Vibrational Analysis of Production Line

Ajit Kumar [1], Yeswant Kumar [2]
Scholar M. Tech (Mechanical Engg) [1], Asst. Prof (Mechanical Engg) [2]
BM Group of Institutions, Gurgaon [1,2]

Abstract: In the process of automation, vibration is a common problem that affects the performance of the process, especially the manufacture of machinery and tools of useful life. Due to the dynamic movement between the production line and the work piece, strong vibrations occur in the operating environment. In all continuous processes, such as rotation, drilling and grinding, vibrations are stimulated by the deformation of the part, the structure of the machine and the operating. The experimental results showed that the depth of the vibration and the speed of operation are the two main factors that affect the three controllable factors (depth of vibration, speed of advance and speed of advance) for the vibration of the production line of alloy of aluminum. Another study could take into account more current parameters, engineering tools, different materials for work materials and lubrication and cooling strategies in the study to understand how the factors affect the level of vibration. This paper examines the vibration analysis in the production line.

Keywords: Vibration, Depth of Vibration, Production Line, Alloy of Aluminum

1. Introduction

Vibration analysis is one the prominent approaches in predictive maintenance. Rotating machines experience the vibration from the start, run and shut down of the machinery. Industrial vibration analysis is a measurement tool used to identify, predict, and prevent failures in rotating machinery. Implementing vibration analysis on the machines will improve the reliability of the machines and lead to better machine efficiency and reduced down time eliminating mechanical or electrical failures. Vibration analysis programs are used throughout industry worldwide to identify faults in machinery, plan machinery repairs, and keep machinery functioning for as long as possible without failure.

1.1 Production line

A production line is a set of processes established at a factory, where materials are placed through a refining process to produce a final product suitable for future consumption, or components are assembled to form a final product. In general, raw materials such as metal ore or agricultural products such as food or textile factories (cotton, flax) require a series of treatments to make them useful. For metals, business includes cracking, smelting, and further refining. For plants, useful materials should be separated from the shell or contaminants and then processed and sold.

1.2 Assembly line

Therefore, from the processing of raw materials to useful products, the next step is the streamlined concept proposed by Eli Whitney. In 1913, Ford Motor Co. entered the next phase where Henry Ford introduced the constant transportation innovations of vehicles assembled from personal workstations. This introduces the idea of standardization. An assembly line is a series of chains and links used to place different parts in different locations around the car. The chassis was moved along a 45-meter line by a chain bus and 140 staff applied the specified components to the chassis. Other workers have brought additional parts to the car manufacturers to save them. Reduce assembly time for each vehicle. The production time of a car dropped from 12 hours to 93 minutes.

1.3 Tool for vibration Analysis

The vibration analyzer analyzes the state of the machine. It analyzes the vibration spectrum (vibration and frequency), establishes a baseline for the test equipment, and the resulting direction of change over time. This advanced analysis not only provides information on whether there is a problem, but also helps the user understand the root cause and time of the failure. However, this traditional type of vibration exploration requires extensive exploration of training and requires an in-depth understanding of the spectrum history and equipment.

When to use:

- For big, complex machines with many variables, such as paper machines, multi–axis machines, turbines and etc.
- For troubleshooting using real time analysis, bump testing, cross channel phase, and resonance testing for faults other than the 4 common faults described above.

2. Vibration Testing Principles

Vibration measurements are not like temperature or voltage measurements. With electrical test equipment, you may read repeatable numbers again and again. Using an accelerometer to measure the vibration of a powered locomotive is another matter. Instead of measuring the vibration of the vibration source (from the spin column), you measure the vibration from the mounting shell of the machine. This means that you can measure the response of the machine structure to the vibrations in the shaft, the components on the column, the bearings, the cover plate and the foundation. There are many random vibrations mixed with the vibration of the rotating shaft. Even repeated vibrations from the spin column contain many variable echoes, speed and load, position, sensor installation, environment, operation, noise, excitation, and other effects on the machine.

