STI Vibration Monitoring Inc.

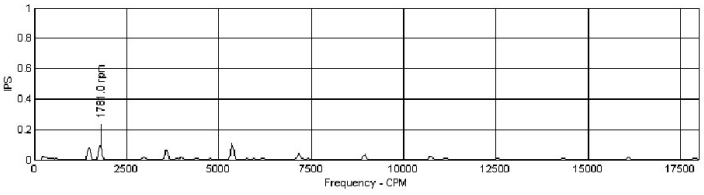
Field Application Note

Acceleration Envelope ENV

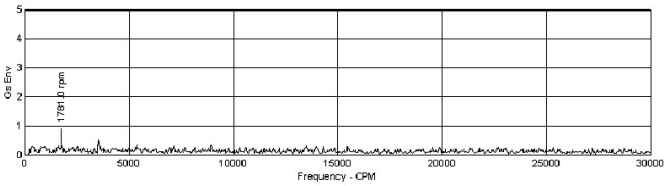
Acceleration envelope measurements are a new introduction to the inventory available to vibration analysts. Although initially it would seem to be most useful for detecting rolling element bearing defects (BPFO, BPFI, BSF, FTF), much more can be performed once the frequency ranges and applications of other more traditional vibration parameters are considered. Once it is understood how acceleration envelope signals are processed, nearly all analysis could be accomplished with these signals. Phenomena associated with motor electrical and gear meshing problems fall into the frequency range of acceleration envelope processing. Unbalance and other lower order problems do not initially fall into envelope analysis, but as these problems degrade they can be detected.

Acceleration envelope signatures are essentially band passed signals where lower order and higher order frequencies are removed. The remaining frequency range is most commonly associated with bearing defect frequencies. Normally, running speed related frequencies are removed by the filters and are not present in acceleration envelope spectra. However, when a running speed order frequency becomes severe enough it will appear in the envelope signature. This is due to the presence of numerous harmonics of the lower order frequency, which are not detectable in velocity signals, falling into the envelope filter range.

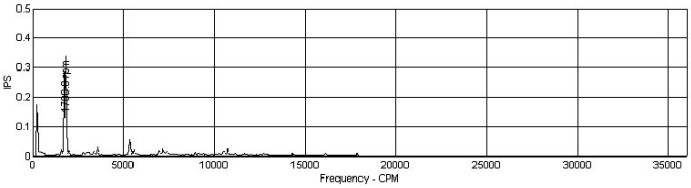
Figures 1 and 2 illustrate that when lower velocity signals are present the running speed components will not be present in acceleration envelope signatures. These spectra were collected on the same day during a routine PM data collection visit.



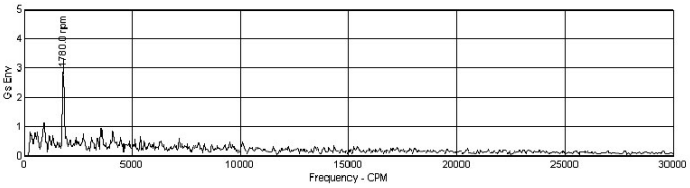
Acceleration envelope measurements were taken on same day. Note that 1Xrpm is missing in Figure 2 due to the filtering used (30k-600k cpm). Also, note the low noise floor and the lack of bearing frequencies in the spectrum. This bearing had recently been installed, no defects were identifiable, and the lubrication is adequate for continued operation.



As the running speed components and their harmonics become larger along with the presence of higher order harmonics the "ringing" associated with these harmonically related frequency components fall into the frequency range of the acceleration envelope measurements. Running speed frequencies are now present in acceleration envelope measurements. Figures 3 and 4 illustrate this phenomenon.



The velocity spectrum, figure 3, has a much larger 1Xrpm frequency component which now appears in the acceleration envelope spectrum, figure 4.



LUBRICATION

Lubrication problems, not normally analyzed with velocity signatures, but can sometimes be detected in acceleration signatures, can readily be detected using acceleration envelope signatures. Experience has shown that an inadequate lubrication condition will cause a shift in the noise floor of the signature.

