



H Hansford Sensors

Excellence in Vibration Monitoring

White Paper
Frame Vibrations



Addressing Frame Vibrations: Causes, Measurement, and Solutions

Introduction

Machine vibrations are often inevitable due to rotating components, operational loads, and dynamic forces. However, excessive or abnormal vibrations caused by improper mounting can lead to structural damage, reduced lifespan, and operational inefficiency. The frame of a machine is particularly vulnerable because it serves as the structural support and is directly influenced by how the machine is mounted.

This white paper delves into the phenomenon of frame vibrations, focusing on:

1. The root causes associated with mounting issues.
2. The use of accelerometers for precise vibration measurements.
3. Strategies for diagnosing and addressing frame vibration problems.

Causes of Frame Vibrations

Frame vibrations due to mounting problems typically arise from:

- **Resonance** - When the natural frequency of the machine's frame coincides with the operational frequency, resonance occurs, amplifying vibrations. Poorly designed or installed mounts can exacerbate this problem.
- **Improper Mounting Surfaces** - Uneven or non-rigid mounting surfaces lead to uneven force distribution, which can cause structural deformation and increased vibration.
- **Insufficient Damping** - Inadequate damping materials or mechanisms fail to absorb vibrational energy, resulting in excessive transmission of vibrations to the frame.
- **Misalignment** - Misalignment between the machine and its mounts creates unbalanced forces that induce frame vibrations. This issue often arises from improper installation or wear over time.
- **Dynamic Imbalance** - Imbalance in rotating components generates forces that are transferred to the frame, magnified by poor mounting stability.
- **Loose or Worn Fasteners** - Loose or degraded mounting hardware can reduce the rigidity of the system, making the frame more susceptible to vibrational excitation.

Measurement Techniques Using Accelerometers

Why Accelerometers?

Accelerometers are highly effective tools for vibration measurement due to their precision, wide frequency range, and adaptability. They measure acceleration, velocity, or displacement, providing insights into the vibration characteristics of the machine's frame.

Placement of Accelerometers

1. **Frame Mounting Points:** To measure vibrations directly transmitted from the machine.
2. **Critical Structural Locations:** To detect deformation or resonance points.
3. **In line to Force Transmission Paths:** To capture vibrations traveling through mounts or fasteners.

Measurement Parameters

1. **Frequency Spectrum:** Identifying resonance frequencies. The easiest way is to perform a measurement during machine run up or make a bump test.
2. **Amplitude:** Quantifying the severity of vibrations. Higher levels are the reason to look for source and cause.
3. **Phase Relationships.**



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Methodology

1. Baseline Measurements: Record vibrations under ideal conditions.
2. Operational Testing: Measure during typical machine operation to identify deviations.
3. Mounting Analysis: Test different mounting configurations to isolate the problem.
4. Comparative Analysis: Use data to compare with industry standards or manufacturer specifications.
5. The easiest way is to perform a measurement during machine run up or make a bump test.
6. Comparing vibration of the frame to machine case enables to understand if they move together or connection is loose and then vibration signals are out of phase between them.

Diagnosing the Problem

1. Visual Inspection: Look for obvious signs of improper mounting, such as uneven surfaces or loose hardware.
2. Data Analysis: Use accelerometer data to pinpoint high vibration zones and frequencies.
3. Finite Element Modeling (FEM): Simulate frame dynamics to predict vibration behavior.

Mitigation Strategies

1. Improving Mount Design: Use vibration-isolating materials or structures.
2. Optimizing Installation: Ensure even and rigid mounting surfaces with proper alignment.
3. Adding Damping: Introduce damping pads, rubber mounts, or tuned mass dampers.
4. Resonance Avoidance: Adjust operational speeds or modify frame stiffness to shift natural frequencies.
5. Maintenance: Regularly inspect and replace worn or damaged mounting hardware.

Case Study

A manufacturing facility experienced abnormal vibrations in a Pump frame. Measurements with piezoelectric accelerometers revealed a peak vibration amplitude at 20 Hz, corresponding to the frame's natural frequency. Analysis showed uneven mounting surfaces and insufficient damping. After installing vibration-isolating pads and realigning the mounts, vibrations were reduced by 75%, improving operational stability and extending machine life.

Conclusion

Frame vibrations due to mounting problems can significantly impact machine performance and durability. Understanding the causes and using accelerometers for precise measurement enables effective diagnosis and mitigation. By addressing mounting issues proactively, industries can ensure smoother operation, longer equipment life, and safer working environments.

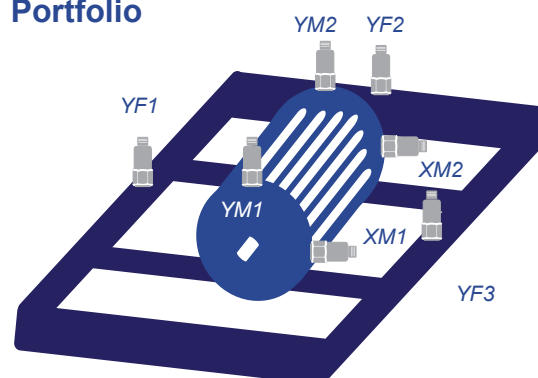
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