Systematic Analysis of Vibration on Production Line

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***Abstract*: Due to the dynamic movement between the production line and the work-piece, extreme vibrations occur in the operating environment. In all ongoing processes, such as rotation, boring and grinding, the vibrations are stimulated by the deformation of the work-piece, the machine structure and the operating tools. In the automated process, forced vibration and natural vibration are defined as operating vibrations. This paper conducts experiments on the production line, uses the comparison function to test the machine vibration and noise tests of horizontal and axial vibration production lines, and the vibration signal collected. 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) of the vibration of the fine aluminum alloy production line. Another study can consider more current parameters, tool engineering, different materials for the work material, and lubrication and cooling strategies in the study to understand how the factors affect the vibration level. This article studies the vibration analysis on the production line. This is an extension of the work that was done on rotating machines in the early days.**

***Keywords*: MATLAB vibration Tool Box,Variable Echoes, VEM Measured**

1. 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.

1.1 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. [18]This thesis investigates the analysis of vibration on production line. This is the extension of earlier work which was on rotatory machines.

2. Experimental Setup: Manufacturing is a complex process, and many variables may harm the expected results. Among them, the vibration production line is the most important phenomenon affecting the dimensional accuracy of components, the functional characteristics of the machine tools and the service life of the maintenance tools. In the operation of the machine, the vibration of the production line is mainly affected by the operation speed, vibration depth, feed speed, and other parameters. In this work, the vibration of the production line is controlled by a damping mat made of neoprene. The experiment was conducted in a device in which the tool holder was with and without a damping pad. Vibration signals from the production line were collected by Mat Lab's data acquisition system. In order to increase the buoyancy and reliability of the experiment, a complete experimental demonstration design was used. Test data collected with MATLAB VIBRATION TOOLS was tested to understand the effect of operating parameters. Develop experimental models using MATLAB VIBRATION TOOLS. Experimental studies and data analysis have been conducted to validate the proposed damping system. Field tests show that the proposed system reduces the vibration of the production line to a wider range.

