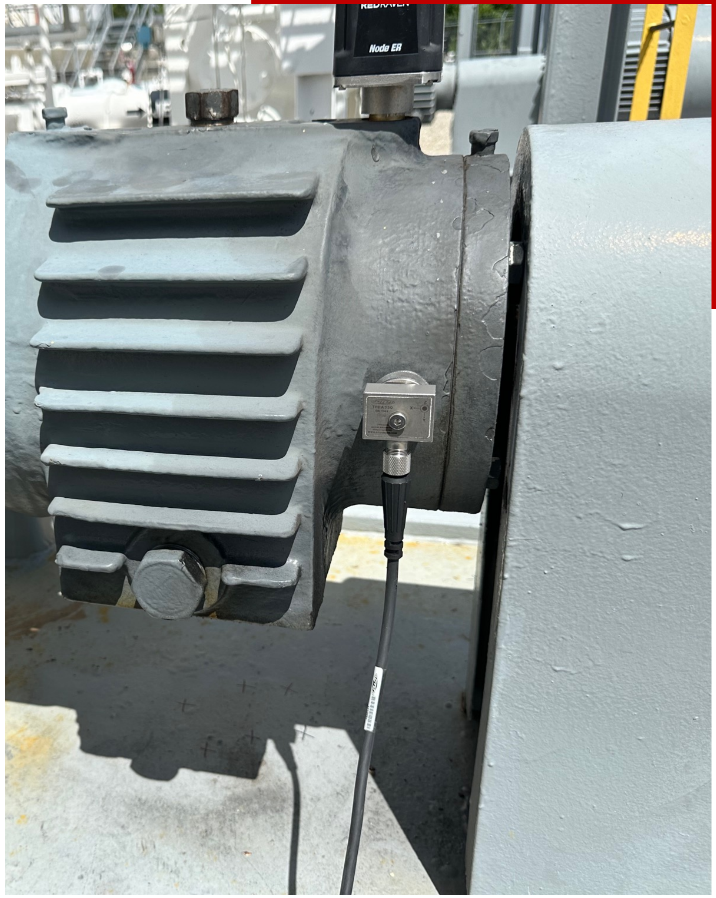
CTC UNIVERSITY

LEVEL 3, LESSON 5

INDUSTRIAL VIBRATION ANALYSIS FOR PREDICTIVE MAINTENANCE AND IMPROVED MACHINE RELIABILITY

Introduction



Welcome to **Level 3, Lesson 5 - Industrial Vibration Analysis For Predictive Maintenance And Improved Reliability**, part of CTC's free online vibration analysis training series.

We hope you enjoyed and benefitted from the previous course and will continue to build your vibration analysis knowledge as you progress through Level 3.

Training Objectives

Upon completion of this lesson, you will understand:

1. How industrial vibration analysis is used to identify, predict, and prevent failures in rotating machinery in a variety of industrial environments.

Background

Industrial vibration analysis is a measurement tool used to identify, predict, and prevent failures in rotating machinery.

Implementing vibration analysis on machines will:

- **Improve the reliability of machines**
- **Lead to better machine efficiency**
- **Reduce downtime by eliminating mechanical or electrical failures**

Background

Vibration analysis programs are used throughout industries world-wide to:

Identify faults in machinery

Plan machinery repairs

Keep machinery functioning for as long as possible without failure

Industrial Vibration Analysis – Typical Machinery

Industrial vibration analysis is often used on:

- Motors
- Pumps
- Gear Boxes
- Compressors
- Turbines
- Conveyors
- Rollers
- Engines
- Machines with Rotating Elements

Industrial Vibration Analysis

The rotating elements of these specific machines generate vibrations at specific frequencies that identify the rotating elements.

The amplitude of the vibration indicates the performance or quality of a machine.

An increase in vibration amplitude is a direct result of failing rotational elements such as bearings or gears.

Based on machine speed, the rotational frequencies can be calculated and compared to the measurements to identify the failure mode.

Industrial Vibration Sensors

Vibration analysis requires measurement and analysis of rotating machines using different vibration sensors, including:

Accelerometers

Velocity Transducers

Displacement Probes

Accelerometers are the most common sensor used in industrial vibration monitoring.

Industrial Vibration Sensors

Accelerometers are case mounted using a permanent bolt or a 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 measured output of velocity (inches/second or mm/second).

Industrial Vibration Sensors

It is very important to choose the correct accelerometer, cable, connector, and mounting method for a specific application.

This will provide quality measurements and accurate vibration data for identifying faults in rotating machinery.

