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Fault detection with vibration transducers

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Abstract

Mechanical faults, usages, slackness's, cause different noises and vibrations with different amplitude and frequency against the normal sound and movement of the equipment.
The vibration transducers, accelerometers and microphone are used for noise and/or sound and vibration detection with fault detection purpose. Vibration transducers and accelerometers have three functioning domain, if the input frequency is les then the resonant frequency of the sensor it is working as an accelerometer, if the input frequency is higher then the resonant frequency of the sensor it is working as vibrometer. Detecting and analyzing the signal of the transducer, amplitude and spectral analyzing, we can detect usages, slackness and forces which act and produce the fault. Analyzing the output signal of the sensor and compare with a base signal or with nominal values mechanical faults can be detect in functioning time without stopping and to take to pieces the equipment. It is an undestroyed method to find out the functioning problems.
In this paper are presented simple transfer functions for two cases, if the mechanical system is vibrating and if through the base is transmitted a vibration to the system. The system behavior is analyzed in Matlab surround the natural frequency of the system. The amplitude and phase modification can be used for signal analysis and fault detection.

Keywords: fault detection; vibration transducer; transfer functions; Matlab

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1. Introduction

Vibrations are dynamical phenomenon and are present in our daily lives. Vibrations are mechanical oscillations around of a fixed point and define the movement of a mechanical system. Vibrations can be characterized in many ways, there are vibrations with low or high frequencies, and there are unintended vibrations (perturbations) or generated vibrations with known parameters.

Vibrations are in many cases destructive, they can be also the disturbance side of a useful work, and can be generated on purpose to do something useful.

To analyze the vibrations and the effects produced by these it will be measured the vibration in more points of the system: at the output of the system to compare the measured values with the maximum admissible values, this is the case of noise and perturbation detection. The characteristics of the vibration can be measured at the input of the system to set these at the established values. To test the system how reacts to the different external forces and noises, vibrations must be measured both at the input and the output of the system.

A mechanical system with many components vibrates oscillates during his operating time and this can be in most time unintended and leads to breakdowns. For example vibrating motors or belts caused by inadequate fixing. But not all kinds of vibrations are destructive. For example, vibratory feeders, conveyors, surface finishers, ultrasonic cleaners or compactors are often used in different places. [3,4]

Undesirable vibration monitoring can save money, time; can prevent damages and quality losses.

1.1. Causes of mechanical vibrations

Applying an external sinusoidal force to a mechanical system this will move with the same frequency as the force. A real mechanical system is composed on many pieces which are bound in different ways and react in different manner to the force and this differences cause repeating force apparition. Repeating forces are due to the rotation of imbalanced or misaligned components. Imbalance is caused by corroded, deformed, broken parts, gaps, non-uniform material density, and component sizes variation. Misalignments are caused by inaccurate mounting, distortions, bad assembly. Worn pieces cause also force apparition and undesirable vibrations.

If the frequency of the force is near to the natural oscillation rate of the system this will vibrate more and more strongly and brings the system in resonance. Repeating force would not be a problem until it begins to cause resonance. Resonance should always be avoided because determines in very short time severe damages.

Vibration monitoring helps to find any problems that might be developing helps to detect unwanted vibration and so problems can be prevent in time. In general critical systems or equipments should be monitored in order to avoid unexpected. For example systems that require expensive, lengthy or difficult repairs if broken down, equipments that frequently suffer damages, systems that affect human or environmental safety. [5]

1.2. Vibration analysis

Vibrations are mechanical oscillations and so they can be characterized with amplitude and frequency. Amplitude shows how strongly the vibration is, and frequency shows the oscillation rate of vibration. These two provide information to identify the root of vibration.

The amplitude is related to the speed of the movement and to the force which cause the vibration. The peak of the amplitude shows the highest speed and the *rms* value of the amplitude shows the vibration energy. The frequency is related to the condition of the system.

Vibration analysis consists of a spectral analysis. The spectrum is a very useful analytical tool because shows the frequencies at which vibration occurs. The information from a spectrum depends on the maximum frequency F_{max} and resolution. How high F_{max} needs to be is dependent on the operating speed of the system. The resolution of a spectrum establishes the detail in the spectrum. Depending on the user, the measured signal can be displayed as either a velocity waveform or a velocity spectrum. Generally a velocity spectrum is used to find out the component of the vibration signal. [3,10]