2.1 How to reduce random vibration, noise and variables:

- Make sure the machine is at the same speed and load each time a measurement is taken.

- Make sure the machine is running at the same operating conditions.
- Make sure the same machines in the area are running at the same operating conditions.

It can try to reduce the random vibration and reduce the variables, but the vibration spectrum will not be exactly the same. The only way you can see this repetition is in the space lab environment. When vibrations pass from the shaft through the loader, to the outside of the mounting housing, to the sensors connected to the magnet and mix with the resonance and noise of the machine, foundation, surrounding structures and similar machines, there are many variables that are expected to be precisely duplicated, using appropriate tools The reason is crucial.

After decades of primitive (screwdriver) or vibration analysis is very expensive and expensive, the latest developments in this field make this practice more widely used. Vibration analysis is now a key component of state-based monitoring programs and is constantly evolving. For ordinary users, access to tools has become easier and simpler.

2.2 Vibration measurements and analysis for mechanical fault detection in production line

Electromechanical component manufacturers often require automated online test systems to accurately monitor the characteristics of all their products and components. Condition monitoring of manufacturing equipment often depends on an analysis of the vibration of the machine, where the occurrence of an error can indicate the difference in the vibration signal generated by it. This is because when the device or structural element is in good condition, the appearance of vibration is "normal" and will change when imbalance begins to develop. Piezoelectric accelerometers and microphones are the most common vibration sensors for diagnosing errors. However, due to many limiting factors such as intrusion, installation problems and high sensitivity to background noise, their appeal to Internet quality control seems to be insignificant. For these reasons, the use of laser Doppler velocity (LDV) devices has become more common due to the non-contact principle of lasers. However, despite the advantages of LDV, vibration measurements on rough surfaces can be distorted due to undesirable surface effects such as speckle noise. The collected vibration signals must be processed and analyzed to identify the characteristics that allow the machine and the wrong mechanism to be distinguished. For this reason, many signal processing technologies have been developed in recent years, such as FFT-based analysis, wavelet analysis, demand analysis, and the like.

3. Measuring Vibration

Vibration tells us about the power inside the device. In order to use this information, a sensor (also called a transformer) is required to convert the vibration into an electrical signal that can be processed and stored. Good data collection is the most important part of vibration analysis. The user must use a suitable sensor (previously installed correctly) and test it the same way each time, which means that the device works the same way as the previous time (previous vibration test). In the speed of the machine or the type of loader, the user must choose between a displacement sensor, a speed sensor and an accelerometer sensor. The manufacturer recommends annual calibration of these sensors. Before conducting any vibration test, the user must carefully study the device and determine the best position of the sensor. Sides should also be considered, such as the operating temperature or the presence of water.

3.1 Types of sensors

As it mention earlier there are three types of sensors. The user should understand the difference between acceleration, velocity and displacement sensors and know which one to use depending on the measurement.

- **Displacement sensors**

These types of sensors are permanently installed when measuring the relative motion between the column and the sensor side. The control system uses this sensor in machines such as turbines, large pumps and large fans. Users can usually connect mobile data connectors to dynamic outputs for spectrum and directional analysis.

- **Velocity Sensors**

The dynamic electric speed sensor is basically a hanging suspended magnet between a spring and a magnet. When the sensor vibrates, the magnet inside it remains constant due to inertia. Therefore, there is a magnet movement between the coils which generates electricity proportional to the mass velocity.

- **Accelerometers**

In vibration analysis, the most common type of sensor is used. There are many different types of acceleration on the market, but the most common is internal piezoelectric amplification. The output of the sensor is proportional to the force and therefore accelerates. In this case, an amplifier is needed to convert the charging output to a voltage output (the speaker is powered by the data acquisition tool).

3.2 Experimental Design

The experimental design approach for investigations is selected in three controllable parameters at three levels, since the effective 3K design is effective for studying the effects of two or more factors. Without loss of the general, three levels of the worker are referred to as low, medium and high. The levels are designed through blocks 0.1 and 2. Each treatment combination in 3K design is denoted by k numbers where the first digit refers to A (vibration) Vibration depth), indicates the level of the second fender and C (feed) indicates a three level. These factors in addition to their specific levels are shown in Table 1.

