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CAUSES OF VIBRATIONS OCCURRENCE DURING OPERATION OF INDUSTRIAL MACHINERY

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Abstract: *After carrying out an industrial process, it can occur that the results we obtain are not always the results we expected. The causes for these problems are various, whether their nature is physical or functional one. Vibration that appear during operation of an industrial machine can be used such as to establish the causes for low efficiency functioning. The present papers comprises industrial machines problems that can lead to unwanted results and can be determined using vibration measuring with measurements examples made on vertical milling machine in three axes DMC 635v.*
Key words: *vibrations, industrial machine, process, measuring*

1. INTRODUCTION

1.1 Generalities

Seldom, during exploitation of industrial machines dynamic phenomenon occur which, due to in service equipment's complexity, with multiple moving parts, can constitute sources of vibration, either they use or not vibration in the ongoing technological process.

The causes that rouse industrial systems vibrations are generally phenomena produced during an ongoing technological process of an installation that can be a forging hammer, a compactor, a pump, a fan, an internal combustion engine, a tool-machine. These can be directly related to equipment's construction, to technological process or independent of the two situations.

The phenomena may be bearing frictions, impacts, shocks within drive mechanisms and drive motors, lost motion inside gears, inaccurate alignments, unbalances, variable pressure determined by combustion processes, variable forces caused by machine's operating error, flow forces of fluids, too high tolerances.

1.2 Vibrating system

Basically, the vibration is the result of the relationship between acting force during machine operation and mechanical impedance considered relatively steady, force variation being responsible for vibration fluctuation, therefore for machine's operating condition changes. It must be taken into consideration the fact that, during an ongoing industrial process, it's not just the action of one force but of many and the wave transfer is performed through many tracks, therefore the vibration response is very complex.

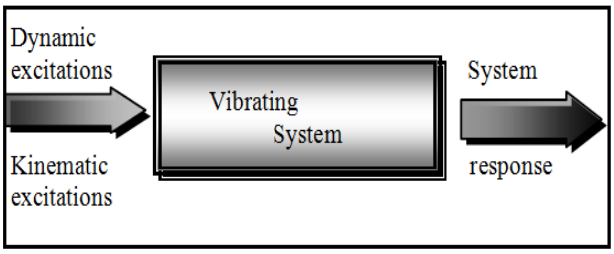


Fig.1. Vibrating system block diagram

1.3 Measuring points

Depending on the imposed requirements and on the results we want to obtain there are three ways to measure:

- Measuring the response from vibrating system output with the possibility of recording and analysing time progress of vibration appeared during machine operation. It has to be verified if measured values are in the domain established through specific vibration standards, having the possibility to determine the degree of harm upon both human factors and constructions; the machine's wear in case of maintenance, quality control for evaluating machine's operating performance. Accordingly, if the measured values are outside vibration limits given by standards it can be concluded that the machine has some physical imperfections or functioning errors.
- Measuring the excitations from the input of the vibrating system enables identification of disturbing sources and their time variation law. Practically this type of measuring is used when the purpose is to design an assembly whose output response levels are between corresponding vibration standard limits or when we aim for determining system reliability. As an example in this direction is the study of vibrations crankshafts at internal combustion engines.
- Measuring simultaneous both systems excitation and response enables development of its analytical pattern and it can be established its dynamic characteristics like damping coefficients, dynamic elasticity modules, mentioning that the excitation is singular, either dynamic or static. For a complex vibrating system we can establish its parameters and we can build its mathematical pattern.

2. VIBRATION MEASUREMENTS ON VERTICAL MILLING MACHINE IN THREE AXES DMC 635V

2.1 System assembly

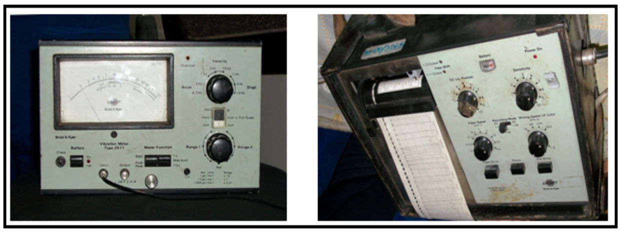
Vibration measurements were made on an operating vertical milling machine in three axes DMC 635v (Fig. 2) from S.C. Hydro-Engineering S.A. endowment.

The milling machine (Fig. 3) has one vertical spindle that performs the main rotational motion and has mounted at its end a milling plate. The feed motion is performed as well by the vertical spindle. The system is provided with CNC, having a Fanuc panel used to adjust parameters value for the operating conditions – speed and feed- and for 3D simulation. Also the machine is equipped with a pump which serves at cooling the piece and a conveyor for chip evacuation (Stroia, M., D.; Rîşniţă, R., 2010).

