

Vibration Studies for Compressors, Pumps, and Piping

Machine and piping vibration remains a key issue for owners. Excessive piping vibration results in fatigue failure and integrity risks. It also causes reliability problems for rotating and reciprocating machines.

A vibration analysis is required for most projects involving new or modified compressor and pump systems. Each class of machine has its own unique vibration characteristics including excitation forces, frequencies, and design guidelines. The following table outlines standard design studies for the “machine package”, off-skid piping system, and foundation.

Site inspections are required to assess the integrity of Small Bore Piping (SBP) and baseline vibration levels.

Application	Vibration Study	Comments	When Required
Reciprocating Compressor or Reciprocating Pump ‘Packages’	Pulsation and Vibration Analysis	Acoustic (pulsation) simulation of piping system and detailed mechanical analysis to reduce vibration. See below for torsional, skid, foundation, and off-skid piping analysis.	Compressors: Remote or critical locations or > 500 HP (375 KW) Pumps: Critical machinery or > 70 HP (50 KW).
	Small Bore Piping	Evaluate and recommend design for Small Bore Piping (also called Small Bore Connections).	All medium to high risk applications
	Skid Dynamic Analysis; Skid Lifting, Loading	Evaluate skid design to avoid vibration and resonance problems. Evaluate stresses due to lifting, environmental loading, transportation, etc.	To optimize the skid design and avoid resonance Lifting analysis for new designs
	Design Optimization	Design service to improve capacity, efficiency, and reliability across the entire operating map.	Where efficiency and reliability are important
Centrifugal Compressors	Surge Control Analysis, Flow Induced Vibration (FIV), Acoustic Induced Vibration (AIV)	Dynamic simulation of surge control for compressor system to prevent surge during ESD. Evaluate flow across dead legs (FIV). Identify AIV risks through valves and restrictions. Assess small bore design and piping vibration (including shell modes).	Recommended for new or modified compressor projects
Screw Compressors	Pulsation Analysis	Acoustic analysis to reduce high frequency pulsations or shell mode vibration.	Design or when vibration problems occur in the field
Centrifugal Pumps	Pump Vibration Analysis, Water Hammer Analysis	Assess excitation on pumping system to avoid resonance. Evaluate small bore design and supports. Transient water hammer analysis recommended.	Medium to large pumping stations
Torsional System	Torsional or Lateral Vibration Analysis	Assess torsional or lateral system to avoid vibration and failures (crankshaft, couplings, etc.).	New configurations or operating conditions
Piping (Liquid or Gas)	Piping Flexibility (Thermal) Analysis	Predict piping stresses (and nozzle loads) from thermal cycles, static pressures, and weights.	If coolers / vessels are located away from main equipment
	Water Hammer & Transient Piping Analysis	Assess piping design to address vibration due to water hammer, blow down, emergency shutdown (ESD), start-up and other transient events.	Large piping systems; critical and complicated piping applications
Foundation (Land, Piles, FPSO, Platform)	Foundation Analysis, Pile Design, or Dynamic Structural Analysis.	Modal analysis and forced response study to avoid resonance and vibration problems in the foundation and support structure. Requires unique understanding of excitation loads, dynamics and proven analysis techniques.	Offshore production facilities (FPSO, platform), pile installations, foundation design for large compressor applications.
Facility Assessment	Energy Institute Evaluation	Facility-wide assessment of piping and machinery systems to avoid vibration induced failure.	Offshore, refineries, large production or pipeline facilities
Site Inspection	Small Bore Piping (SBP) Integrity Program	Identify high risk locations; assess vibration and stress, remedial actions, integrity program.	Plant piping and facilities involving pumps/compressors
	Vibration Audit	Baseline vibration check includes frame, driver, piping, skid, and foundation.	Recommended practice

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