Detection of an Inner Race Defect Using PeakVue

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In early January of 2012, I assumed the responsibilities of the vibration analysis program at a customer’s site that had been using another contractor before Allied Reliability transferred me to the site. The former company was using Emerson’s AMS software and the CSI 2120 data collection equipment. We continued using the same software with the newer 2130 Machinery Health Analyzer.

I looked over the existing database and realized that the former PdM contractor was not using PeakVue in its analysis. PeakVue, or the peak value analysis methodology, is Emerson’s process of using demodulated data for vibration analysis. One can set up the database so that the PeakVue reading is acquired at the same time that another reading is being acquired.

I ran the initial route on the support equipment for the paper mill in February, which included the vacuum pumps that pull water out of the pulp stock to help form a sheet of paper. I noticed a pattern on the drive end of the #2 pump matching how an inner race defect should appear. I did not have the bearing information, so I noted this for further investigation. The pattern was not visible on the normal vibration data.

In March, I had the proper bearing information and pump speed set up for data collection and acquired data on a regular route. Normal vibration readings did not show any bearing defects (Figure 1). However, PeakVue analysis showed that the bearing fault did indeed exist (Figure 2). The next step would be to try to assess the amount of damage to the bearing as the site wanted to know if failure was imminent.

PeakVue uses ultrasonic emissions and signal processing to produce the spectrum for analysis. Ultrasonic emission is usually a very early detector of bearing failure. The system is purported to detect a defect before it breaks the surface of the bearing race. However, ultrasonic emissions degrade quickly each time they move through an interface. An inner race defect must move from the defect into the roller, then through the roller into the outer race, and finally through the outer race to the accelerometer on the machine surface.

Based on my findings, I advised the site that catastrophic failure of the bearing was probably not imminent, but the bearing should be changed in the near future. To do this, the site would need to schedule a contractor to perform the work. This large vacuum pump is the second pump in a set driven by one motor and is furthest from the motor (Figure 3). The pump would need to be moved from its mount in order to change the bearing, and the work was estimated to take at least 12 hours to complete. The Planner for the area questioned me a few times about how certain I was about the call. As this would be a large expense for the site, he wanted to make sure he needed to spend the money. I told him I was positive that the failure was there.

The site opted to change the bearing two months later during a regularly scheduled outage, which allowed them to minimize downtime on operations. The pump’s coupling was disassembled, the pump was moved away from its mounts, and the bearing was removed. An inner race fault about 3/8 of an inch wide and 1 inch across the bearing was found (Figure 4). The bearing was changed and the pump was reinstalled and put back into operation. Total time to perform the work was 12 hours.

The savings potential for this discovery is immense. The obvious savings could have been at least 12 hours of downtime while the bearing was changed out in an emergency situation. Realistically, the time
would have been greater as no preparation would have been made to get the proper tools to the job site. Personnel would also have to be moved around in order to accomplish the work. If the failure had occurred during off hours, mechanics would have had to be called in to perform the work. All of this would have added up to a best case scenario.

The worst case scenario would have been if the inner race had cracked and the impeller had worn down. A new rotor would cost in excess of $100,000, and new rotors are not kept on hand at the manufacturer.

PeakVue, or demodulation, is a tool that should be used to help determine problems in our equipment. Proper use will help keep equipment running and avoid unwanted downtime.

Figure 1: Normal Spectrum Before Repairs
Figure 2: PeakVue Spectrum Before Repair

Figure 3: #1 and #2 Vacuum Pumps
Addendum

When this case study was posted on Allied Reliability’s blog, Carlos Hernandez asked an interesting question: did the PeakVue time waveform and autocorrelation waveform give indications of the inner race defect issue?
The PeakVue waveform showed a pattern of increasing amplitudes at the rotational speed of the inner race. As the spall begins to enter the load zone, the amplitude increases. This increase is due to the added load causing the rollers to impact the spall harder. The level generally peaks at the bottom of the load zone, then the level decreases as the roller moves away from the load zone.

**Figure 6: PeakVue Waveform With Rotation Markers**

Autocorrelation of the PeakVue waveform uses statistics to reduce the random impacting shown in the waveform. The waveform after it passes through the autocorrelation formula clearly shows the increase in impacting at rotational speed and the inner race defect impacting.
Figure 7: PeakVue Spectrum After Autocorrelation