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VIBRATION SEVERITY GUIDELINES for FRICK SCREW COMPRESSORS

Vibration Severity Guidelines for Frick Screw Compressors

The International Standards Organization publishes several standards which provide guidelines for the measurement and evaluation of vibration severity on rotating machinery. In particular, ISO 2372, 2954, & 3945 discuss vibration measurements taken on the machine bearings in the range of 10-1000 Hz, for machinery operating at 600-12,000 rpm.

The guidelines given in these standards are sensitive to the size of the machinery, type of foundation, and specific characteristics of the machine design. Based on these three criteria, a particular machine is categorized into one of four classes, allowing a simple comparison of measured vibration to the suggested limits. This document interprets the ISO guidelines in terms of Frick screw compressors.

I. Machine Classification

SIZE: Frick compressors can be classified as medium size (RXB,RXF), large (RDB, RWF, and RWB), and very large (RDB 546, RWB 496,676 and larger).

FOUNDATION: Frick manufactures compressor packages in two arrangements. In the majority of cases, the compressor and motor are mounted on top of a horizontal oil separator vessel. The inherent flexibility of the vessel relative to the compressor casing implies a flexible foundation. All RDB, RWF, and RWB models with horizontal oil separators fall into this category. The separator vessel of the RXB,RXF models is somewhat stiffer, and its foundation may be considered semirigid/semiflexible.

For the larger machine sizes, the drive train is usually mounted on a structural steel frame, and discharge from the compressor is piped to a separate, vertical oil separator. This gives the RWB 496 and 676 a rigid foundation.

For package mounting guidelines, refer to publication S70-210 IB.

TYPE: Although the mechanical motion in a screw compressor is pure rotation, the positive displacement compression results in a gas pulsation, similar to that experienced in a reciprocating machine. Thus, a screw compressor can be treated as a purely rotating machine, except at frequencies related to the gas pulsation, at which it should be treated as a reciprocating machine. The RXB, RXF machines will have 5 pulses per male rotor revolution, and RDB, RWF, and RWB models will have 4 pulses per revolution.

Using these characteristics, Frick screw compressors would fit the ISO classifications as follows:

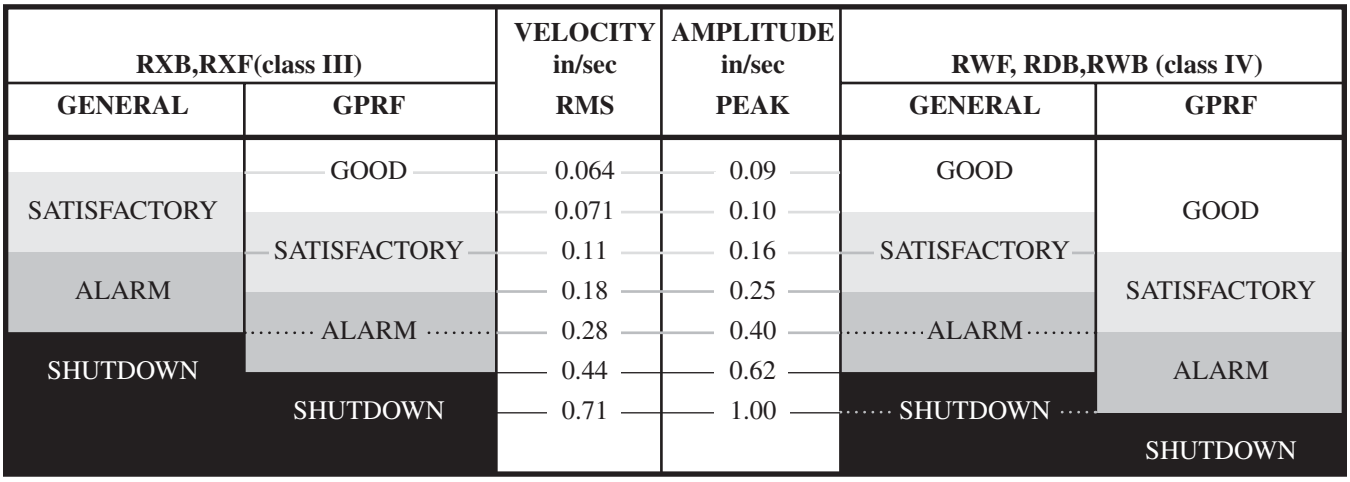
MODEL	DESCRIPTION	ISO CLASS
RWB 496,676 & larger	very large, rigid foundation	IV
RDB 546	very large, flexible foundation	IV
RDB, RWF, RWB (except above)	large, flexible foundation	IV
RXB, RXF	medium, semirigid foundation	III

