Application Note

Monitoring of Screw Compressor Bearings and Rotational Elements

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Introduction

Monitoring screw compressors can be very different from monitoring other types of equipment, such as pumps, fans and motors. The primary difference is the extremely high noise level caused by the gas pulse that is generated as the compressed gasses are discharged from the unit. This is compounded if the unit is a two-stage compressor with two discharge gas pulses. The gas pulse frequency will be equal to the female rotor speed (or speeds), and enveloped acceleration amplitudes will be high. Under normal operating conditions, amplitudes in excess of 15 gE have been observed.

One problem users may encounter is that of perception. Many employ the Autorange feature in their monitoring software. With a gas pulse amplitude of 15 gE, a bearing fault signal will often be "down in the dirt", even though it may have a high amplitude that would indicate a fault.

In **fig. 1**, the Ball Pass Frequency Outer race (BPFO) exceeds 1,5 gE. This definitely indicates a serious problem. However, since the signal's overall value is over 15 gE, the 1,5 gE peak does not "stand out". If the signal's overall value was, for example, around 1,7 gE, the 1,5 gE BPFO would be much more obvious.

Monitoring techniques

Two techniques may be used to help prevent overlooking these "hidden" enveloped acceleration amplitudes. The first, and easiest, is to use the Frequency Analysis Module (FAM) and assign the installed bearing's fault frequencies to the measurement POINT. When data is collected, overlay the FAM markers on the spectrum, regardless of how the spectrum looks, and look for energy spikes at the marker positions, much like the spectrum shown in **fig. 1**.

Place the frequency cursor on top of the 1X BPFO marker and read the amplitude in the data display box. Although outer race faults are most common, it is advisable to also check the Ball Pass Frequency Inner race (BPFI) in the same manner. Using this technique, you can easily locate and read amplitudes generated by typical bearing faults.

The second technique will provide you with the same information in a different way, but will allow you to alarm on the bearing fault frequencies more easily. Again, using the FAM fault frequencies, build a spectrum alarm band around the BPFO and BPFI frequencies. Set each band's frequency limits at 10 Hz below and 10 Hz above the FAM value. Set the band's peak alarm levels for 0,5 gE for an Alert, and 1,0 gE for the Danger alarm. The overall alarm limits can be set at the same values because, due to the narrow frequency ranges used, the overall value is not a significant factor.

Note that at the bottom of **fig. 1**, the measurement's overall value is indicated as 16,31 gE. The gas pulse energy spike occurs at 40 Hz, with an amplitude of 10,94 gE. The amplitude of the BPFO is 1,55 gE. At this rotation speed, a 1,55 gE BPFO is certainly cause for concern. One may also note that the FAM markers do not exactly line up with the energy spikes. It turns out that this was a badly worn bearing whose geometry had changed significantly enough to cause drift in the generated frequencies. Remember, the FAM program calculates fault frequencies based on the geometry of a new bearing.

As described in the second monitoring method, let's add the narrow band alarm. The FAM program calls for the BPFO fault frequency to be at 206,25 Hz. Using rounded numbers, we build a band ranging from 195 to 215 Hz. To do this in PRISM^4, double-click on the POINT ID in the hierarchy, select the **Bands** button, press the "**+**" button to add a new band alarm, and fill in the frequency ranges and amplitude fields as shown in **fig. 2**.

When the band is assigned to the measurement POINT, all that is necessary to monitor the POINT is to print an alarm report. The software will alert you if the POINT is in alarm. Note that without zooming, the band will look very small on the auto-ranged spectrum. If there are other frequencies of interest, they can also be spectrum alarm banded. For example, the gas pulse pressure could be banded to show an increase in its amplitude.

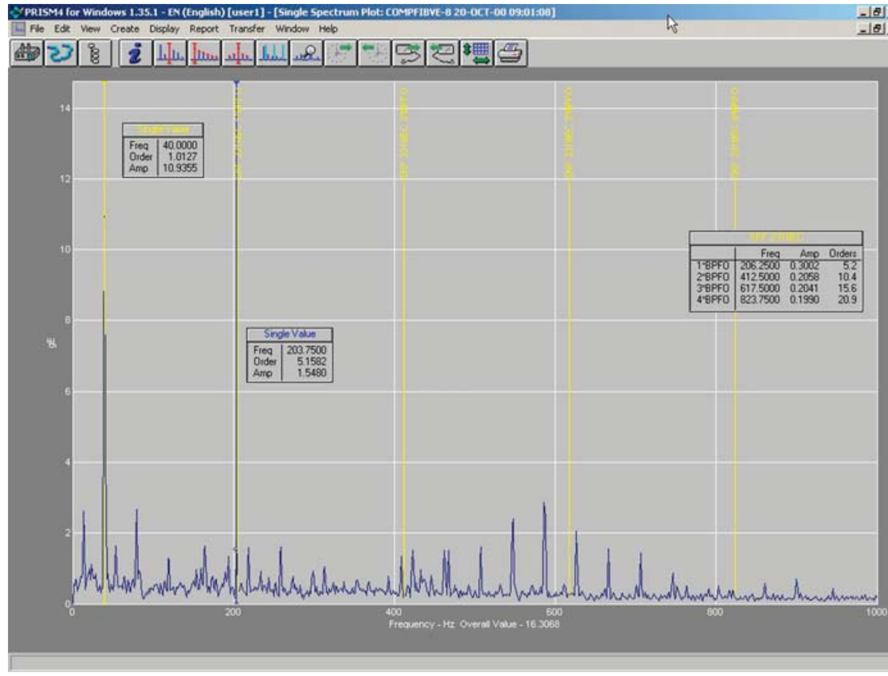

Figure 1. Enveloped acceleration spectrum of inboard female rotor bearing.

