TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics and Mechanics
Vol. 55, Issue IV, 2012

MONITORING AND ANALYSIS OF A CNC TURNING LATHE MACHINE VIBRATION - CASE STUDY

Ovidiu CHIRIBĂU, Cornel CIUPAN

Abstract: *Monitoring and analysis of vibration provides precious information regarding the operating state of the machine, allowing early programming of the intervention. Article aims at presenting vibrodiagnosis stages and also presents a case study that monitored and vibrodiagnosed a CNC lathe for more than two years. Significant identified flaws in the operation of the presented CNC have been determined since the early stages, offering the possibility of early planning of required interventions and highlighting the importance of implementing a predictive maintenance system through vibration.*

Key words: *predictive maintenance, vibration analysis.*

1. INTRODUCTION

A machine during its operation undergoes wear and tear process, during which the machine gradually loses its capacity to meet the social need for which it was created [1].
During operation of machinery its moving components, produce vibrations at specific frequencies. By knowing the spectral component of the overall vibration you can determine which machine components has a problem [10].
Vibration monitoring and analysis – vibrodiagnosis - is the fundamental element of a predictive maintenance program. The ultimate goal is to give safe operation of the system under the program and to predict the occurrence of failure at an early stage, enabling planning interventions in optimal conditions and time. Identifying the manifestation of failures in vibration spectra can lead to their easy diagnosis with taking measures designed to prevent taking out of use of the machine and their functioning in improper conditions. The anticipation of the occurrence of faults have a major impact on the cost of maintenance and repairs of the paper machine, significantly reducing them by targeting interventions in the conditions of strict human and material resources, for both optimal time intervention and strictly fault localized place [2].

2. PREDICTIVE MAINTENANCE OF THE MACHINERY

Upgrading and updating maintenance techniques and policies have resulted from the development and increasing complexity of industrial systems. Following a theoretical study, textbooks noted that the need to reduce production costs in industry, led to the evolution of four systems and maintenance concepts: corrective maintenance, preventive maintenance, predictive maintenance and proactive maintenance, fig. 1 [8].

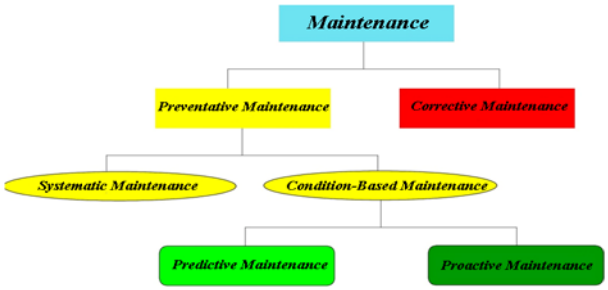

Figure 1. Maintenance systems in the industrial field [7, 9]

Predictive maintenance method is characterized by the ability of measuring the operating state of a machine with specific devices, defects being detected since early state [3].

Predictive maintenance is characterized by an endless cycle of activities: measurement, diagnosis, repair and verification, see fig. 2.

Figure 2. Predictive maintenance stages

Monitoring equipment acts as a guide for maintenance systems, entailing clear advantages such as: machinery efficient, reliable and safe, which is consistent with the environment. Monitoring is the process of acquiring and evaluating data to determine the time evolution compared with a reference so that you can make a decision regarding the level of wear of the machine or group of equipment in question [4].

Through monitoring, accidental shutdowns of the technological line are avoided or even eliminated by early detection of defects in progress, which can be solved in a given time interval. Specialized technical staff and advanced equipment forms a perfect combination so that the repair will consist only in the replacement of the used parts. By anticipating the repair, the amount of spare parts is reduced, and by anticipating the need for spare parts, the labor price will also decrease.

The main concern of users and designers of equipment is the reliability and maintenance of the proper functioning for a longer period of time. Vibration is the main feature that defines the operational status of a machine. Vibratory movement of the machine during operation must be characterized by small amplitude so that it does not exceed the permissible limit. A high level of vibration of a machine can become a potential hazard with possibility of leading to damage and in catastrophic cases could damage surrounding equipment or, even worse, injury the service personnel in the area [5].

