LAYCO ELECTRIC INNOVATIONS

Your Premium Provider for Supply and Service of Electric Motors, Industrial Controls, and Power Distribution Solutions

Information Sheet # 08

Your Reliable Guide for Power Solutions

ELECTRIC MOTOR VIBRATION
Definitions and Sources Within a Motor

1.0 Introduction:

An electric motor is a rotating electro mechanical piece of equipment. As for all moving pieces of equipment the rotating mass is a sum of all its parts, if any of those parts create an out of balance force vibration will occur. While all rotating machinery creates some level of vibration, if vibration exceeds designed limitations it will lead to failure. It is important to understand what is vibration and how it effects an electric motor. Users that understand the significance of vibration on their equipment ensure testing for vibration is part of any planned maintenance program.

This information sheet discusses the vibration within a motor, areas subject to vibration, the limits of vibration and should be read in conjunction with information sheet #09 that discusses measuring and analyzing vibration within a motor.

Figure 1

Sources of Vibration in an Electric Motor

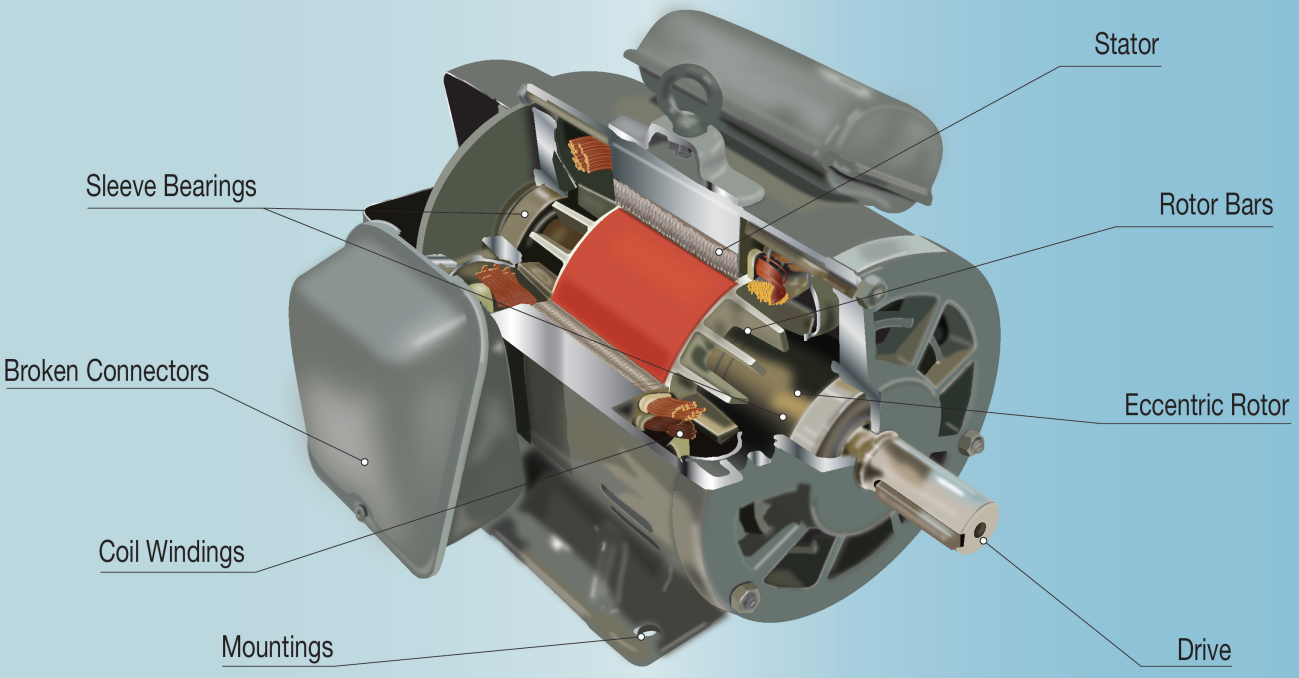
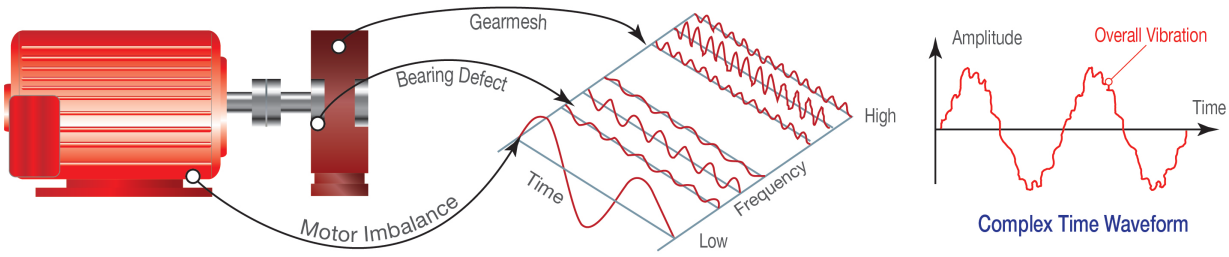


