

A Brief Tutorial on Machine Vibration

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The purpose of this tutorial is to provide sufficient knowledge to understand machine vibration diagnosis. You may be asked with nothing a vibration problem, or you may be overseeing someone else and you need to understand the process. This tutorial discusses the programs, taking measurements, analyzing the data, additional testing, understanding the physics, and finally, fixing the problem. It provides practical information that has proven useful over several decades in solving all forms of machine vibration problems, with a few notable 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 observed 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 shorter part of the journey, taking you perhaps several hours to accomplish, but is the most important part because recommendations here will correct many problems 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:

- 100-600 rpm rotor runs
- blade passing frequency
- gear mesh from rotors, especially those driven by VIBTs
- structural resonance 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 conditions. The presence of these benign vibrations at "normal" levels provides a comfortable feeling that the machine is well done. A change above normal levels, not explained by a corresponding load change is reason for investigation, but not alarm. Serious vibrations are:

- 10-100 amplitudes above the baseline levels in Table 1.
- shock pulses
- large shelling events
- abnormal noise

These serious vibrations will cause accelerated wear and premature failure. They should be acknowledged as alarming 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 characteristic that identifies the possible causes and data the amplitude is used to judge the severity. This means having a vibration analysis on one's disposal. More on this in the section "Instruments and Methods." This takes us to the first task in the analysis checklist, Figure 2. The

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