For a measurement to be eloquent transducers are mounted as close to the shaft, on the bearing or machine housing. Data collection will be done by installing sensors on three directions: axial, horizontal and vertical see Fig. 3, so that the longitudinal axis of the sensor to be extended bearing beam with a maximum deviation of 5 degrees.

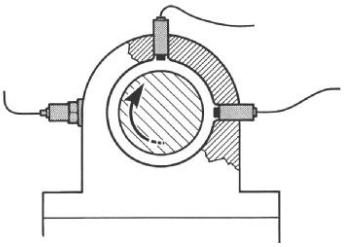

Figure 3. Directions for collecting data [6]

3. VIBRODIAGNOSIS STAGES

a) Data collection of specific tools and process parameters

Each dynamic machine is unique in its own way, so a detailed statement must be prepared before its vibroanosis.

These detailed records will contain information such as: monitoring mode for each machine, technical specification and technological parameters of the process, last but not least connection with other machines [3].

In practice, these records actually refer to:

- Machine card, containing information such as: type of operation, machines with constant or variable speed, constant or variable load, machine components;
- Process card must contain all operating parameters that directly affect machine dynamics and its vibration profile.

b) Mounting transducers

Mounting transducers is always made on bearings in a firm attachment to the three directions: axial, vertical and horizontal. The acquisition will be made by the same bearing numbering system on all measured machines [10].

Consideration should be very careful in setting appropriate type of measurement and measuring equipment type.

c) Configuring the analyzer for data acquisition

In order to purchase, the input signal and the FFT analyzers must be configured by setting the following parameters [11]:

- Set rotation speed;
- Set the maximum frequency up to which to make a purchase;
- Set minimum frequency;
- Set the number of samples in frequency;
- Set the number of mediations;
- The percentage of overlapping of mediation;

d) Configuring collection points

At this stage, make sure to set [11]:

- The analysis parameters that quantify the dynamics of the machine
- Set signal filters, here we refer to the set tape filters or types of windows used;
- Attention and danger limits.

e) Data interpretation

This step involves the analysis of spectrum frequency (amplitude / frequency diagram), identifying high amplitude frequencies, and indicating defects and then notify their presence within the measured spectrum.

Great care must be taken in interpreting vibrations, because if shaft speed (which is the fundamental frequency) is not known, spectral analysis can't be performed because the followed frequencies are dependent on this frequency.

f) Drawing up vibrodiagnosis reports

These vibrodiagnosis reports are drafted in so that the beneficiary is informed what measures should be taken for the proper functioning of the machine.

Within these it will be specified:

• Name of the machine;
• Spectrum;
• Machine state;
• Observations / recommendations based on collected data;

4. VIBROANALISE OF A CNC LATHE MACHINE - case study

The paper presented a report prepared after monitoring CNC lathe, model Doosan Lynx 220 LC, which has the following parameters: power of 5 kW, speed 1500 RPM and 25 Hz and voltage of 380 V. In fig. 4 we can see the time evolution of its vibrations. The machine was monitored for over two years, during which as you can see it has normally functioned.

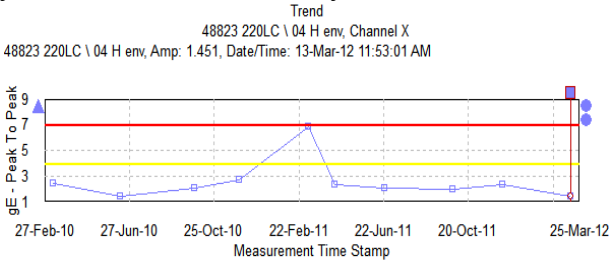

Figure 4. Time evolution of vibration

Defects that can occur inside a machine, referring only to the mechanics, are mechanical weakening defects in camps, movement inside bearings and any weakening of bearings, are closely related to the amplitude and superior harmonics number of fundamental frequency.

