

Industrial Vibration Analysis for Predictive Maintenance and Improved Machine Reliability

Background:

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 world wide to identify faults in machinery, plan machinery repairs, and keep machinery functioning for as long as possible without failure.

Machines:

Typical machines include motors, pumps, fans, gear boxes, compressors, turbines, conveyors, rollers, engines, and machine tools that have rotational elements.



Measuring Motor Bearing Vibration

The rotating elements of these machines generate vibrations at specific frequencies that identify the rotating elements. The amplitude of the vibration indicates the performance or quality of machine. An increase in the vibration amplitude is a direct result of failing rotational elements such as bearings or gears. Based on the machine speed, the rotational frequencies can be calculated and compared to the measurements to identify the failure mode.

Industrial Vibration Sensors:

The practice of Vibration Analysis does require the measurement and analysis of rotating machines utilizing different vibration sensors (accelerometers, velocity transducers, or displacement probes). The most common sensor used in industry is the accelerometer.



Accelerometers on a Gear Box

Accelerometers are case mounted using a permanent bolt or portable magnet to hold them in place. They will measure the vibration of the machine and output a voltage or current proportional to the vibration and relative to a “g” level (unit of gravitational pull). This signal can also be integrated to provide a measured output of velocity (inches/second or mm/second).

It is very important to choose the correct accelerometer, cable, connector, and mounting method for each application. This will provide quality measurements and accurate vibration data for identifying faults in rotating machinery.

Sleeve bearing applications require displacement probes to measure the actual movement of the shaft inside the sleeve bearing.

These non-contact probes measure the vibration of the shaft and the gap between the shaft and the internal diameter of the bearing. Using an eddy current process, these probes will provide an output voltage proportional to displacement (inches or mm).

Faults Identified by Vibration Analysis:

There are several faults in rotating machinery that can be identified by measuring and analyzing the vibration generated by the machine.

- Machine out of balance
- Machine out of alignment
- Resonance
- Bent shafts
- Gear mesh disturbances
- Blade pass disturbances
- Vane pass disturbances
- Recirculation & Cavitation
- Motor faults (rotor & stator)
- Bearing failures
- Mechanical looseness
- Critical machine speeds



Monitoring Cooling Tower Vibration

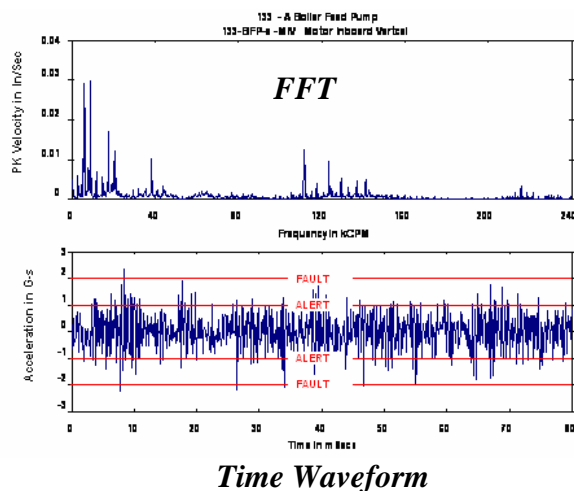
Dynamic Vibration Analysis:

The measurement and analysis of dynamic vibration involves accelerometers to measure the vibration, and a data collector or dynamic signal analyzer to collect the data. Analysis is usually completed by a technician or engineer trained in the field of rotating machinery vibration.



Monitoring Motor & Fan Vibrations

The analog voltage output of the accelerometer, 100 mV/g, is measured by the data collector and presented as a Time Waveform and FFT (Fast Fourier Transform) for frequency identification.



The plots of amplitude vs. time, (Time Waveform) and amplitude vs. frequency (FFT) are required for the trained technician or engineer to analyze and determine the machine fault. Since each rotating element generates an identifying frequency, analyzing the frequency disturbances will identify the faulty element. Once the fault is identified, parts can be ordered and repairs can be scheduled.

Dynamic vibration analysis can be accomplished in several different manners.

