MECHANICAL VIBRATION INSULATION

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Contents

Summary

The different types of vibrations created by machines are examined and described. The amplitudes of the vibrations due to a rotating machine (harmonic motion) are calculated and the conditions to obtain resonance are established.

Subsequently, the criteria to design machine foundations and some technical solutions to reduce the amplitudes of vibrations are given.

1. Introduction

Moving parts of machines such as turbines, pumps, diesel engines, fans, mills, or crushers generate vibrations. These vibrations, if not correctly damped or attenuated, can be the origin of a bad functioning of the machine or, even worse, can cause the destruction of their supports if not of the machines themselves (Timoshenko et al. 1974). Moreover, those vibrations can alter the functionality of other equipment in the vicinity.

In some circumstances, shocks and vibrations created by machines can disturb sensitive equipment or simply human life.

One way to improve those effects and to reduce the cost of maintenance of the machines is to make a good and well dynamically designed foundation (BSPC 1974, DIN 1988a, b).

2. Origin and Type of Vibrations

2.1. Periodic Vibrations

These vibrations are the most frequently encountered in desalination and associated power plants (Major 1962, Rausch 1959). The trace of the amplitude of the vibration versus time reproduces itself after a certain duration called period (see Figure 1). The inverse of the period is the frequency (also named round s^{-1} or round min^{-1} for rotating machines). There are two type of periodic vibrations according to the machines.

2.1.1. Harmonic Vibrations

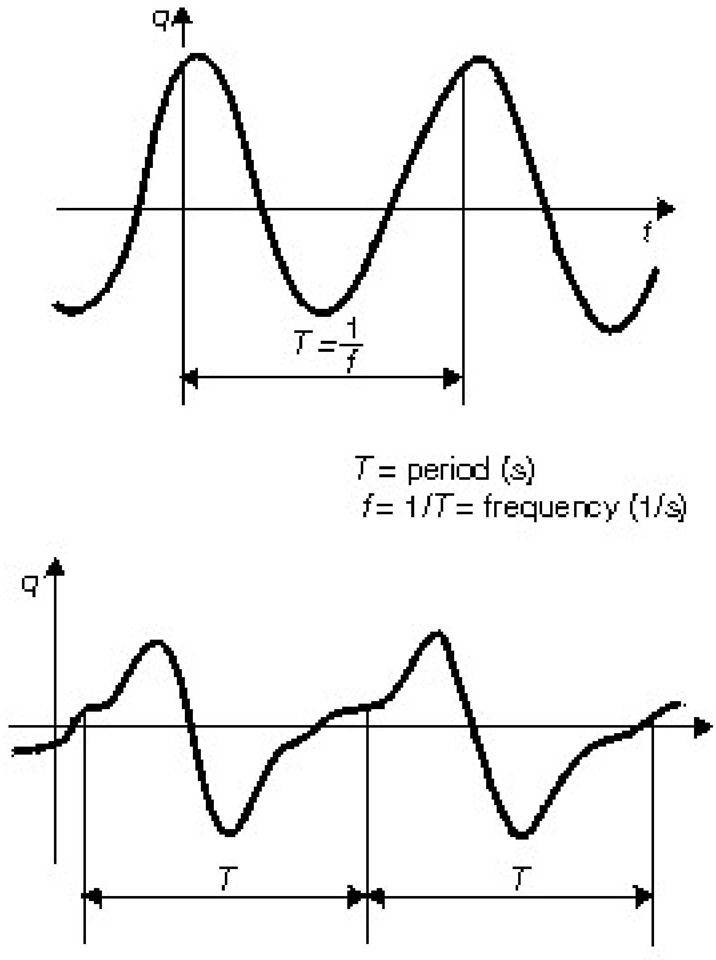

Figure 1. (a) Periodic vibration: harmonic motion. (b) Periodic vibration: alternate motion.

In general, harmonic vibrations are generated by rotating machines: the smallest eccentricity of mass in the rotor of a generator creates a centrifugal force perpendicular to the axis of rotation. The components of that force transmitted to the bearing vary like an harmonic (a sine or a cosine) function, whose frequency is proportional to the rotational speed of the machine. A missing blade or the rupture of one blade produces such forces at the bearings of a turbine.

2.1.2. Alternate Vibrations

This vibration is generated by the unbalanced inertial forces of a mass in alternate translation, such as a piston or the head of a filing machine where the masses of the pistons are not well balanced with auxiliary masses fixed to the crank arm. A diesel motor is also the source of alternate vibrations.

Another example is the alternate torque generated by a default of synchronism or a short-circuit in a generator.

2.2. Nonperiodic Vibrations

When the vibration is caused by a sudden mechanical change or by forces not regularly spaced, the motion does not repeat itself after a certain duration.

These vibrations can last a certain time, such as the motion generated by a passing train, a passing truck, an elevator or an earthquake. They can be pseudo periodic, if the origin of the disturbance is regularly repeated. A vibration generated by a unique pulse, with a short duration, is called a shock.

In desalination plants, most of these vibrations occur in pumps and pipes and are caused by hydraulic or steam flow problems. An example is the water hammer generated by a rapid discontinuity in the flow of a liquid, such as the rapid closure of a valve or the starting of a pump.

3. Vibration Analysis

Because the periodic excitation and in particular the harmonic force is the most frequently encountered in desalination and associated power plants, the dynamic amplification due to a harmonic excitation will be examined in more detail (Den Hartog 1956).

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