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ROTARY EQUIPMENT PREDICTIVE MAINTENANCE PRACTICES

(PROJECT STANDARDS AND SPECIFICATIONS)

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SCOPE

This Project Standards and Specification covers the recommended practices and procedures for carrying out predictive maintenance of rotating machinery. Predictive maintenance covers monitoring of vibration and shock pulse measurement levels, comparing them with standard values and analyzing the readings taken to find out the real cause of machinery problem.

INTRODUCTION

The Rotary equipment plays a vital role in hydrocarbon processing industry. Timely inspection and maintenance of Rotary equipment will go a long way in ensuring safer operations of the installations in Oil Industry.

VIBRATION

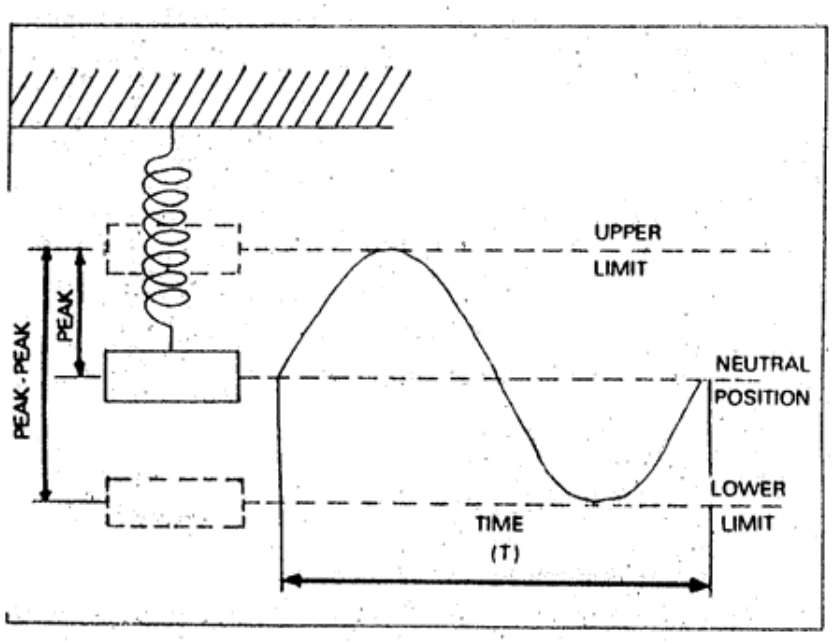
Vibration is the motion of a machine or machine part back and forth, from the position of rest. The cause of vibration must be a force which is changing in either its direction or amount. It is the force which causes vibration and the resulting characteristics will be determined by the manner in which the forces are generated. Hence each vibration has its own typical characteristics.

1. VIBRATION PARAMETERS

Referring to figure 1 where the movement of weight is plotted against time, various parameters can be defined as:

a) CYCLE: The motion of the weight from its neutral position to the top limit of travel back through the neutral position to the bottom limit of travel and its return represents one cycle of motion.

   Hertz (Hz) is a unit of measurement for vibration frequency. One Hz is equal to one full vibration cycle of oscillation per second.



DISPLACEMENT VS TIME

Figure 1

b) PERIOD: The time required for completing one cycle of vibration is called the period of vibration.

c) CPM (CYCLES PER MINUTE): The number of cycles repeated in a given interval of time normally minute (because the rotating speed is expressed in RPM), is the frequency of vibration, which is expressed in the abbreviated form as CPM.

d) VIBRATION DISPLACEMENT: Displacement at any instant of the cycle is the distance traveled by the vibrating part from one extreme limit of travel to the other extreme limit of travel and is selected for measurement which is referred to as the 'peak to peak' value of displacement. It is expressed in microns in metric units and in mils. in British Units.

e) VELOCITY: The velocity of the vibrating part is constantly changing as displacement changes. The peak value, which represents the most severe condition during a cycle, is selected for vibration measurement. It is expressed in mm/sec. and inch./sec. in Metric units and British units respectively.

f) ACCELERATION: Acceleration is another important characteristic of vibration and peak value is measured which is normally expressed in 'g's.

g) PHASE: Phase is another important characteristic of vibration which is defined as the position of vibrating part at a given instant with reference to a fixed point or another vibrating part.

2. CRITERIA FOR MEASUREMENT

The displacement, velocity and acceleration of vibration are referred to as the Amplitude of vibration. Displacement, velocity and acceleration of vibration are directly related. Vibration velocity is directly proportional to the displacement and the frequency as shown in Equation 1 and Vibration acceleration is directly proportional to the displacement and frequency squared as shown in Equation 2.

V Peak =52.30D (F/1000) x 10 -3 (equation 1)
g peak =5.6 D (F/1000) 2 x 10 - 4 (equation 2)

V peak = Vibration velocity in mm/s peak
g peak = Vibration analysis peak
D = "Peak to peak" displacement in microns
F = Frequency in CPM

The forces, which cause vibration, are generated through the rotating motion of the machine parts and these forces change in amount and direction and the rotating part changes its position with respect to rest of the machine. Hence the frequency of the vibration produced would be related to the rotating speed of the part which has the trouble. Because of this, it is essential to know the vibration frequency for analysis.

Vibration severity is a function of both the distance the vibrating part moves from its position of rest (peak displacement) and the number of times the vibrating part moves about its position of rest in unit time (frequency). Since vibration velocity is a function of the displacement and frequency, unfiltered vibration velocity should be recognized as a direct measure of vibration severity.

Vibration acceleration is directly related to the force causing vibration in the machine. Since vibration acceleration is a function of the displacement and frequency squared, a very small displacement at very high frequency may be due to a large vibrating force

present in the machine. Hence, vibration acceleration measurements are recommended for vibration frequencies above 60,000 CPM.

3. FILTER OUT AND FILTER IN

The vibration of a machine may not always generate harmonic motion as the weight suspended from the spring does. The machinery vibration is mostly complex, consisting of components at many frequencies, i.e. the machinery does not vibrate at a single frequency but vibrate at many frequencies. (The frequency is decided by the troubles causing vibration).

The total amplitude of vibration measured is the vector sum of vibrations at different frequencies. This is termed as the 'Filter out' amplitude. When the vibration is complex, we will have to analyze the vibration to know the amplitude at different frequencies of interest.

For this purpose, vibration analyzers are made use of. With this, by tuning the filter, vibration amplitude at different frequencies can be measured. This is termed as 'Filter in' amplitude.

VIBRATION MEASUREMENT AND SEVERITY STANDARDS

1. VIBRATION MEASUREMENT

Electronic instruments for measuring machinery vibration are generally classified as meters, monitors and analyzers.

a) A vibration meter is a portable device and used for periodic vibration checks on machinery to determine the overall machine vibration level.

b) A vibration monitor is similar in function to a vibration meter, but is permanently installed to provide continuous monitoring of equipment vibrations.

c) A vibration analyzer includes a tunable filter for separating the individual frequencies of complex vibration. This can measure and record all vibration amplitudes at different frequencies.