- Portable sensors and portable data collection following a predetermined route of machinery measurements.
- Permanent sensors and portable data collection following a predetermined route of machinery measurements.
- Permanent sensors and permanent data collection that provides machinery protection 24 hours/day, 7 days/week, 52 weeks/year.

Process Vibration Alarms:

A recent development in the predictive maintenance and reliability market is to leverage the investment already made in process control systems (PLC, DCS, & SCADA). This allows the operations, maintenance, and process control teams to monitor and alarm vibration levels on critical machines.

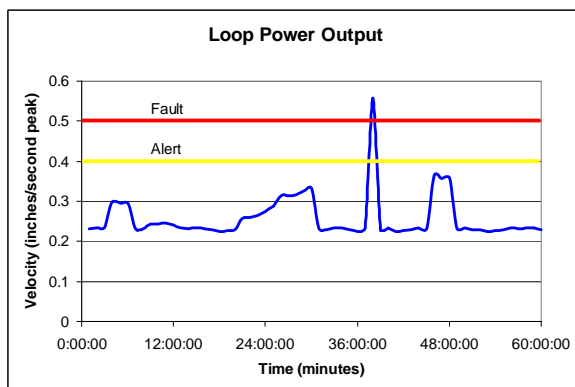
Using a standard 4-20 mA output, the loop power vibration transmitters and sensors provide a current output proportional to the overall value of the machine vibration. This is

not a dynamic analog signal, and it can not be used to analyze the machine fault, but it can be used to alarm the machine and indicate when vibration levels are too high.



Loop Power Sensors to Monitor Bearing Vibration

When high vibrations are measured by the process control system, action can be initiated to determine the cause of the vibration or shut the machine down to prevent damage and failure.



Process Vibration Alarm Plot

Loop power 4-20 mA outputs can be achieved using three different methods.

- A dynamic accelerometer with a 100 mV/g analog output can be connected to a transmitter. The transmitter provides signal conditioning and a 4-20 mA current output proportional to vibration. It offers several different frequency filters to alarm the region of interest. The dynamic signal, 100 mV/g, is also available for the trained technician or engineer to analyze.
- A loop power sensor with a direct 4-20 mA output can also be used. This sensor does not require a transmitter, but the frequency filters are limited to 10 – 1000 Hz and 3 – 2500 Hz.
- A dual output loop power sensor with a direct 4-20 mA output and secondary 100 mV/g dynamic output can also be used. This sensor does not require a transmitter, but the frequency filters are limited to 10 – 1000 Hz and 3 – 2500 Hz. It does have the dynamic signal, 100 mV/g, available for the trained technician or engineer to analyze.

No matter what method you choose, standard 4-20 mA outputs proportional to machine vibration are available for process control. This allows the factory to leverage typical process control monitoring methods and alarm schemes. Convenient alarms for critical machines!

Summary:

Vibration analysis is not a new technology. The Piezo effect and charge output of certain materials was discovered in 1880 by the Curies. The first accelerometer was built in 1923. Over the last 100 years, this technology has been refined for today's industrial market to provide fast efficient measurements of rotating machinery vibration. Sensors are designed to withstand the harsh industrial environments and provide critical measurements year after year.

Cables and connectors are constructed of the most rugged materials available, and provide the critical link from the sensor to data collection. Designed for all types of environments, the proper cable and connector combination will eliminate any concerns for data transfer.

Mounting hardware is available for a broad range of applications. Measurements are

accomplished quickly with portable magnet mounts or quick disconnects. Permanent sensor installation can be accomplished with epoxy, stud mounting, or an array of special mounts designed for permanent applications.

Junction boxes are extremely useful in collecting multiple cables and organizing them in a manner that protects them and makes them accessible to the user. They prevent tangled cables and identify each measurement point.

Dynamic Vibration Analysis or Process Vibration Alarms will provide a proven technology to predict failures in rotating machinery and improve machine reliability.

Protect your investments by using CTC Industrial Vibration Sensors, Cables, Connectors, Mounting Hardware, & Junction Boxes !

Industrial Vibration Analysis

- ✓ *Measure*
- ✓ *Analyze*
- ✓ *Alarm*
- ✓ *Repair*



***Failed Motor Bearing
Don't Let This Happen To Your Machines !***