Brüel & Kjær Vibro

Application Note

Monitoring strategy – Condition monitoring of centrifugal and axial compressors

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Scope

This machine monitoring strategy is applicable to all types of large centrifugal and axial compressors. It is a generic solution, so it can be used for machines in a wide range of industrial processes for all types of gas applications.

Machine operation and maintenance requirements

Compressors are used in many applications, including the petrochemical and power industry. The amount and type of maintenance required for pumps is highly dependent on the type of process they are used in and their operation duty. There is consequently a wide range of different failure modes that can occur. Typical faults include unbalance, misalignment, liquid ingestion, leaking seals, erosion/corrosion, deposits and damaged bearings. The wet portion of the compressor can also be affected by flow disturbances and surge. If unchecked, these potential failure modes can consequently result in in excessive loading, high axial thrust, premature bearing failure, seal leaks, component damage or even a catastrophic failure.

Monitoring strategy

A condition monitoring strategy is intended to detect most developing faults at an early enough stage such that maintenance can be cost-effectively planned ahead of time without stopping the machine. The sensors used for protective monitoring are also used for condition monitoring, but some process signals, either imported or directly measured, are used in addition. Protective monitoring is vital for many large compressors for monitoring failure modes of critical components which have little or no advance warning, such as liquid ingestion, rubbing, thrust bearing contact or loss of lubrication. The condition monitoring strategy can be extended with Performance monitoring techniques for detecting a greater number of potential failure modes and for optimising the overall performance of the compressor.

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Monitoring configuration and techniques

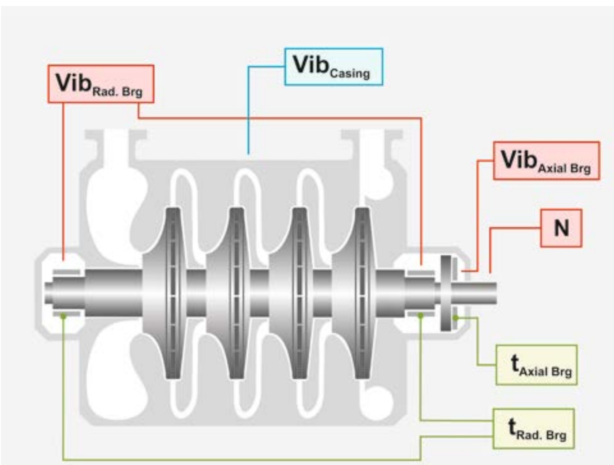

Figure 1. Monitoring inputs (centrifugal compressor shown).

Symbol	Signal
Absolute Vibration Monitoring Sensors	
Vib_{Casing}	Casing radial vibration (accelerometer)
Relative Vibration Monitoring Sensors	
$Vib_{Rad.\ Brg}$	X-Y Bearing radial vibration (displacement sensor)
$Vib_{Axial\ Brg}$	Axial displacement (displacement sensor)
N	Shaft speed, phase reference
Process Values (Imported or Sensors)	
$T_{Rad.\ Brg}$ $T_{Axial\ Brg}$	Axial and radial bearing temperature
Other process	Bearing lube temp., pressure, differential pressure across filter, level, flow

Table 1. Input signal symbols.

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Monitoring configuration and techniques (cont.)

Sensor Location (type)	**Measurements**	**Plots**	**Faults that can be detected and diagnosed**
Shaft (Relative radial vibr.)	• **Overall** (ISO:1Hz/10Hz - 1kHz) • $\mathbf{S}_{max}$ • **DC** (shaft position) • **Autospectrum** (FFT) • **DC vs. RPM** • **1x, 2x, 3x**	• Trend vs. time/speed • Spectrum • Waterfall • Orbit • Shaft position polar • Transient (Bodé)	Bearing damage, lack of lubrication, overload, wear, misalignment, unbalance
Shaft (Tacho)	• **Speed, phase**	• Trend vs. time	Phase and triggering used in other measurements
Thrust bearing (Relative axial displ.)	• **DC** (displ.)	• Scalar vs. time/speed	Bearing damage, lack of lubrication, overload, wear
Casing (Absolute radial vibr.)	• **Overall** (ISO:1Hz/10Hz - 1kHz) • **CPB6%** • **Autospectrum** (FFT)	• Trend vs. time/speed • Spectrum • Waterfall	General faults, flow problems, cavitation, blade clearance, rubbing
Bearing (Process)	• **DC** (bearing temp. oil level, oil pressure, power)	• Trend vs. time/speed	Bearing damage, lack of lubrication, overload, wear.

Table 2. Monitoring techniques.

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