frequency of 400 Hz, the maximum value of 0,0165 g was reached and the value of 0,1778 g is the maximum measured value at 900 rpm and the respective frequency of 600 Hz. Difference between the measured values represents 70,19 % growth.

It is possible to conclude from the frequency spectrum envelope that at 560 rpm, the highest value vibration acceleration amplitude was reached compared to other selected revolutions of 355 and 900 rpm respectively. The maximum value of 0,722 g was reached at 355 rpm and the frequency of 100 Hz. At 560 rpm and the frequency of 1,1 Hz, the maximum value of 0,7792 g was reached and the value of 0,7780 g is the maximum measured value at 900 rpm and the frequency of 300 Hz. Difference between the minimum and maximum value represents 7,32 % growth.

## CONCLUSION

By comparing the results of individual measurements with values designated for the given lathe it can be stated the values that were achieved cause damage. The maximum measured vibration values in the gear-box appear only in the beginning of the process to stabilize later on and fall back within the unlimited operation domain. Rotating parts, such as the chuck and the workpiece, show high values even after stabilization and cause significant damage to device. Therefore it is recommended to use a fixing grip during machining of

longer materials in order to decrease vibration on the workpiece and the chuck. For operation with a 4 mm reduction in material, it is recommended the turning process be carried out at 560 rpm of the engine. Given proposals are useful for reduction of vibration and thus increase in quality of the machined surface, extension of life of the device and its functional parts.

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**Note:** The responsible for English language is Mgr. Lucia Gibfáková, Bratislava, Slovakia