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Condition-Based Monitoring and Acoustic Lubrication:

Bearing May Need Lubrication Prior to When “Scheduled”

by Jim Hall
Although many are utilizing ultrasound in their condition-based monitoring (CBM) program, many are still lukewarm about implementing the acoustic lubrication application as part of a CBM program. But here’s why that application should be utilized.

The Uptime Elements™ framework includes five domains:

- Reliability Engineering for Maintenance (REM);
- Asset Condition Management (ACM);
- Work Execution Management (WEM);
- Leadership for Reliability (LER);
- Asset Management (AM).

Within the ACM domain, there is an element known as asset condition information (Aci). It comprises all the data, observations and conditions of an asset. This information is more than just current state; it is the cumulative condition of an asset over its lifecycle.

This approach enables day-to-day decision support and is a prognostic of future conditions. Therefore, data collected through CBM is a key component in Aci. This allows for the detection of early onset failure and is normally aligned to known failure modes. This would include vibration analysis, oil analysis, ultrasonic testing, nondestructive testing and any other methodology of analyzing the condition of an asset with regard to its deviation from its normal operating condition. The use of CBM to ascertain the onset of failures is only as valuable as the information collected.

Acoustic lubrication is a program that can be implemented as part of a scheduled or unscheduled lubrication program. When implemented as part of a CBM program to assist with the identification of early signs of failures, the benefits can mean huge savings by reducing loss of production, loss of equipment (asset) and loss of man-hours from unscheduled maintenance.

CBM is a strategy that monitors for certain key performance indicators (KPIs) that may indicate signs of a lack of performance. These KPIs drive reliability while guiding your choices for improving maintenance. Unlike time directed (TD) tasks maintenance, which are maintenance tasks performed at predefined intervals, CBM maintenance is performed when the KPIs are indicating lack of performance or signs of a future failure.

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Types of Condition-Based Maintenance

The types of technologies used for CBM include instruments and processes, among them:

- Vibration Analysis – vibration sensors, permanent or handheld;
- Infrared (IR) – IR cameras to detect high temperatures of utilized motors;
- Nondestructive Testing (NDT) – ultrasound used to detect cracks in welds, corrosion of pipes, or the thickness of metals;
- Ultrasound – used to detect leaks of gases or a vacuum;
- Oil Analysis – measure particles/sampling;
- Electrical – motor current analysis;
- Operational Performance – sensors throughout a system to measure performance.

When looking at this list of instruments and processes, the technology of ultrasound comes to the forefront. Ultrasound is defined by most technicians as leak detection of compressed air or gases. Or, depending on their background, ultrasound may mean ultrasonic NDT of welds or pipes for corrosion, or for thickness readings.

An effort must be made by industry to educate technicians and engineers in the differences of these two technologies. If your knowledge of ultrasound is limited to finding air leaks and NDT, then you truly lack a strong foundational understanding of the uses of ultrasound for maintenance inspections.

Ultrasound is used to detect leaks of compressed air or gases (positive or negative pressure); monitor motor bearings, acoustic lubrication and gear boxes; diagnose steam traps; and inspect electrical apparatus, such as transformers, electrical switchgear, substations, and distribution for the presence of arcing, tracking, or corona discharge (e.g., low, medium, or high voltages). Ultrasound detects high frequency signals above the human hearing range. That means in a noisy plant environment, ultrasound can detect electrical anomalies, compressed air or vacuum leaks, monitor the motor bearings, hear a gearbox failing, or detect that double spherical bearing is being eaten up by a badly misaligned short shaft connected to an agitator on the other side of the room.

Ultrasound is high frequency sound above 20,000 hertz or 20 kHz, a short wave that typically measures 1/8 inch to 5/8 inches long and is directional.

Ultrasound training from an experienced trainer/technician is most valuable when it is utilized in multiple applications or simply to complement other technologies, such as vibration and infrared.

CBM and Acoustic Lubrication

You can actually find CBM and acoustic lubrication mentioned in the same sentence by ultrasound manufacturers on the Internet.

- Is the practice of acoustic lubrication and CBM too new of an application?
- Are there too many skeptics regarding the practice of acoustic lubrication and CBM?
- Are there too many technicians unsure of the actual procedure to implement acoustic lubrication as a CBM program?

The response to the first question is probably, no, but yes to the others. Some skeptics do remain regarding acoustic lubrication, but they outweigh the frequent feedback from users on how the program is working well for them.

