Vibration Analysis and Machine Reliability Simplified

A practical Guide to Vibration Analysis

Mohammed Hamed Ahmed Soliman

Contents

Introduction and Terminologies

Vibration can be defined as simply the cyclic or oscillating motion of a machine or machine component from its position of rest.

Displacement:
It is the amplitude of a point on a structure.

Velocity:
Is the speed of a point in a system, It is the rate of change of displacement.

Acceleration:
Is the rate of change of velocity of a point in a system.

Frequency:
Is the no of cycles (vibrations) per second, measured by hertz (HZ).

Harmonics:
Frequency component at a frequency that is an integer (whole number e.g. 2X. 3X. 4X, etc) multiple of the fundamental (reference) frequency.

How many RPMs in 1 hertz?
Since hertz is in sec, and RPM is in minute, 1 hz= 60 RPM.

How to convert RPM to Hertz?

1500 RPM = 25 Hz.

Why we measure the vibration?

- ✓ To detect what is out of the human sense.
- ✓ To discover hidden failures.
- ✓ To Detect early failures & monitor the machine health condition.
- ✓ To assure the quality of repairs.
- ✓ As a useful tool to improve the maintenance reliability.

Common Industrial Applications:

- Pumps.
- Fans.
- Turbines.
- Agitators.
- Stirrers.
- Compressors.
- Electric. Motors.
- Gearboxes.

Vibration& Reliability

Vibration analysis alone doesn't improve reliability, root cause analysis and acceptance testing can help.

There are two ways that we can utilize vibration to improve reliability:

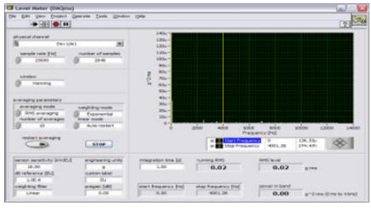
First, if we study the vibration we can often determine why the fault condition developed in the first place; for example what caused the crack to appear in the inner race of the bearing? If we perform root cause failure analysis we can make chances to our proactive so that the bearing don't suffer the same fate in the future.

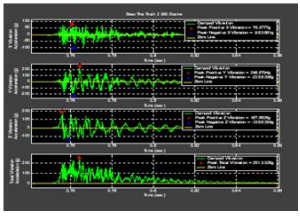
Second, when we overhaul the machine, we can again use the vibration analysis to check that the maintenance repair has been made correctly; and that the machine is correctly aligned and balanced, this called acceptance testing.

Vibration is still used to monitor the health of the machine, but if we improved the reliability of the machine we will see fewer faults conditions develop.

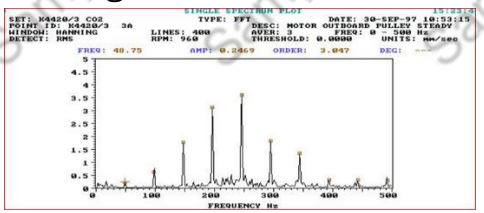
Measuring With Smart Sensors "Collecting Data"