II. Vibration Severity Limits

For a global evaluation of the vibration severity, the vibration levels should be measured in each of three dimensions and as near to the bearings as possible. FFT vibration spectra should be collected in velocity units over the frequency range of 10 to 1000 Hz and acceleration units from 10 to 10,000 Hz.

The standards propose limits based on the expected relative levels for the various categories. Typically, for a given type of machine (e.g. reciprocating or rotary), observed vibration levels are most severe for larger machines on flexible foundations. Thus, the highest limits are suggested under these circumstances. When looking specifically at a gas pulsation related frequency, higher vibration levels can be expected, and the limits are adjusted one classification to account for this.

The ISO severity limits can be summarized for Frick screw compressors:



General Any frequency in the 10 - 10,000 Hz range, ***except*** gas pulsation related frequencies

GPRF Gas Pulsation Related Frequency and its harmonics
For RXB, RXF, gas pulse is 5x male rotor RPM. For RDB, RWF, and RWB, gas pulse is 4x RPM.

III. Recommendations for Alarm Levels

For permanent vibration monitoring systems, the recommended alarm and shutdown levels are defined by the boundaries of the above chart at Gas Pulsation Related Frequencies.

A similar analysis can be applied in the case of acceleration measurements. Frequently, a vibration monitoring system will measure high frequency acceleration (e.g. “spike-energy” or “HFD”) near the bearings. Acceleration measurement is generally most suitable for monitoring bearing integrity, though a finite alarm level cannot be given. The shape of the acceleration spectrum gives more information about potential bearing deterioration.

Machine classification for this type of measurement is primarily affected by the size of the rolling element bearings. Again, Frick compressors would be considered as medium, large, and very large.

In general, the use of spike energy, HFD, acceleration enveloping or derivatives of acceleration are the best indication of bearing condition and will give the best protection, and earliest warning of impending bearing failure. The best practice for setting alarms on these types of systems is to run the compressor throughout the speed range when new, noting the highest reading at any % load. Set the alarm 2x and shutdown 3x the measured highest new value.

In the event new values are unknown or cannot be established, Frick recommends the following alarm and shutdown levels for spike-energy or HFD measurements at the same bearing locations as shown on page 3:

MODEL	ALARM	SHUTDOWN	UNITS
RXB,RXF	2.0	6.0	**g-SE or g-HFD**
RWF,RDB,RWB	1.5	4.0	
RDB 546, RWB 496 & larger	2.0	6.0	

IV. Example for Application of These Guidelines

Model RWB-II 399 @ 3550 rpm

This machine has four lobes on the male rotor. Thus, the gas pulsation will occur at 4x RPM or about 240 Hz. The highest vibration levels would be expected at this frequency and its harmonics (i.e., the gas pulsation related frequencies). From the standpoint of vibration, we can consider the compressor to be operating normally at up to 0.40 *in/s PEAK* or 1.5 *g-SE*. At other frequencies, the limit for normal operation is 0.25 *in/s PEAK*.

Above these levels, the compressor can still be operated safely in the ALARM region. Note that operation in this range should be closely monitored, and action should be taken to identify and correct the source of the vibration. If the vibration levels climb further to either 1.00 *in/s PEAK* or 4.0 *g-SE*, shutdown of the machine should be considered.

It is difficult to give a single alarm and shutdown number for proprietary vibration measurements because levels vary depending on the measuring instruments being used.

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