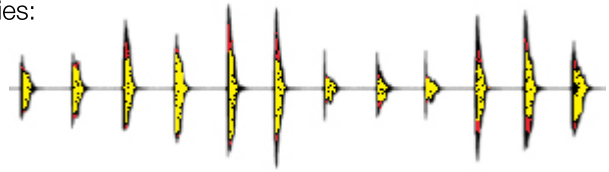
Piping Vibration Services

Evaluating Steady-State and Transient Piping Vibration

Process piping is typically designed to withstand pressure, temperature, gravity, and wind loads that are applied slowly and evaluated statically. When the load history is applied slowly, the piping system is able to respond and thus remain in equilibrium. For a small subset of piping systems, loading due to flow, process conditions, or other dynamic effects is applied over shorter durations and can cause piping vibration. While low levels of piping vibration are often harmless, moderate to high vibration levels can create a serious threat to piping component integrity. Excessive vibration may cause fatigue failure at pipe weld connections, equipment nozzle and pipe interfaces, pipe supports, or appurtenances such as vents, drain gage lines, or instrumentation.

Dynamic loading encountered in process piping typically falls into two categories:

1) Steady-state piping vibration
2) Transient (non-steady state) piping vibration

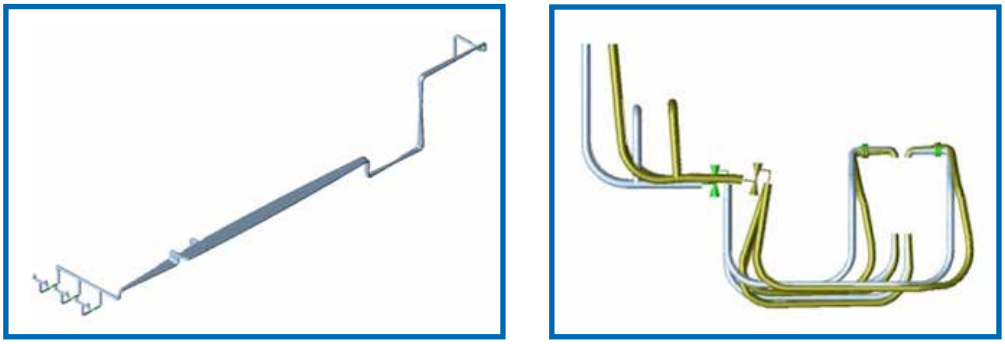


STEADY-STATE PIPING VIBRATION

Steady-state piping vibration can be repetitive or random in nature. Piping vibration related to machinery sources such as compressor pulsation is nearly always repetitive (periodic), and is assessed as a constant-amplitude problem. Vibration related to process flow and turbulence, including two-phase flow, is usually random (steady but not repetitive), and is assessed as a variable-amplitude problem.

Pulsation flow occurs most often with reciprocating compressors or reciprocating pumps. A pressure wave is created by the volumetric change of flow, along with the acoustic effect of piping in response to this volumetric change. Based on the length of the piping and the dominant frequencies of the pressure excitation, an acoustic resonance may be formed and accompanied by high-pressure pulsation and significant displacements.

Random vibration occurs due to the combined effects of turbulent flow and flexible piping arrangements. Piping systems designed for thermal expansion require flexible supports, and these designs are particularly vulnerable to flow-induced vibration (FIV). This type of vibration is seldom considered in piping design, making it one of the most common issues encountered in the field.



Engineering modeling combined with field measurements ensure that reality matches predictions and increase confidence in the fitness-for-service (FFS) of the pipeline.

TRANSIENT PIPING VIBRATION

Transient-state vibration occurs when the piping system experiences significant loading over a very short duration. Common sources include the following:

- Fluid Hammers occur when the flow of the fluid through a piping system is suddenly stopped at one end (e.g., due to closing a valve), causing fluid compression at the stoppage location and low pressure at the other end.
- Steam Hammers are caused when a pocket of steam condenses rapidly in sub-cooled condensate. The collapsing steam pocket accelerates the surrounding condensate and can create a substantial impact to the piping and supports.
- Slug Flow occurs in condensate, flare, and two-phase lines where vapor flow picks up a layer of liquid flowing in the bottom of the line. The resulting slug of liquid travels at the vapor transport velocity of the line.
- Relief Valves are set to open to vent fluid and reduce the internal pressure. This process induces a sudden force on the piping system over a short duration, sometimes causing system vibration and fatigue.

ABOUT STRESS ENGINEERING SERVICES, INC.

Stress Engineering Services offers unique expertise in the assessment of piping vibration problems and fatigue damage. We combine hands-on field measurements with state-of-the-art analytical tools to ensure that our results and recommendations will effectively reduce vibration and increase system reliability and safety. With decades of experience on hundreds of piping vibration problems of all types, our vibration experts have a well-earned reputation for solving any vibration problem – from the routine to the most challenging.

- Unique for consulting services groups, our team specializes in fixed equipment vibration.
- Our vibration engineers hold ISO/ANSI Category 4 Vibration Certification, the highest recognized industry standard for industrial vibration.
- Our engineers serve on code and standards committees responsible for developing industry guidelines for piping vibration, such as API 579-1 “Fitness-for-Service” and the Vibration Institute.
- Our team is unmatched in data processing and signal analysis.
- We are fully capable with advanced modeling techniques such as modal, harmonic, time history, random response, response spectrum, pulsation and acoustics, finite element modeling, and computational fluid dynamics.

Our work in piping vibration combines synergistically with our other related areas of expertise: FFS evaluation, fatigue and life prediction, signal processing and data analysis, structural evaluation, acoustic emission (AE) measurement, process flow engineering, metallurgical evaluation, fracture mechanics, and failure assessment.

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