

A Brief Tutorial on Machine Vibration

by
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The purpose of this tutorial is to provide sufficient knowledge to understand machine vibration diagnosis. You may be asked with solving a vibration problem, or you may be measuring, recording and also need to understand the process. This tutorial discusses the programs, taking measurements, analyzing the data, statistical testing, understanding the physics, and finally, fixing the problem. It provides practical information that has proven useful over several decades in correcting all forms of machine vibration problems, with a few technical exceptions. There are usually several technical solutions to any vibration problem, and this tutorial will guide you through the choices.

The first step is to understand the problem from its outward symptoms. This means observation and measurements to quantify the symptoms, and then analysis to interpret the data. It is usually best to proceed from a position of knowledge while defining symptoms that are not supported by the data. The diagnosis is the shortest part of the journey, taking one person several hours to accomplish, but is the most important part because recommendations here will control many persons and many hours of remedial work. We would like the correction to be successful on the first attempt.

Strategy

All vibration is not bad. Machines produce some oscillatory motion as part of their normal operation and there are nothing to be concerned about. I call these benign vibrations and here are some examples:

- 120-Hz motor hum
- blade passing frequency
- gear train from motors, especially those driven by VFD's
- thousands of vibrations from fluid handling machines, like fans and pumps
- ground frequency

These benign vibrations are characteristic of regular operation of a machine doing what it is supposed to do. The amplitudes will vary from machine to machine and are a measure of the quality of manufacturing and load condition. The presence of these benign vibrations at "normal" levels provides a comfortable feeling that the machine is still alive. A change above normal levels, not explained by a corresponding load change is reason for investigation, but not alarm. Serious vibrations are:

- 1x rpm amplitude above the baseline levels in Table 1.
- shock pulses
- large shaking motion
- abnormal noise

These serious vibrations will cause accelerated wear and premature failure. They should be substantiated as troubling and addressed with some corrective action.

The first task in the vibration analysis is to obtain frequency selective amplitude data to identify the source of vibration. The frequency is the key parameter that establishes the possible causes and also the amplitude is used to judge the severity. This means having a vibration analyzer at one's disposal. More on this in the section "Instruments and Methods." This takes us to the first job in the analysis checklist, Figure 2. The

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