Studies Regarding the Influence of Cutting Regime on Vibration and Noise Pollution in a Parts Processing

Mihai Demian[1, a *], Gabriela Demian[1,b] and Stefan Radu[1,c]

[1]University of Craiova, Faculty of Mechanics, Department of Engineering and Management of Technological Systems, Drobeta Turnu Severin, Romania

[a]mihaidemian@yahoo.com, [b]gabriela demian@yahoo.com, [c]stefan.radu@yahoo.com

Abstract. This paper presents the results of experimental research of the authors in terms of overall vibration behavior MUSD (machine tool, tool-device) during processing by removing metal on a pump body on a CNC milling and boring machine. At the research conducted in this direction were considered mechanical vibration measurements occurred during the processing of various operations of the technological process in parallel with noise measurements. These experimental research in determining the direction of vibration occurring in machining process led to some conclusions about the interdependence between the intensity and quality cutting data processing carried out and the influence of noise pollution produced.

Introduction

In recent years, highly industrialized countries methods of obtaining parts by cutting processing tools a special scale is continuously monitored cutting regime parameters and factors that lead to these changes in the process as well the noise made during processing.

The problem on dynamic aspects where machining has been investigated since the early twentieth century, Fredrick W. Taylor show that vibrations occurring in the cutting process presents a difficult aspect to control. It has demonstrated the existence of three types of vibration when cutting: free vibration, forced vibration and self-sustained vibrations as the three types of responses of mechanical systems in operation.
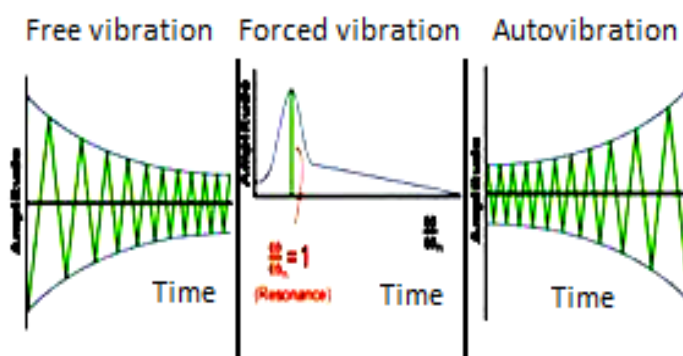

Fig.1 Types of vibrations that occur in machining [1]

Materials and experimental procedure

Cutting process is a dynamic system and vibration are determined by various components specific to the (depth of cut, feed, cutting speed, speed). In most cases, the phenomenon vibrator when machining leads to: excessive wear until the destruction of the cutting tool; poor quality surface finish, tolerances and deviations default dimensional; increased production costs implicit, requiring further treatment finishing. Therefore, vibration is almost always considered a negative factor machining because influenced in bad the surface roughness.

There are also cases in which self-sustained vibration can be beneficial to fragmentation chip and exhaust their better processing area, such as hole diameter 2-3 mm, and lengths of 10 to 16 mm, as show Russian teacher V.N. Poduraev in the 50s.

Vibration frequency and amplitude were able to cause fragmentation chip, frequencies used are in the tens of Hz and amplitude of the vibrations reaching values of the order of millimeters. Cutting regimes thus determine a specific frequency and vibration amplitude and noise pollution depending on operating parameters.

In the calculation of vibration following formulas were used relations like:

$$X = X_{virf} \sin \omega t \tag{1}$$

if $\sin(\omega t) = 1$, than $X = X_{virf}$

X_{virf} = are singular values are removed for a better description of the movement, in practice mean square values X_{RMS} and V_{RMS}

$$X_{RMS} = \sqrt{\frac{1}{T} \int_0^T X^2(t)dt} \qquad (RMS = \text{root mean square}) \tag{2}$$

where - T = period movement and t = time
for a harmonic motion integral above becomes:

$$X_{RMS} = \sqrt{2} X_{virf} \tag{3}$$

$$v = \frac{dx}{dt} = \omega X_{virf} \cos(\omega t) = \omega X_{virf} \tag{4}$$

for $\cos(\omega t) = 1$

$$v_{virf} = \omega X_{virf} \tag{5}$$

$$v_{RMS} = \omega \frac{X_{RMS}}{\sqrt{2}} \tag{6}$$

$$v_{RMS} = 2\pi f \frac{X_{RMS}}{2} \tag{7}$$

$$X_{RMS} = \frac{\sqrt{2} v_{RMS}}{2\pi f}, [\text{mm}] \tag{8}$$

$$\frac{n}{60} = f \tag{9}$$

$$X(nm)_{RMS} = X_{RMS} 1000, [\text{nm}]$$

The experiments were made on a CNC Milling and boring machines AFP 180

Fig.2 CNC Milling and boring machines AFP 180

For the measurements of the noise pollution were used a Volcraft device SL 451 (fig. 3) and for the vibrations were used a vibrometer SKF Microlog CMVA 60 (fig. 4).
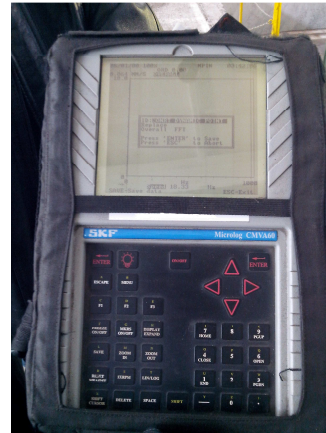

Fig.3 Volcraft SL 451

Fig.4 Vibrometer SKF Microlog CMVA 60

The devices were put in optimal position to obtain precise measurements. Measurements scheme for vibration and noise pollution are presented in fig. 5.

Fig.5 Measurements scheme for vibration and noise pollution

Results and discussion

In experimental research program was provided measurements of noise and vibration measurements [2,3,4]. Noise measurements were performed in parallel with vibration measurements (table 1 and 2).

Table 1. Vibrations and noise measurements for the table
of milling and boring machines

	Position Accelerometer	Speed v_{RMS}	Amplitude X_{RMS} [μm/mm]	sound intensity dB
	speed: 74 rot. / min. advance: 10 mm / min.			
vibration measurements milling machine table	Axial	1,850	337,615	76,4
	Horizontal	0,990	180,67	
	Vertical	1,060	193,445	
	speed: 77 rot. / min. advance: 8 mm / min.			
	Axial	1,52	266,58	77,6
	Horizontal	1,07	187,66	
	Vertical	1,18	206,95	
	speed: 84 rot. / min. advance: 8 mm / min.			
	Axial	1,100	176,845	79,1
	Horizontal	1,150	184,885	
	Vertical	1,300	209,00	

Table 2. Vibrations and noise measurements for the piece
on the milling and boring machines

	Position Accelerometer	Speed v_{RMS}	Amplitude X_{RMS} [μm/mm]	sound intensity dB
	speed: 74 rot. / min. advance: 6 mm / min			
Vibration measurements piece on the milling machine	Axial	0,310	56,575	76,4
	Horizontal	0,780	142,345	
	Vertical	0,480	87,595	
	speed: 77 rot. / min. advance: 6 mm / min.			
	Axial	0,605	106,107	77,6
	Horizontal	0,745	139,661	
	Vertical	0,521	91,375	
	speed: 84 rot. / min. advance: 6 mm / min.			
	Axial	0,900	144,69	79,1
	Horizontal	0,720	115,755	
	Vertical	0,560	90.03	

Vibration measurements were performed on the three axes; axial, vertical and horizontal. Vibration measurements were conducted for milling machine table and for the part of the grip on the drill table. In the calculation of vibration were used formulas from the chapter Materials and experimental procedure.

Conclusions

The first conclusion that can be drawn from the experimental tests is that the vibrations of the mounting jig are higher than those of the milling machine table. This indicates that the work piece mounting jig is improper and he must be redesigned so that differences in measurement of vibration amplitude for milling machine table and for the piece of the grip of on the mill mass to be very small.

A second conclusion is that with the increase of the cutting regime parameters, increases the amplitude of vibration and noise pollution.

A third conclusion that can be drawn from the experimental tests is that noise pollution exceeds acceptable limits of standards and so on milling machine worker must wear protective equipment or use a cutting regime parameters diminished.

Noise pollution and vibration is an important element in finding an optimal cutting regime together with cutting depth [mm]; advance [mm/rev]; cutting speed [m/min].

Future experimental program will try to determine the optimal balance between performance of cutting regime, reduced vibrations in the processing and smaller noise pollution values, because all of this influenced the surface roughness.

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