Table 1. Input parameters and dynamic response of accelerometers (Production Line) with and without damping pad

Expt. No.	CS		DOC	FR	Amplitude of acceleration level of Production Line in g			
					Tangential Direction		Axial Direction	
					RMS		RMS	
					Without damping pad	With damping pad (Neoprene)	Without damping pad	With damping pad (Neoprene)
1	200		0.05	.01	2.46	1.05	1.5	0.56
2	200		0.05	.02	3.1	0.86	2.18	0.75
3	200		0.05	.03	2.76	1.2	1.7	0.59
4	200		0.05	.01	3.45	0.79	2.4	0.79
5	200		0.075	.02	4.04	1.9	2.07	0.68
6	200		0.075	.03	4.08	2.05	2.3	0.70
7	200		0.075	.01	3.74	1.7	1.95	0.60
8	200		0.1	.02	4.64	2.12	2.86	0.95
9	200		0.1	.03	4.44	2.24	2.28	0.75
10	200		0.1	.01	3.07	1.78	2.16	0.70
11	230		0.05	.02	3.6	1.84	3.04	1.01
12	230		0.05	.03	3.9	1.95	3.26	1.08
13	230		0.05	.01	3.75	1.62	2.48	0.80
14	230		0.05	.02	4.45	2.5	2.85	0.90
15	230		0.075	.03	5.05	2.56	3.42	1.14
16	230		0.075	.01	3.77	1.92	2.34	0.75
17	230		0.075	.02	5.04	2.45	3.34	1.10
18	230		0.1	.03	5.15	2.5	2.96	0.97
19	230		0.1	.01	2.85	1.6	1.94	0.68
20	230		0.1	.02	4.04	1.98	3.85	1.28
21	260		0.05	.03	4.84	2.54	3.96	1.30
22	260		0.05	.01	4.54	2.34	3.16	1.5
23	260		0.05	.02	5.0	2.64	3.64	1.20
24	260		0.05	.03	5.25	2.73	3.76	1.25
25	260		0.075	.01	5.85	2.82	3.48	1.15
26	260		0.075	.02	5.55	2.72	2.96	0.97
27	260		0.075	.03	5.95	2.47	3.87	1.28
28	260		0.1	.01	4.84	2.42	3.04	1.01
29	260		0.1	.02	5.65	2.57	3.82	1.25
30	260		0.1	.03	5.60	2.74	3.16	1.05
	CS= running Speed in m/min				DOC= Depth of Vibration in mm		FR= Feed Rate mm/rev	