The processed parts are stainless steel rotor blades used to build up a Francis turbine model. An accelerometer type 4339 is placed on the machine's fastening holder, where the blade is mounted, in order to measure vibrations of system output response. Mechanical vibrations were measured using a vibrometer type 2511 (Fig. 4.a) connected to a graphic recorder type 2306 (Fig.4.b), for further analysis (Bruel&Kjaer, 1973).

Fig.2. Vertical milling machine DMC 635v

Fig.3. Milling process



a) Vibrometer type 2511 b) Graphic recorder type 2306

Fig.4. Measuring system

2.2 Vibration measurements

There are many causes that can determine vibrations during a milling process.

Due to the fact that part's section is not constant, while processing, milling force permanently fluctuates determining the occurrence of vibrations.

Other variable forces that can cause vibrations are the ones that appear between the impeller and the stator of the electrical engine of CNC equipment. Corresponding vibrations have frequencies around value of rotation frequency (Gafitanu, M.; Cretu, S. & Dragan, B., 1989).

Fluid flow from cooling pump can determine vibrations through the jet effect upon the solid surface of the processed blade. Vibration so created has a high number of frequencies.

Unbalance that appears when centre of mass of the spindle doesn't coincide with centre of rotation can lead to vibrations. A certain degree of unbalance is present at any machine spindle in which case the vibration's form is sinusoidal with a frequency equal to the one of rotation motion.

Last situation is when vibrations occur due to chosen operating conditions. Wrong parameter values, speed spindle and feed in this case, can lead to unwanted results like roughness on blade's surface. The roughness has a negative effect on the final turbine model which won't function with maximum efficiency.

For figure 5 parameters values were set accordingly: speed was set to 1,025 rpm and feed was set to 400mm/min. The result was a high enough fluctuation of the vibratory signal.

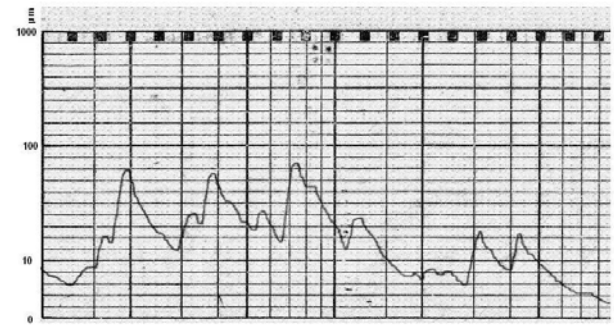


Fig.5. Speed value 1,025 rpm and feed value 400 mm/min

With the same speed value - 1,025 rpm - but with an increased feed value up to 600 mm/min it can be observed in figure 6 that compared with the graph obtained in figure 5 the vibration level lowered from 100μm down to 10μm.

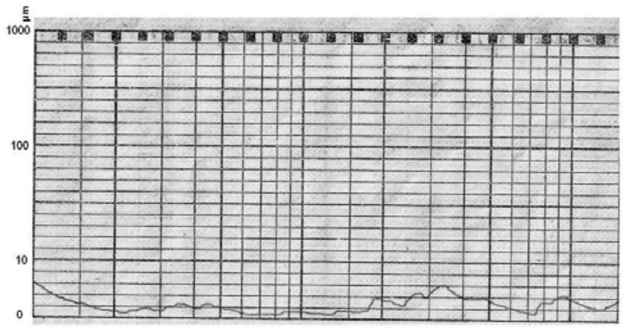


Fig.6. Speed value 1,025 rpm and feed value 600 mm/min

3. CONCLUSION

During operation of an industrial machine and in the evolution of a technical process there are many sources and causes that determine the occurrence of vibrations. As long as their values are in the limits given by the specific standards their negative impact can be neglected. Vibration analysis can be used for diagnosis of industrial machines, thus avoiding major failures.

4. REFERENCES

Bruel&Kjaer, (1973), *Technical Review No. 4*, K. Larsen&Son, Soborg Publishing, Denmark

Constantinescu, A.; Pavel, C. (2009). *Mechanical vibration*, Matrixrom Publishing, ISBN 978-973-755-46-80, Bucuresti

Gafitanu, M.; Cretu, S. & Dragan, B. (1989). V*ibro-acoustic diagnosis of machinery and equipment,* Technical Publishing, ISBN 973-31-0123-0, Bucharest

Stroia, M., D.; Risnita, R. (2010). Optimization of cutting condition on a vertical milling machine using vibromechanical analysis, *Proceedings of International Conference of Mechanical Engineering*, pp. 919-924, ISBN 978-606-510-878-3, University of Craiova Faculty of Mechanics, April 2010, Universitaria Publishing House, Craiova

*** (2010) http://www.gildemeister.com -, *Accessed on: 2010-03-10*