Inadequate lubrication, which can encompass insufficient quantity, excessive quantity, and/or improper specifications, can be readily identified using acceleration envelope measurements. This phenomenon manifests itself as a shifting of the noise floor. Properly installed and operating bearings will not necessarily generate specific bearing defect frequencies when an inadequate lubrication condition exists.

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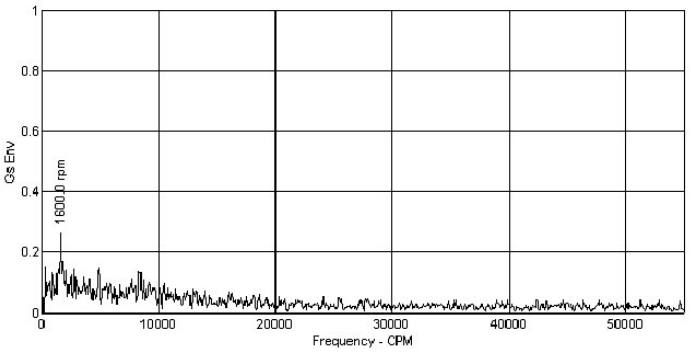
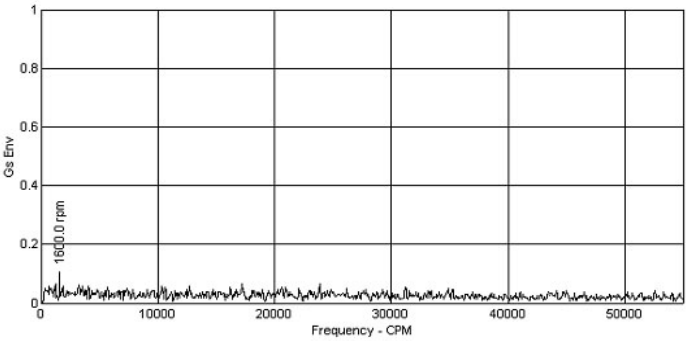


Figure 5 illustrates how a lubrication problem can be identified. The left portion of the spectra has been elevated with overall amplitudes of 1.1 G's. Once the bearing was greased the elevated portion shifted back down, figure 6. Overall amplitudes were reduced to 0.7 G's.



Sometimes the entire noise floor is elevated when a lubrication problem exist, as illustrated in figures 7 and 8. Figure 7 shows the elevated noise floor. No identifiable bearing defect frequencies are present, only an elevated noise floor. Overall amplitudes were at 8.2 G's.

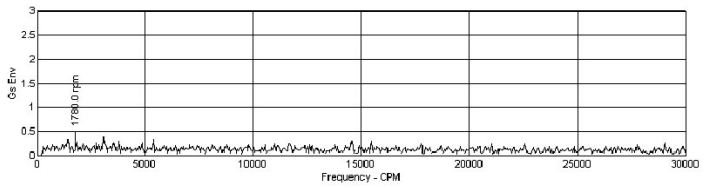
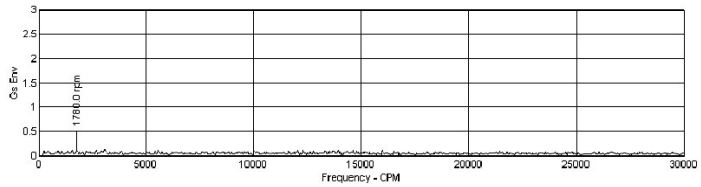


Figure 8 was collected after the bearing was lubricated. Note that bearing defect frequencies are not present and the noise floor has dropped. The overall amplitude dropped to 1.1 G's.



CONCLUSION

Acceleration Envelope measurements, due to the signal filtering, can be used to identify more machinery defects than damaged rolling element bearings. This measurement parameter is commonly only used to identify the smaller frequencies associated with bearing defects.

If machinery defects are classified into lower order problems and higher order problems they can be effectively diagnosed with acceleration enveloping measurements. Lower order problems would be balance, misalignment, looseness due to fasteners, or looseness due to worn bearings. Higher order problems would be bearing defect frequencies, motor bar pass frequencies, or gearmesh frequencies.

The presence of lower order problems in envelope spectra indicate a severe problem which most likely will need immediate attention. The filtering will eliminate these frequencies from an otherwise healthy machine.

Tracking of higher order problems can be accomplished normally using envelope measurements.

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