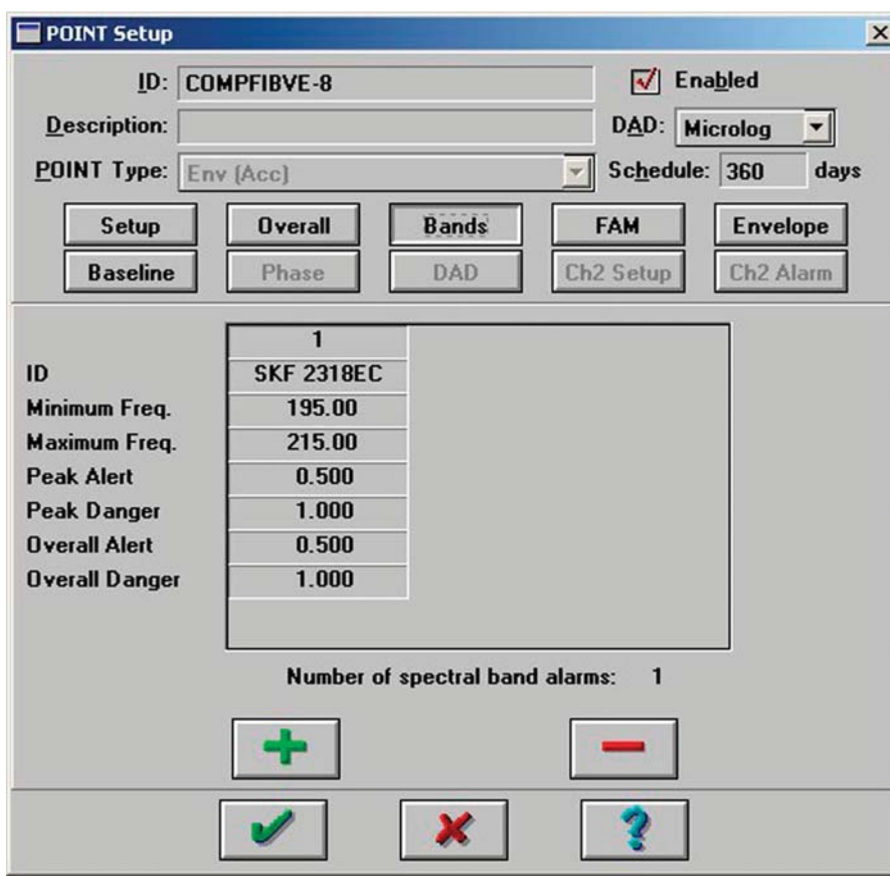

Figure 2. PRISM^4's band alarm setup dialog.

Additional tips on screw compressors

- Remember that the female rotor turns at a different speed than the male rotor, which is driven by the motor. The manufacturer will be able to provide you with the rotor ratio.
- The compressed product may be corrosive, which will reduce bearing life.
- If “slugs” of liquid enter the compressor, a bowed rotor may result. Physical evidence appears as rub marks at the nine o’clock and three o’clock positions on the stator.
- Always dynamic balance the rotors when replacing bearings.

Conclusion

Standard monitoring techniques apply to the monitoring of screw compressors; however, special attention must be placed on monitoring bearing fault frequencies that may be overlooked due to the high overall amplitudes generated by the gas pulse. Use the spectrum alarm band technique to help isolate the specific frequencies of interest and monitor the alarm report for any band alarms.

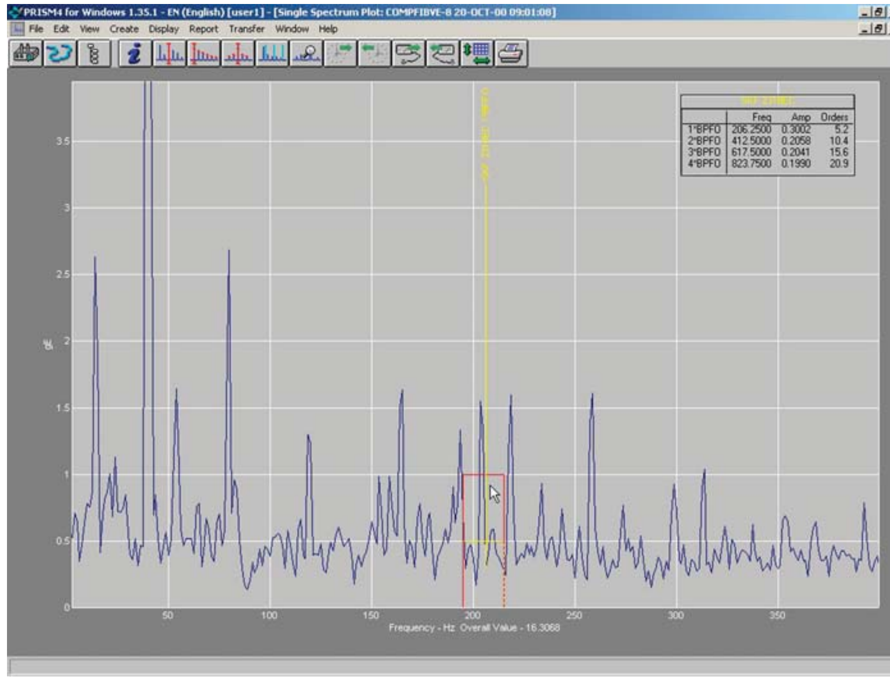

Figure 3. Zoomed spectrum from fig. 1, showing band alarms and BPFO marker.

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