As it can be seen in fig. 3 by monitoring CNC lathe March 2011, the overall level of vibrations indicate a fault in lathe operation. Following the investigation of the vibration spectrum of the horizontal axis, see fig. 5, we can see that there is a defect in development, namely the axle bearings show signs of wear. Defect intensity being small a thorough monitoring is recommended, and if the parts do not come out qualitative or if there are any noises, the change of bearing is necessary.

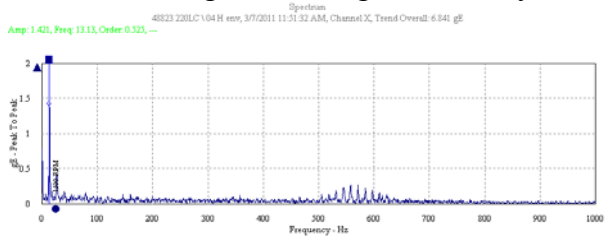

Figure 5. Vibration spectrum indicating the beginning of wear on one of the bearings on the shaft

As the pieces didn't come out in the desired precision class it was decided to change bearings.

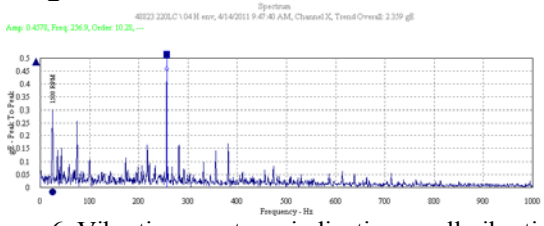

Figure 6. Vibration spectrum indicating small vibrations which should not cause problems

Following this procedure, equipment vibration returned to a steady evolution, to lower values,

as shown in the spectrum acquired in April 2011, see figure 5.

5. CONCLUZII

It is imperative to know the exact axle speed, in the vicinity of which the data acquisition is performed, because on this it depends the spectra interpretation.
Despite technical performance used in this service the factor on which accuracy and quality of vibrodiagnosis depends is the human operator.
Following the case study we can emphasize the importance of implementing a predictive maintenance system by highlighting the advantages offered in the case of CNC lathe monitored, namely:

- High quality in terms of the final product was maintained;
- High reliability was maintained;
- Maintenance costs were reduced by scheduling its intervention only where needed and when necessary;
- Residence time was reduced.

6. ACKNOWLEDGEMENTS

This paper was supported by the project "Doctoral studies in engineering sciences for developing the knowledge based society-SIDOC" contract no.
POSDRU/88/1.5/S/60078, project co-funded from European Social Fund trought Sectorial Operational Program Human Resources 2007-2013.

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Monitorizarea si analiza vibratiilor unui strung CNC - studiu de caz

Rezumat: *Monitorizarea si analiza vibratiilor ofera informatii precioase cu referire la starea de functionare a utilajelor, permitand programarea din timp a interventiilor. Articolul are drept obiectiv prezentarea etapelor vibrodiagnozei si totodata prezentarea unui studiu de caz in care este monitorizat si vibrodiagnosticat un strung CNC, timp de mai bine de doi ani de zile. Defectele importante intalnite, in functionarea strungului CNC prezentat, au fost determinate inca din stadii incipiente, putand planifica din timp interventiile necesare si scotand in evidenta importanta implementarii unui sistem de mentenanta predictiva prin vibratii.*

Eng. Ovidiu CHIRIBĂU, PhD Student, Technical University of Cluj-Napoca, The Faculty of Machine Building, Department of Design Engineering and Robotics, ovidiu_chiribau@yahoo.com, Muncii Boulevard, no 103-105.
Cornel Ciupan, Prof. Dr. Ing., Technical University of Cluj-Napoca, The Faculty of Machine Building, Department of Design Engineering and Robotics, Cornel.Ciupan@muri.utcluj.ro, Muncii Boulevard, no 103-105.