Analysis with Smart Software





Getting Results

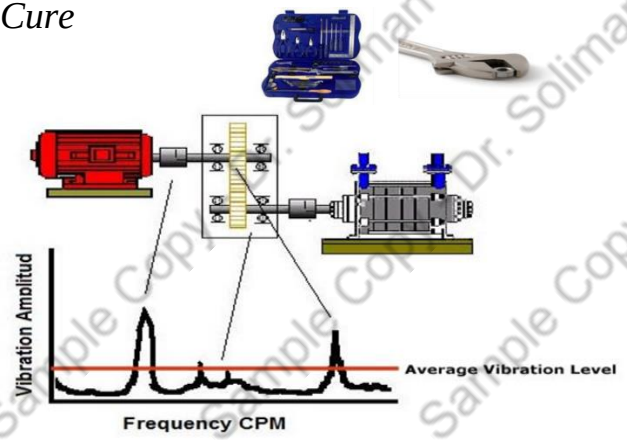


Performing Actions accordingly

Maintain

Repair

Cure



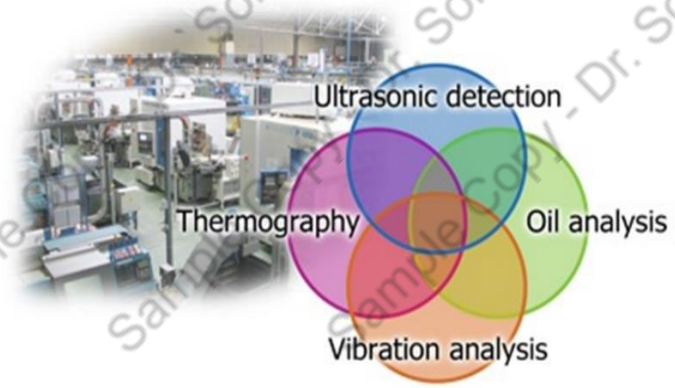
What to Measure??

We normally measure the vibration speeds in in/sec or mm/s.

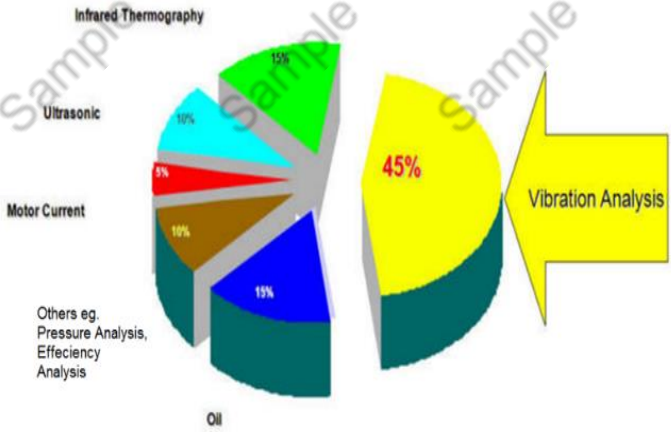
Why using Condition Monitoring programs (predictive maintenance)? And why particularly Vibration Analysis technique?

Benefits of setting up a Predictive Maintenance (PdM) program:

1. To detect what is out of the human sense. 2. To discover hidden failures.
3. To Detect early failures & monitor the machine health condition.
4. To reduce Maintenance Costs.
5. As a useful tool to improve the machine reliability.



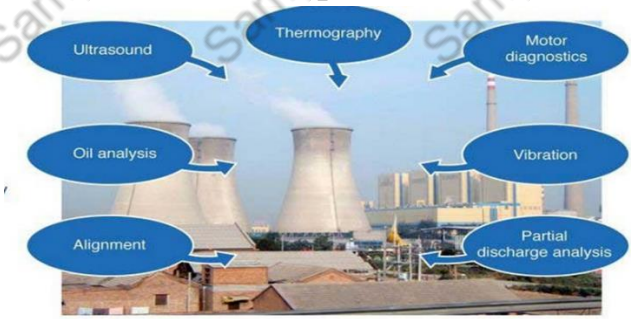
Four tools make up 85% of any PdM program.



Vibration presents 45% of PdM programs.

Equipment that fails in service can cost up to 10 times more to repair than the equipment repaired when predicted by condition monitoring.

Other PdM Techniques



Notes:

Motor diagnosis = motor current analysis, and it's a technique involve intensive diagnosis of motor currents.

Oil Analysis involve Wear Particles Analysis for more intensive diagnosis about the sources of failure. For more information about the technique read the book: Machinery Oil Analysis and Condition Monitoring.

Thermography: involve thermal analysis using infrared camera. For more information about the technique, read the book: Industrial Applications of Infrared Thermography.

Ultrasound Analysis: is an acoustic method based on high frequencies measurement. For more information, read the book: Ultrasound Analysis for Condition Monitoring.