

Sinusoidal vs. Impact Vibration

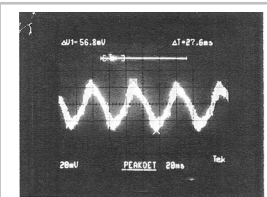
There are two basic types of vibration applied as flow aids: Sinusoidal and Short Timed Duration Impulse.

Sinusoidal: One vibration type is approximately sinusoidal. Sinusoidal vibration is commonly delivered by rotary, or “silent” piston vibrators. Rotary vibrators are characterized as high frequency/low amplitude. Common types of rotary vibrators are Ball, Turbine and Electromechanical vibrators. With rotary vibrators, bin displacement response is proportional to the frequency and amplitude of the forcing function of the vibrator. This means the bin wall deflects according to the forcing function of the vibrator in order to transmit the vibrating energy into the bulk material. With this method, much of the vibration energy is spent on creating the wall deflection and is lost to the purpose of facilitating material flow.

Rotary vibration develops force vectors tangential to the rotation; these shear vectors must be accounted for in the mounting. To do so, long channels with intermittent welds are normally used for mounting. This type of mounting also stiffens the bin wall, raising the natural frequency of the bin in that area. Caution must be taken not to operate the vibrators at the resonance frequencies of the bin wall. If operated at resonance, mounting failure can occur— regardless of vibrator size.



A pneumatic ball vibrator



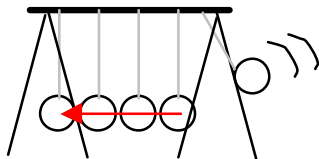
Sinusoidal vibration measured

Pneumatic piston vibrators that are silent or air cushioned can also create sinusoidal output. In this case there are no shearing forces because force vectors are normal to the bin wall. Generally, these vibrators are characterized as low frequency/high amplitude, so resonance is not often a problem. However, the bin response is still proportional to the forcing function $f(x)$, with much of the vibrating energy used as it passes through the bin wall.

Short Time Duration Impulse: The second type of vibration is short time duration impulse or ‘impacting’. This type of vibration is commonly delivered by pneumatic piston vibrators. The impulse is a form of elastic collision between the piston and the base of the bore. The ideal result is conservation of energy and momentum, with the energy being efficiently transferred through the hopper wall. The bin responds with its own natural frequencies (like ringing a bell) and the energy is transmitted efficiently into the material in order to facilitate flow.

Pneumatic piston vibrators generally operate with a forcing frequency well below the bin wall natural frequencies, so resonance is not a concern.

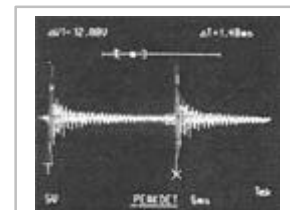
Analogy: The desk toy that has five metal balls in a line, suspended by thin strings. When you drop one end ball, the energy is transmitted to the opposite end ball, through the three middle balls, with no loss of energy.



Energy will transfer to opposite ball



Pneumatic Piston
Vibrator



Impulse vibration
measured

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