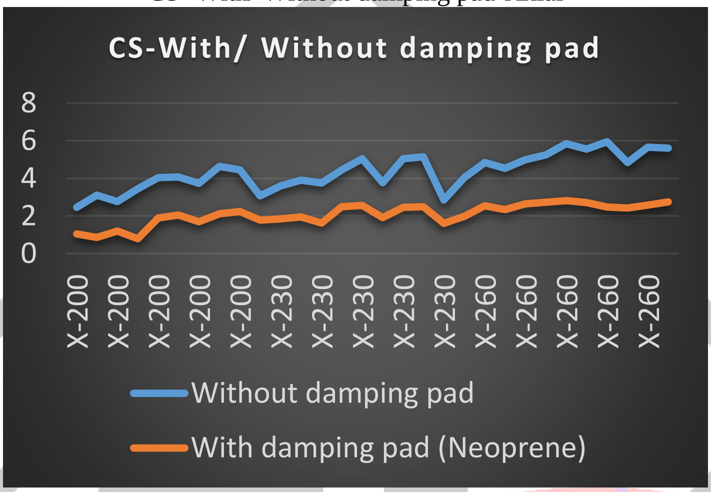
2.1 Experimental Design

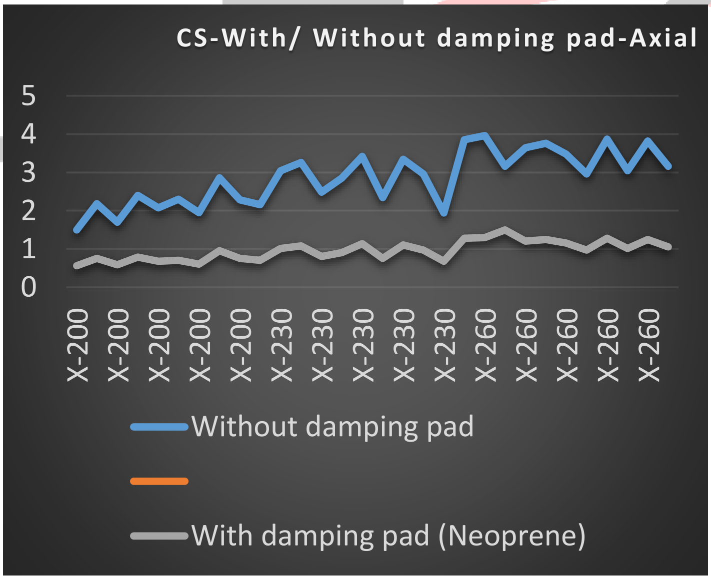
- The experimental design approach for investigations is selected in three controllable parameters at three levels, since the effective 3K design is effective for studying the effects of two or more factors.
- Without loss of the general, three levels of the worker are referred to as low, medium and 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 below Table

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
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	

CS -With/ Without damping pad-Axial





3. Results and Discussion

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. Shows the experimental results of running and axial vibration. After the vibration analysis, a negative damping pad is provided below the line elements. Figure 1 shows a comparison of the vibration of the operating tool under different lateral working conditions without the damping pad and damper pad. Figure 2 shows the comparison of line vibration under different axial working conditions without the use of damping pads and damping pads.

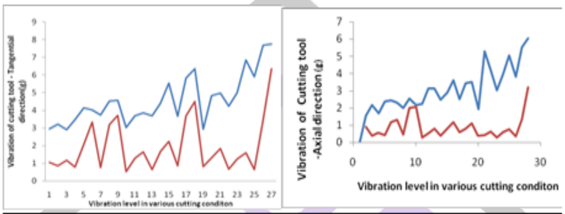


Figure1 & 2: Displays the comparison of vibration of running

The upper curve shows vibration signal without damping and lower curve is with damping.

This passive cushion dissipates energy under different operating conditions. Due to the addition of damping material in this experiment, the vibration level was reduced to 60%. One of the objectives of this study is to find important and comprehensive factors that affect the level of vibration in the production line, and use less performance better. The experimental results were analyzed using MATLAB VIBRATION TOOLS, a tool used to identify factors that significantly affect performance measurements. Use Mat Lab to analyze the results. The results of MATLAB VIBRATION TOOLS analysis show that vibration depth is the most effective factor in vibration. The contribution rate shows that the vibration depth is 38%, the operating speed contributes 35%, and the feed rate is only 27%. Therefore, the vibration depth of the vibrating line is considered to be a more important parameter. According to the MATLAB VABATION TOOLS tool, obtain the best regression equation (1&2) to obtain axial and axial vibration of the production line:

(1) Vibration Level (VT) = - 3.50 + 0.0184 x1 + 3.92 x2 + 7.32 x3

(2) Vibration Level (VA) = - 3.34 + 0.0217 x1 + 1.40 x2 + 5.48 x3

Where *x*1 =running Speed , *x*2 = Depth of vibration , *x*3 = Feed rate, *VT* = Vibration level in terms of acceleration, *g* in tangential direction, *VA* = Vibration level in terms of acceleration, *g* in axial direction. To perform the parametric study using these regression models, the relationships have been drawn between the machining conditions and responses like Acceleration vs. running speed, Acceleration vs. Depth of vibration, Acceleration vs. Feed rate.

3.1 Main Effect, Interaction plot and Contour plot–Tangential direction

The relationship between the main effect and the interaction index (vibration depth, running speed, feed rate, and vibration level) is shown in Figure below. Shows the main effects of line vibration levels on different vibration depths, operating speeds, and feed rates, with the operating speed to the left. He pointed out that with the increase of the operating speed, the operating speed of the production line is continuously increased, up to 200 m/min, which produces the lowest vibration capability and 260 m/min produces the highest vibration capability. In fig. below, the right side is the depth of vibration, which shows that as the vibration of the production line continues to increase, the depth of vibration increases. The vibration depth of 0.05 mm produces less vibration and 0.1 mm produces higher vibration capability. The feed rate at the bottom left shows that the feed rate has increased and the vibratory production line has been increasing. The feed rate of 0.01 mm/cycle produces less vibration and the 0.03 mm/cycle produces higher vibration capability.