With hundreds of copies of the Acoustic Lubrication Guidelines for Rolling Element Bearings in Electric Motors having been downloaded, one may reflect on the amount of downtime, lack of production loss and how a large percentage of motor maintenance is being reduced through the practice of acoustic lubrication. Someone is doing something right.

However, a large segment of ultrasound users have not implemented the acoustic lubrication practice correctly. When inflection points are not adhered to, lubrication continues with possible adverse effects from over lubrication, such as premature bearing failure due to high temperatures, blown grease seals due to excessive internal pressure and possibly grease getting into the armature of the motor. Figure 3 shows a motor that ran inefficiently for several months due to grease working its way into the stator body and rotor assembly. Eventually, grease was distributed into the windings.

Acoustic lubrication is the use of a high frequency receiver or translator to detect sound that may relate to the condition of a motor bearing prior to lubricating the motor bearing.

Technicians should be trained to focus on the decibel because the rise in decibels means something is going wrong. Often times, technicians are told to focus on the sound of the bearing. However, what the practitioner hears through his/her own hearing may differ greatly from one person to another. The other problem with listening is that today’s digital ultrasound instruments are not as revealing as yesterday’s analog instruments. The highs and the lows are missing. For example, an analog instrument with frequency tuning allows the user to focus on certain sounds or conditions to detect brinelling, balls out-of-round or ball defects, inner and outer race defects and under or over lubricated bearings. It is, however, a digital age, so data logging and waveform analysis are part of it, especially waveform analysis. A down converted ultrasonic (above 20,000 hertz) recording, which takes the high frequency signal and converts it to low frequency so it can be used for ultrasound signal analysis or converted to a decibel, can reveal numerous conditions or faults.

Today, there are instruments that adapt to your grease gun and allow the end user to simply use the ultrasound instrument and magnetic or contact transducer to monitor a motor bearing during the lubrication procedure. This is very ef-
Figure 4: Ultrasound is the first detectable signal on the P-F curve

Effectiveness in preventing over greasing of the motor bearings.

Acoustic lubrication is a viable means for CBM. Why? Simply put, ultrasound is the first means of detecting a fault before vibration or infrared. Also, the learning curve to use and implement an ultrasound program is short.

A good understanding of ultrasound and the many applications this technology offers is recommended prior to implementing an acoustic lubrication program, such as the equivalent to an ultrasound Level I training course.

**NOTE:** Prior to starting an acoustic lubrication program, you should follow your local plant’s recommendations and the original equipment manufacturer’s suggestions for removing the purge port, plugs, or bottom grease relief valves, when applicable. You should also know the type of bearing to be lubricated.

Granted, there are many different ways and different configurations used to apply acoustic lubrication. One way includes the use of an ultrasound instrument “fixed” upon a grease gun for a one person, two-handed operation. Second, is simply taking an ultrasound instrument in one hand and a grease gun in another, which may or may not require a second person.

**Here is an example of the procedure:**

Once you have the instrument and grease gun ready, place the zurk or hook onto the lubrication point. Many technicians prefer a button and hook with a short connection to the ultrasound transducer because the tightness of the connection provides a more consistent and repeatable decibel.

**NOTE:** Within the acoustic lubrication practice, technicians are instructed to implement greasing if the dB level is 10 or more decibels above baseline.

As you start the procedure, you may notice the baseline was 35 decibels for this motor bearing, but your reading today is 48 decibels (13 dBs above baseline). Using a grease gun with a handle, you choose to use the preferred half stroke method versus the full stroke method of the grease gun for this application. After a half stroke, you pause three to four seconds; no reduction or increase in dBs is evident. After a second half stroke, you pause another three to four seconds and again, no dB drop or increase is seen. Then, after the third half stroke, you notice the dB drop is two dBs. Another half stroke, pause and another two dB drop is seen. You are now getting a smidgen of grease on the bearing. Another half stroke, pause, a three to four dB drop is seen. Another half stroke, pause, the dB rises. This is the inflection point. Pause 10 seconds. If the dB level doesn’t return to the reading prior to inflection, you then log the reading and stop lubricating.

However, what if during the acoustic lubrication, inflection occurred (an increase of one to two dBs) after one half stroke of the grease gun? You should pause 10 seconds and if the dB reading does not return to where it was prior to inflection, you should stop the lubrication procedure. