VIBRATION ANALYSIS

Fundamentals of Machinery Vibration

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Vibration Analysis:

Fundamentals of Machinery Vibration

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What is Vibration?

As a simple definition, Vibration can be described as the back-and-forth motion of parts or components reacting to forces. These forces could be internal (i.e., from within the system) or external. Vibration can also be viewed as cyclic movement of solid objects because of some form of excitation. If all the forces are completely removed, then vibration will decrease to zero through friction and damping. Imagine everything coming to a complete standstill, this is not so good. We need some vibration in our machines, but how much? and do we measure it?

How is Vibration measured?

Measurement of vibration helps us to assess the severity and possible source(s) of any likely issues in our machines. Using the following sensors, we can measure vibration:

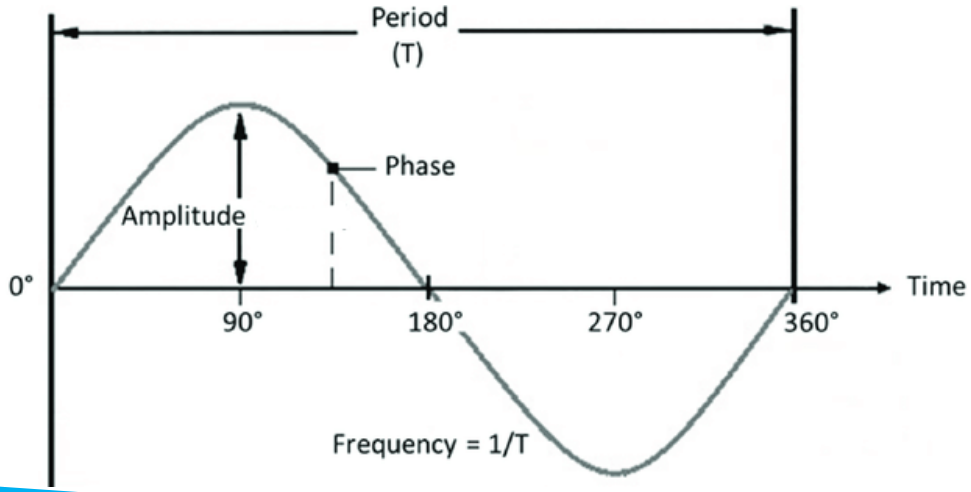
- **Accelerometers:** These are sensors mounted on the machinery casing (as close as possible to the bearings). They utilize Piezoelectric crystals which respond to varying changes in motion (Acceleration) by producing a proportional voltage change. Sensitivities of sensors in this category are typically expressed as mV/G (Millivolts Per G). The original data's unit of vibration when using Accelerometers is same for Acceleration (m/s^2 or in G's).
- **Velocity Sensors:** They operate based on the principle that the relative motion between a coil and magnetic field induces some form of current whose voltage is proportional to varying changes in motion (Velocity). They are mounted on the casing of the machine. Since it measures Velocity, sensitivities are usually rated in mV/mm/s. They can be bulky and sometimes challenging to install them in areas where there is not enough space. When using a Velocity Sensor, the original data's unit of vibration is mm/s (measuring unit for Velocity).

- **Non-Contact Displacement Proximity Probes:** As the name implies, these sensors do not need to make contact with the machinery casing to be able measure vibration. Using principles of eddy currents, they measure how much relative motion (Displacement) is happening to a targeted area of the shaft by producing corresponding gap voltages as the target area gets closer to or further away from the probes. Sensitivities are typically in mV/micron. The original data's unit of vibration when using Proximity Probes is same for Displacement (micron).

Characteristics of Vibration

Rotating Machinery issues can be easily spotted in the vibration signature in advance prior to catastrophic failure if the characteristics of the signature are examined properly. These are the three primary characteristics of any vibration signature:

- **Frequency:** How many times (cycles) the machinery vibrates each second (Hz). This tells us the potential **source** of the problem.
- **Amplitude:** This is the magnitude of vibration that is present. This indicates how much vibration is present. It tells the **severity** of a potential problem so that we can identify and prioritize what type of action is required.
- **Phase:** This describes how one component is moving in relation to a given **reference** point. This tells us the direction of the vibration. Phase is important when we want to isolate certain faults or carry out a corrective action such as balancing and imbalanced Fan.



Why is it important to monitor vibration?

Machinery Vibration Monitoring has been around for decades, and it is an important part of any machinery maintenance program. It plays a major role in determining the health status of machines without intrusive blind-folded maintenance. Without a functional Vibration Monitoring Program, you run the risk of:

- Excessive unplanned downtime, which can lead to production delays.
- Sudden severe machinery damage or catastrophic failure with associated high costs for repair or replacement.
- Reduced safe operations of equipment leading to potential worker injuries and damage to equipment.
- Reduced machinery efficiency and possible increase in power consumption due to machinery not running at optimal levels.
- High levels of Infant failures after overhaul if there is no non-intrusive way to validate repairs.
- Continuous workload of opening up machines and carrying out repairs if there is no quality vibration data to help prioritize maintenance and make better decisions.
- Missing out on asset life maximization if there is lack of vibration data to carry out extension time intervals between stipulated service overhauls.

Brain Teasers: Check your Comprehension

Q1: Which one of the following types of sensors does not need to make contact with machinery casing to measure vibration? (A): Accelerometers (B): Displacement Probes (C): Velocity Sensors

Q2: Three Pumps showed the following Vibration Amplitudes. Which one needs to be prioritized for analysis and repair? (A): Pump #1 – 7mm/s (B): Pump #2 – 15mm/s (C): Pump #3 – 4mm/s

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