Detection of Electrical Fluting in Rolling Element Bearings

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Abstract

Random electric currents will damage bearing rings and rolling elements. Detection of this damage using enveloped acceleration (gE) is shown by the examples given.

Discussion

One characteristic of electricity is that it is always seeking the path of least resistance. For that reason, grounding strips are made of copper to shunt unwanted electrical currents from the motor frame to ground. At least that is what happens when everything goes according to plan.

Occasionally, random currents are generated in the rotating elements of both DC motors and AC motors operating on a variable frequency drive (VFD). These random currents can originate from faults in rotor windings, or may be induced in the stator of the motor (whenever a conductor is passed through a magnetic field, a current is induced in that conductor). These unwanted currents perform their normal function and seek a path to ground, which is often through the rotating elements. A common sign of trouble in a DC motor is a spike of energy at 21 600 CPM (18 000 CPM for 50 Hz machines) that is usually generated by a malfunction in one or more of the silicon controlled rectifiers (SCR). Their purpose is to reshape the DC voltage into the desired frequency that will provide the target r/min for the motor.

Needless to say, bearings are not designed to be conductors of electricity, so the result is a damaged bearing. The damage is seen in a very characteristic pattern known as fluting. Close observation of the contact surface of the bearing ring will disclose a series of ridges and groves that lay in the ring from side to side, often described as looking like a washboard. If you pass your fingernail around the inner surface of the ring, these ridges and valleys are readily apparent.

What has happened is that the current has performed a long series of micro welds and has eroded the surface to form this pattern. Some interested party has probably figured out the math involved to generate this well known pattern, but for the purpose of this paper, just accept that it is a well known phenomenon caused when electricity passes though the bearing on the way to ground.

SKF Microlog AX

The problem is, how does one detect such problems? What do you look for, what does the spectrum look like, is velocity or enveloped acceleration the best technology to employ?

Thanks to Dragan Trivanovic (SKF Customer) we have some field data to compare and analyze. The following data was collected using an SKF Microlog on an extruder driven at 822 r/min by a DC motor. Data was collected in both velocity and enveloped acceleration. Please follow the notes beneath each plot.

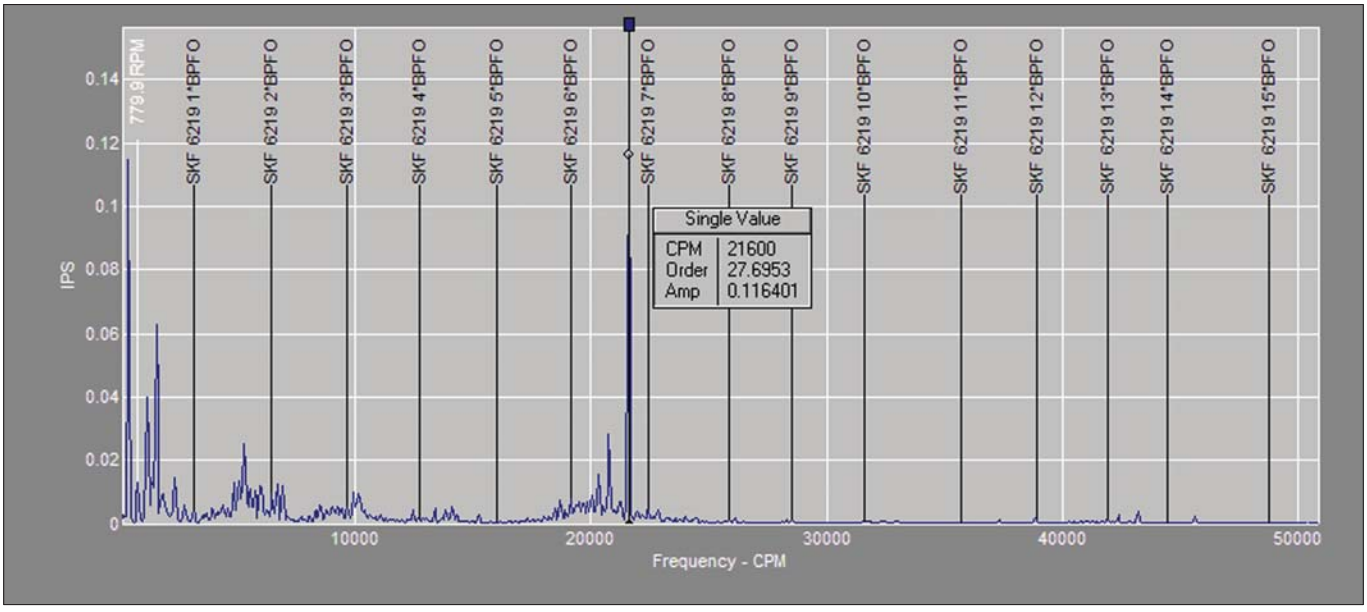

Figure 1. A problem was suspected in February. The velocity spectrum does not show any indications of a bearing problem; however, the spike of energy at 21 600 CPM is a red flag that there are electrical problems with the controlling SCRs.

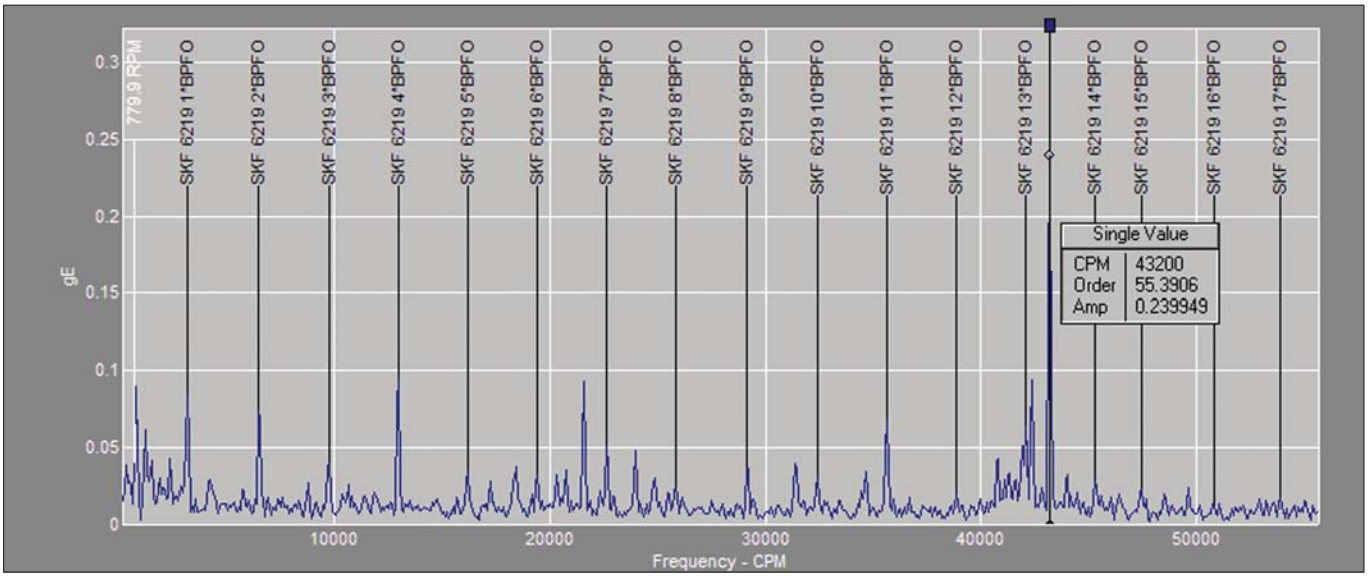

Figure 2. An acceleration enveloped spectrum taken on the same bearing. Clearly, there is something happening with the bearing's outer race. However, at these amplitudes, there is no call to change the bearing. At this point, all that is needed is to alert Maintenance that something is going on.

Six months later, we see the following developments.

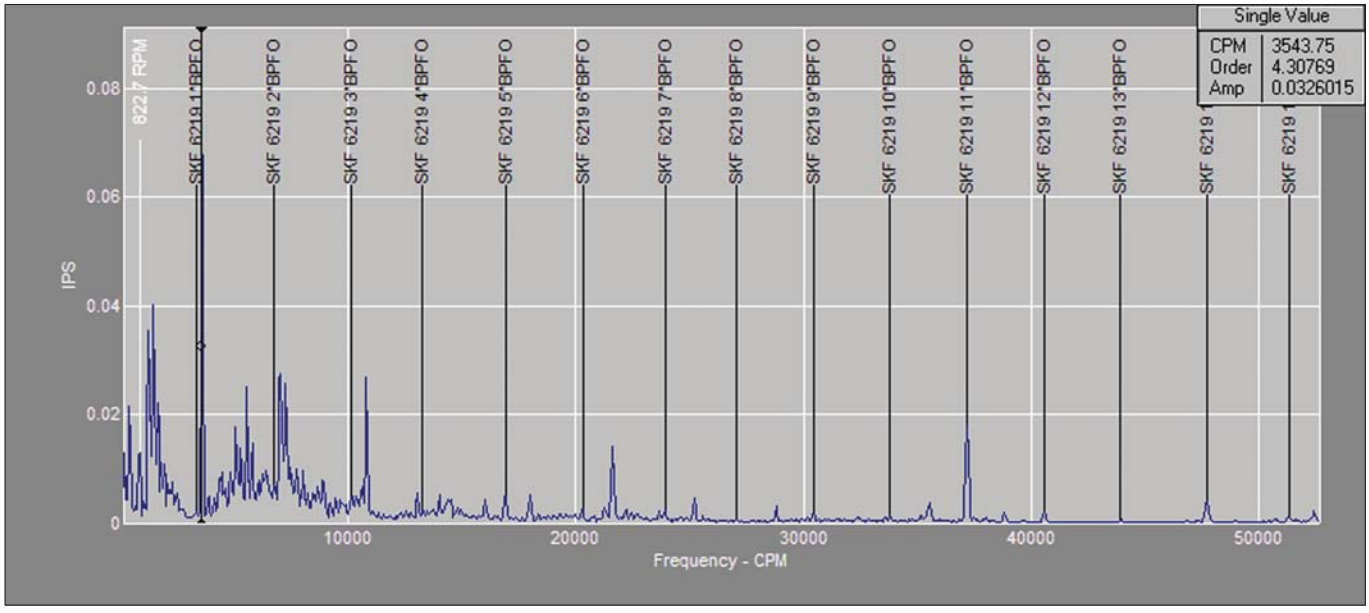

Figure 3. The velocity spectrum shows small indications that a problem is developing in the outer race, but at these amplitudes, there is no need for concern.

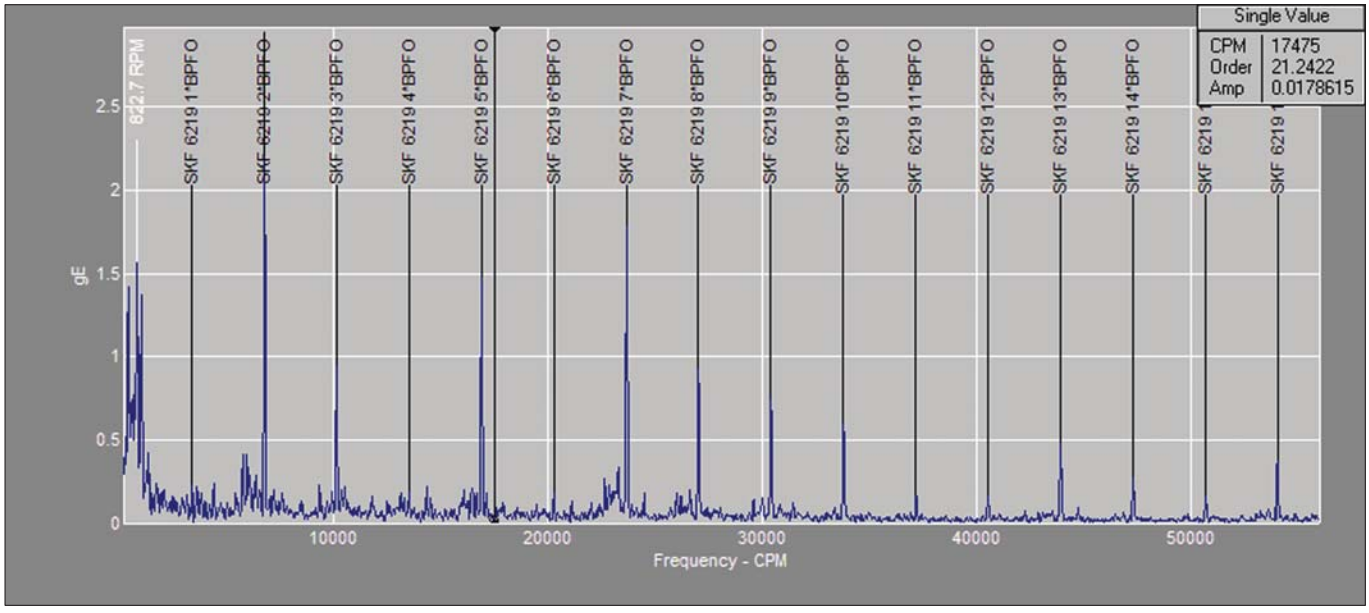

Figure 4. Enveloped acceleration clearly shows there is a serious problem.

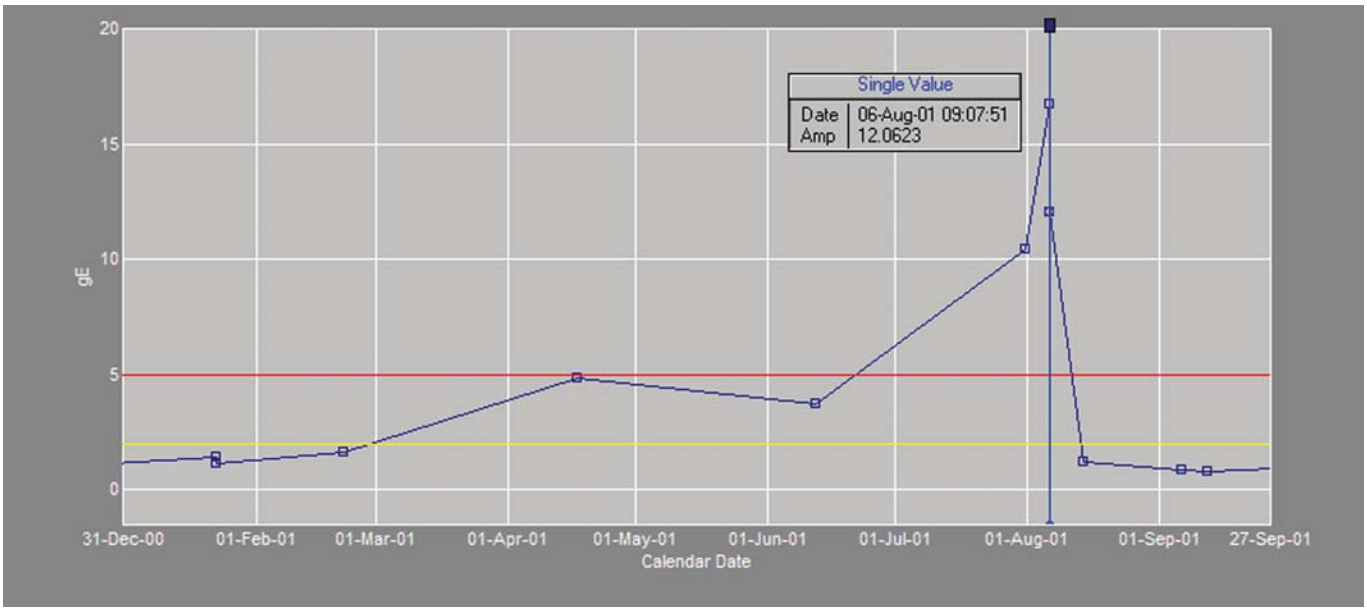

Figure 5. Trend of acceleration enveloped overall amplitude.

Clearly, this bearing is damaged and should be replaced as soon as possible. The trend shows it was replaced shortly after August 6. A photo of the actual bearing is shown in **fig. 6**.

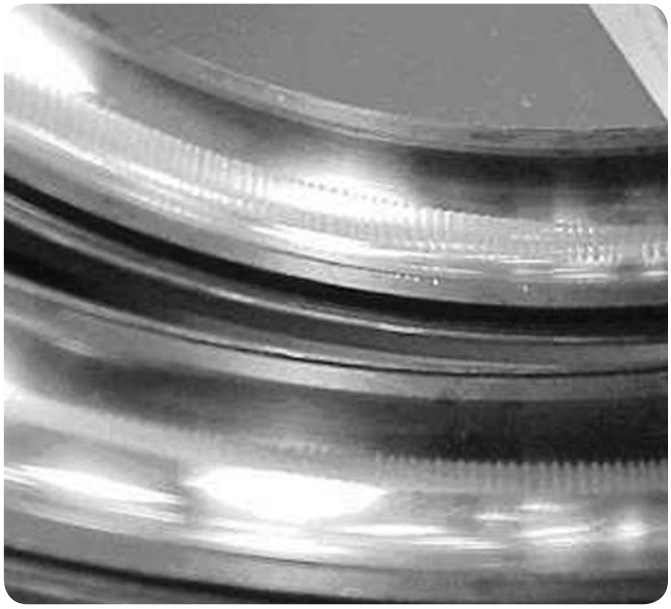

Figure 6. Damaged bearing.

Conclusions

In DC and AC motors using VFD's, there are two warnings of probable bearing damage from electrical discharges.

- First is the spike of energy seen at 21 600 CPM. This is usually an indication of damage to the SCR's and should be investigated by the electricians. Note that in our example the amplitude of the spike decreased over time for some reason, but is still present.
- Second, with fault frequency overlays, damage in the bearing rings is apparent. Enveloped acceleration is the preferred technology to use whenever bearing damage is suspected.

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