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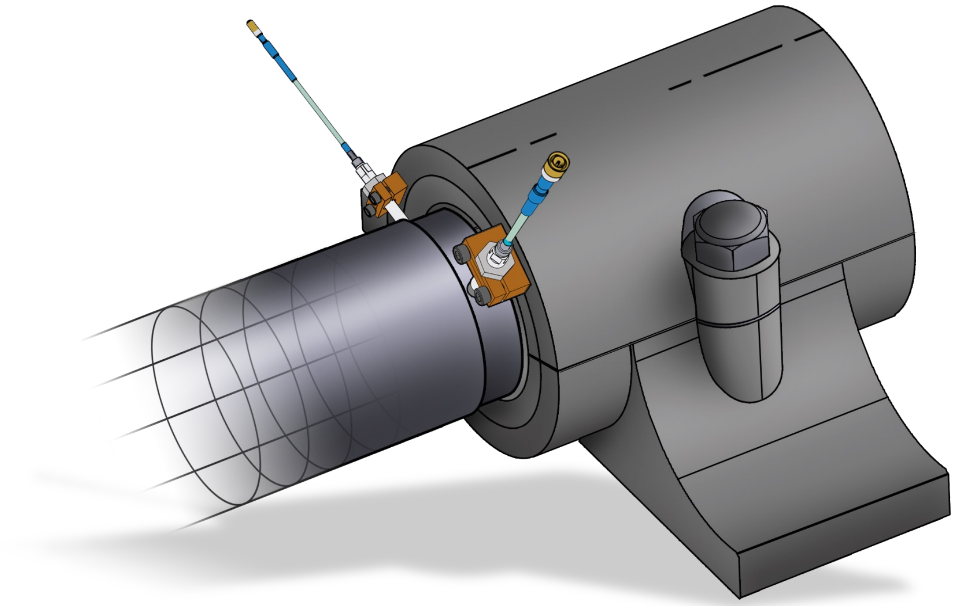
Displacement Probes



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).

Vibration Analysis – What Faults Can Be Identified?

There are several faults in rotating machinery that can be identified by measuring and analyzing the vibrations generated by a machine, including:

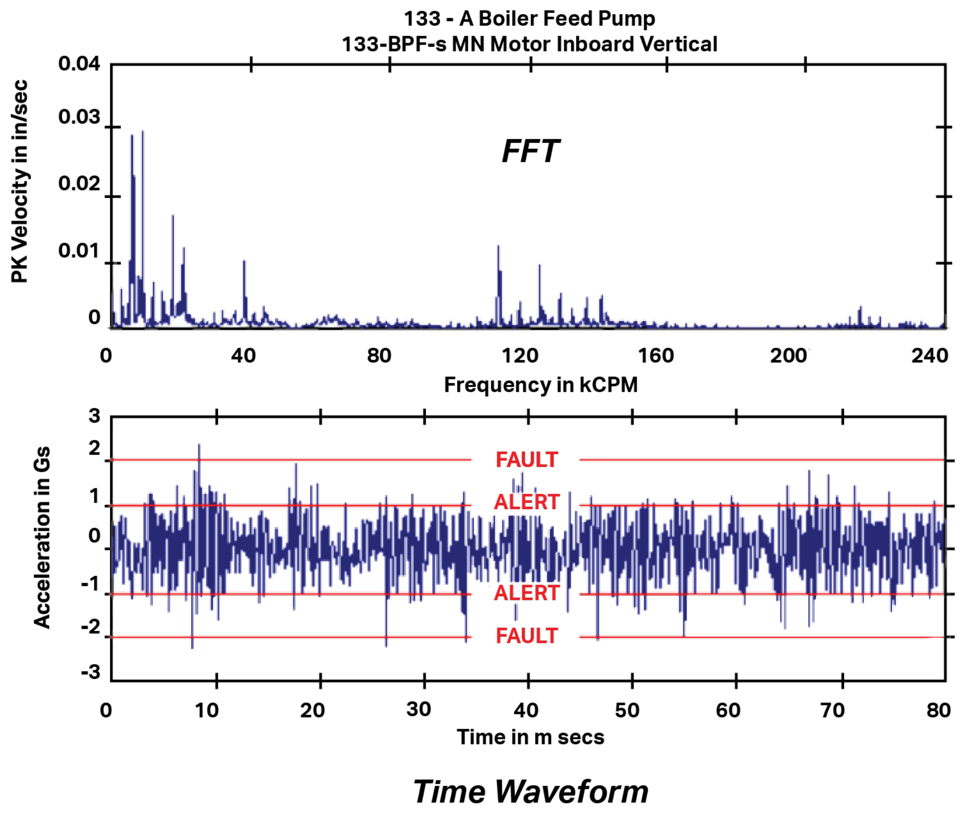
- Machine out of balance
- Machine out of alignment
- Resonance
- Bent shafts
- Gear mesh disturbances
- Blade pass disturbances
- Vane pass disturbances
- Recirculation and cavitation
- Motor faults (motor & stator)
- Bearing failures
- Mechanical looseness
- Critical machine speeds

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.

Dynamic Vibration Analysis



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 Transformer) for frequency identification.