Figure 2

Time Waveform Analysis of Vibration



To fulfill our commitment to be the leading supplier, the Layco Electric Innovations team ensures they are always up-to-date with the current industry standards as well as industry trends. As a service, our **Information Sheets** are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power and motor control industry.

2.0 Definition of Vibration:

Vibration is a mechanical phenomenon whereby oscillations occur about an equilibrium point. The word comes from Latin vibrationem. The oscillations may be periodic, such as the motion of a pendulum, or random, such as the movement of a tire on a gravel road. Vibration in an electric motor is simply a back and forth movement, or oscillation, of the total motor and components incorporated into the motor. Individual vibration signals combine to form a complex time waveform showing overall vibration.

3.0 Determining Unacceptable Vibration:

Amplitude versus frequency is measured when considering the severity of vibration. Vibration amplitude indicates the severity of the problem while vibration frequency indicates the source of the problem.

Vibration sources within a motor are numerous, both electrical and mechanical. A Wave Form Analysis of Vibration, as indicated in *figure 2*, details how the individual vibration sources can result in a complex waveform when measured as overall vibration.
In troubleshooting the following terms are referred to:

- **Frequency** - refers to how many oscillations in a given time, measured in cycles per minute (CPM), or cycles per second Hertz (Hz).
- **Displacement** - the length of distance or movement measured in mils (1/1000th inch). Used for frequencies up to 600 CPM.
- **Velocity** - The speed the component is moving measured in inches/second or mm/second to the peak. Used for components where important frequencies lie in the 600 to 60,000 CPM range.
- **Acceleration** - Refers to the forces that are causing vibration measured in gs (normal gravity "g" is 32ft/sec^2) this is shown as the root mean square (RMS). Acceleration is best used when troublesome vibrations are at frequencies above 60,000 CPM.

4.0 Defects that can Produce Excessive Vibration Within Electric Motors:

Within limits vibrations are nothing to worry about, but beyond the design limits vibrations can also lead to more severe damage and significant downtime. All motors have a small level of vibration. However, it's when the movements cease or become more intense that the motors within a system have to be checked for excessive vibration.

Areas within an electric motor, see *figure 1*, include:

4.1 Stator:

Stator problems can generate high vibration. Stator eccentricity produces an uneven stationary air gap between the rotor and stator. The differential air gap should not exceed 5% for induction motors and 10% for synchronous motors. Shorted stator laminations can cause uneven, localized heating which can distort the stator itself. This produces thermally-induced vibration which can significantly grow with operating time, causing stator distortion and static air gap problems.

4.2 Rotor Vibration Issues:

Electromagnetic force unbalance due to variations in rotor current is commonly caused by broken or cracked rotor bars, broken, cracked or poorly brazed end ring joints, high resistance end ring joints, or shorted or loose rotor laminations. These conditions will most often occur on the spectrum analyzer when the motor is under load.

4.3 Eccentric Rotor:

Rotor eccentricity produces an uneven stationary air gap between the rotor and stator which produces very directional vibration.

4.4 Drive:

Poor drive connections, such as misalignment will result in excessive vibration and finally wear and failure.

4.5 Mounts:

Incorrect foot mountings, sometimes referred to as a soft mount will amplify vibration. Soft foot and warped bases can produce an eccentric stator. Loose iron is due to stator support weakness or looseness.

4.6 Coil Windings:

Loose stator coils in synchronous motors will generate fairly high vibration at a coil pass frequency (CPF) that equals the number of coils x RPM (#coils X poles X # coils/pole). The CPF will be surrounded by 1X RPM sidebands.

4.7 Broken Connections:

As for rotor vibration issues, an electromagnetic force unbalance can result in excessive vibration.

4.8 Sleeve Bearings:

Latter stages of journal bearing wear are normally evidenced by presence of a whole series of running speed harmonics (up to 10 or 20). Journal bearings with excessive clearance may allow a minor unbalance and/or misalignment to cause high vibration which would be much lower if bearing clearances were set to specifications.

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