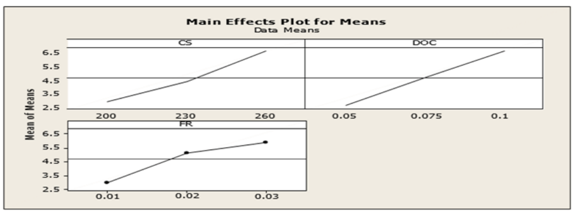


Figure 3: shows the interaction plot for amplitude level at 260 m/min CS, Feed rate 0.03 mm/rev. In this plot, the parallel trends of the lines clearly show very little interaction between the two parameters.

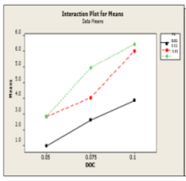
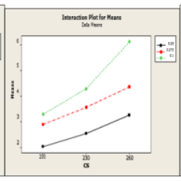
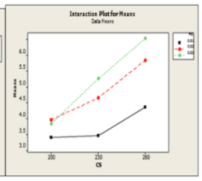




Fig4: Interaction plot between depth of vibration and feed rate for Production Line vibration in tangential direction.
Fig5: Interaction plot between running speed and depth of vibration for Production Line vibration in tangential direction.
Fig 6: Interaction plot between running speed and feed rate for Production Line vibration in tangential direction.

3.2 Main Effect, Interaction plot and Contour plot– Axial direction

The graphs of the main effects and reaction patterns (between vibration depth, operating speed, and feeding rate and vibration level) are shown in a pivotal pattern in Figs shows the main effect of the vibration level of the production line with different depths of vibration, operating speeds and feeding rates, with the left side of the operating speed. He pointed out that with the speed of implementation, the value of production line vibration continues to increase. The operating speed produces 200 m / min minimum vibration capacity and 260 m / min produces the highest vibration capacity. In the depth of the vibration on the right indicates that the depth of the vibration increases with the continuous vibration of the production line in the increase. Vibration depth 0.05 mm produces less vibration and 0.1 mm produces higher vibration ability. The nutrition rate at the bottom left shows that the feeding rate has increased and the vibration production line is increasing. Feed rate 0.01 mm / mm produces less vibration and 0.03 mm / mm produces the highest vibration ability.

Experimental Design

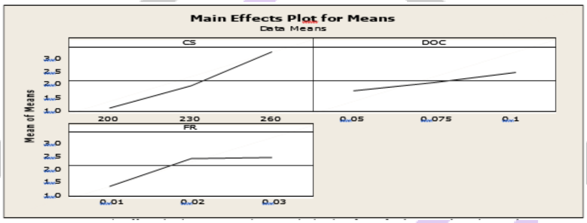


Figure 7. Main effect plot between running speed, depth of vibration, feed rate and Production Line vibration (g) in axial direction.

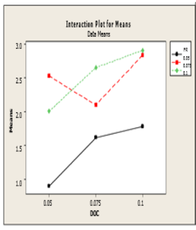
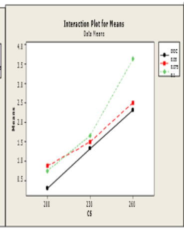
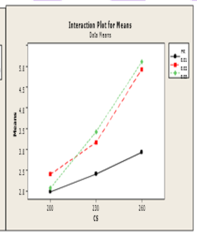




Figure 8. Interaction plot between depth of vibration and feed rate for Production Line vibration in axial direction.
Figure 9. Interaction plot between running speed and depth of vibration for Production Line vibration in axial direction.
Figure 10. Interaction plot between running speed and feed rate for Production Line vibration in axial direction.

4. Result & Conclusions

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) of the vibration of the fine Al-Alle alloy production line. Another study can consider more current parameters, tool engineering, different materials for the work materials, and lubrication and cooling strategies in the study to understand how factors affect vibration levels.

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