Dynamic Vibration Analysis

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

Dynamic vibration analysis can also 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 requirements

Permanent sensors and permanent data collection that provides machinery protection 24 hours per day, 7 days per week, 52 weeks per 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, and SCADA).

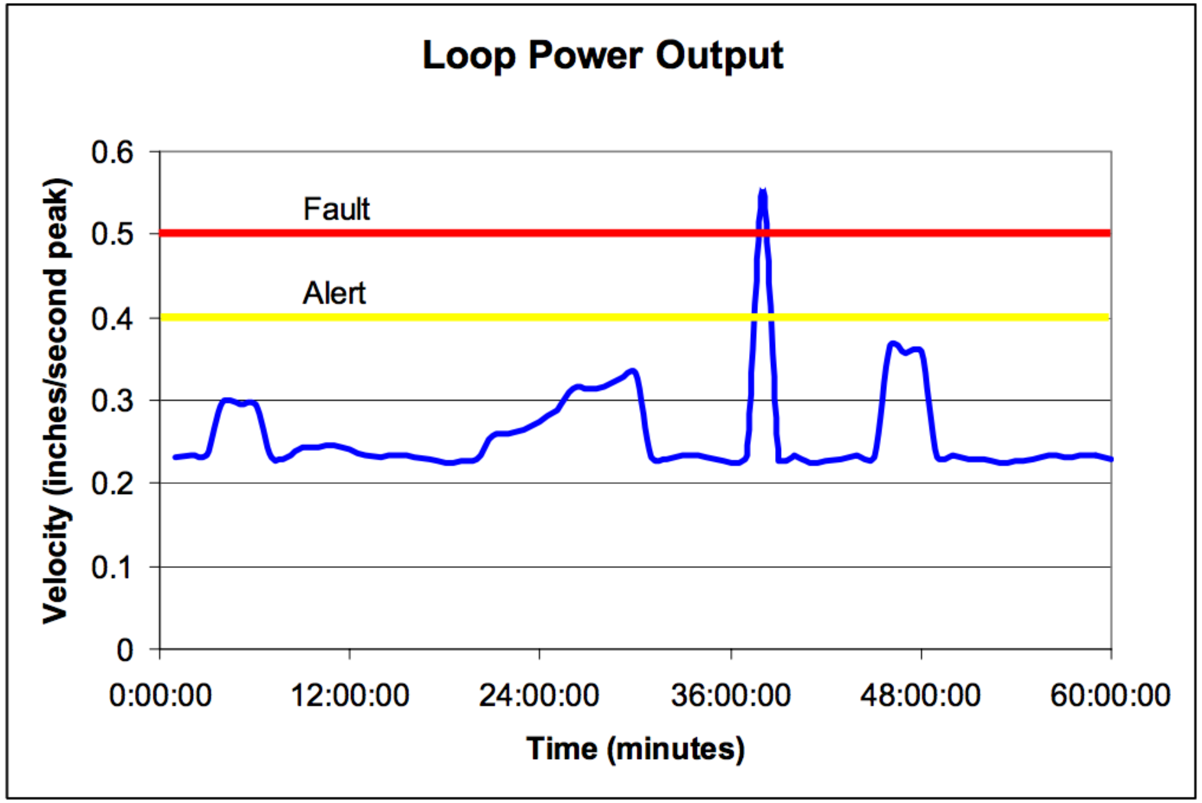
This allows the operations, maintenance, and process control teams to monitor and alarm vibration levels on critical machines.

Using a standard 4-20 mA output, the signal conditioners and sensors provide a current output proportional to the overall value of the machine vibration.

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

Process Vibration Alarms

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



Process Vibration Alarm Plot

Methods For Achieving Loop Power 4-20 mA Outputs

Method 1

- A dynamic accelerometer with an analog output can be connected to a signal conditioner
- The signal conditioner provides signal conditioning and a 4-20 mA current output proportional to the vibration
- It offers several different frequency filters to alarm the region of interest
- The dynamic signal is also available for the trained technician or engineer to analyze

Methods For Achieving Loop Power 4-20 mA Outputs

Method 2

- A loop power sensor with a direct 4-20 mA output can also be used
- This sensor does not require a signal conditioner, but the frequency filters are limited to 10 – 1,000 Hz and 3 – 2,500 Hz

Methods For Achieving Loop Power 4-20 mA Outputs

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!

Conclusion

Vibration analysis is not a new technology – the Piezo effect and charge output of certain materials was discovered in 1880 by the Curies, and 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 and efficient measurements of rotating machinery vibration.

Sensors are designed to withstand harsh industrial environments and provide critical measurements year after year.

Conclusion

Cables and connectors are constructed of the most rugged materials available and provide the critical link from the sensor to the data collector.

Designed for all type of environments, the proper cable and connector combination will eliminate any concerns for data transfer.

Conclusion

- 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 specialty mounts designed for permanent applications.

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