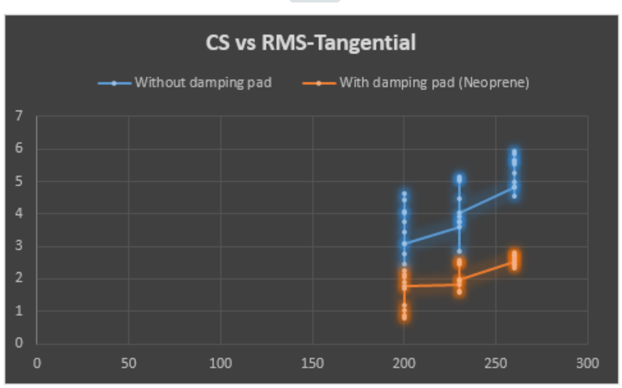

Fig 1. CS vs. RMS – Tangential

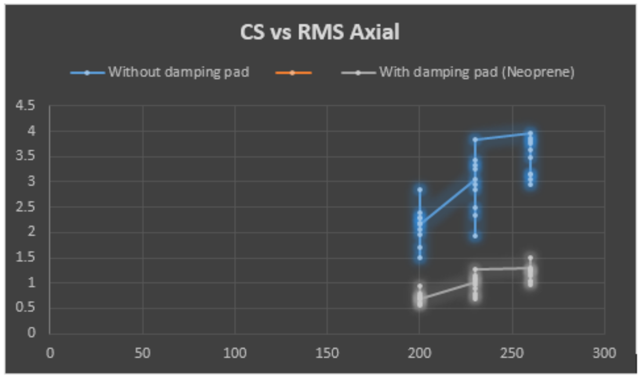

Fig 2. RMS Axial

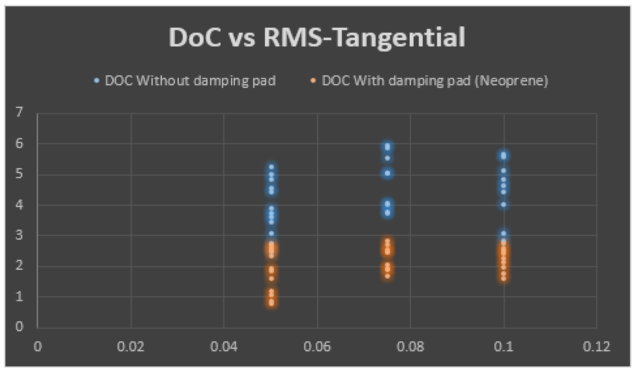

Fig 3. Doc vs. RMS- Tangential

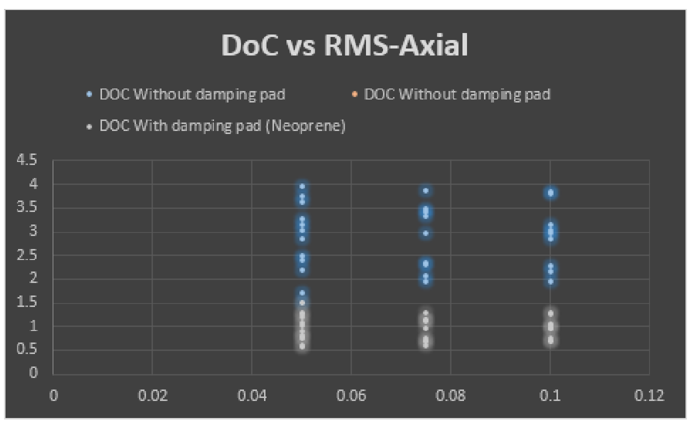

Fig 4. Doc vs. RMS- Axial

Table 2. Identified control factors and their levels

Variables or parameter	Parameter designation	Level 1	Level 2	Level 3
Vibration ting speed(m/min)	A	200	230	260
Depth of vibration(mm)	B	0.05	0.075	0.1
Feed(mm/rev)	C	0.01	0.02	0.03

The MABLAB program was used to analyze the vibration under different operating conditions. The test plan aims to evaluate the effect of operating speed, feed rate, and vibration depth on the vibration of the production line. Table 1 shows the experimental results of running and axial vibration. After the vibration analysis, a negative damping pad is provided below the line elements. The same experiment is now performed for different operating conditions and the line vibration is measured and listed in Table 2.

4. Result and Future Work

In this study, an experiment was conducted on a production line to use a comparison function to test the machine vibration and noise tests of the horizontal and axial vibration production lines, and in the AD-3552 operation based on the vibration signals collected by MATLAB and controlled by the VEM Measured) neoprene. The effects of operating parameters such as operating speed, vibration depth and feed rate are evaluated on the machine variables.

Test results show that the advanced method is successful. Based on the current research, the following conclusions can be drawn:

• The damping rate of the neoprene mat production line increased from 0.0256 to 0.0782, which indicates that the use of production line panels helps to extend the life of the production line.

• Observe that the normal frequency deviates from the operating frequency, thus avoiding the actuator's resonance.

• The neoprene damping pads have axial and axial vibration levels of 65% and 73.5%, respectively.

• Negative damping can provide significant performance advantages in many types of structures and machines, usually without significant weight or cost loss. In all aspects of the research conducted, a significant reduction in tool vibration was achieved during the automated testing of the AD-3552 running test.

• This method effectively measures and monitors the vibration of the production line. The goal of this search has been successfully achieved.

• Multiple regression models have been developed and validated by experimental results.

• The analysis of variance (MATLAB vibration TOOLS) reaches the depth of vibration (38% contribution), the operating speed (35% contribution) and the feed rate (27% contribution) have a greater effect on the vibration of the production line. The experimental results show that the vibration depth and operating speed are the main parameters affecting the three controllable factors (vibration depth, running speed and feed rate).

References

[1]. Thanh-Phong Dao and Shyh-Chour Huang. Design and Dynamic Analysis of a Parallel Compliant Vibration Mechanism for High Precision Production Line, International Journal of Innovation and Scientific Research, ISSN 2351-8014 Vol. 8 No. 2 Sep. 2014, pp. 118-123

[2] Aditi B. Patil, Jitendra A. Gaikwad and Jayant V. Kulkarni, Bearing Fault Diagnosis Using Discrete Wavelet.Transform And Artificial Neural Network, IEEE 2016, pp. 399-405.

[3]. S. S. Chavan and M. M. Joshi, Study On Vibration Analysis of Composite Plate. Volume-1, Issue-4, pp. 69-76, 2015.

[4]. Claudiu bisu. Three-dimensional Vibration Analysis for on-line Monitoring of Milling Process and Spindle Bearings. ICSV24, London, pp. 23-27 July 2017.

[5]. Johan Wandell. Multistage Gearboxes. Vibration Based Quality Control. Stockholm, May 2006

[6]. Jiri Vass and Cristina Cristalli. Optimization of Morlet Wavelet for Mechanical Fault Diagnosis. Twelfth International Congress on Sound and Vibration, 2015.

[7]. Sumit Narwade, Prasad Kulkarni and C.Y.Patil. Fault Detection of Induction Motor Using Current and Vibration Monitoring. International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-3 Number-4 Issue-13 December-2013.

[8]. Valmet technical paper. Vibration Analysis. pp. 1-13 *May 10, 2011*

[9]. Marco Cavallari et.al on the use of vibration signal analysis for industrial quality control. *Engineering Department in Ferrara (EnDIF), University of Ferrara, Italy*

[10]. Shyam Patidar and Pradeep Kumar Soni. An Overview on Vibration Analysis Techniques for the Diagnosis of Rolling Element Bearing Faults. International Journal of Engineering Trends and Technology (IJETT) - Volume4Issue5- May 2013.

[11]. Ali Vaziri and Prof. M. J. Patil. Vibration Analysis of a Cracked Shaft. International Journal of Advanced Engineering Technology. IJAET/Vol. IV/ Issue II/April-June, 2013/103-104

[12]. Vincenzo Niola et.al. Nonlinear models for the vibrational analysis of acomplex dynamical system. 2016 Third International Conference on Mathematics and Computers in Sciences and in Industry IEEE 2016

[13]. Jim-Long Kuo et.al. Vibration Mode Analysis of the Vibration Motor with Current Ripple Based Intelligent Pseudo Speed Measurement in Mini-Scale Production Line. IEEE-2004, 373-380.

[14] Yonghui Hu et.al. Simultaneous Measurement of Conveyor Belt Speed and Vibration using an Electrostatic Sensor Array. IEEE-2015.

[15] D. Stegemann, W. Reimche, U. Sudmersen, Pietsch, Y. Liu. Monitoring and Vibrational Diagnostic of Rotating Maci-Iinery in Power Plants. Power Station Maintenance: Profitability through Reliability, 30 March - l April 1998.
Conference Publication No. 452, *IEEE*, 1998

[16] www.wikipedia.com

[17] http://en-us.fluke.com/community/fluke-news-plus/vibration/vibration-analysis-comes-of-age.html.

[18] http://www.loccioni.com/upload/articoli/documenti/837-Vibration-measurements-and-analysis-for-mechanical-fault-detection-in-production-line.pdf

[19] https://www.sorbothane.com/machine-vibration-reduction.aspx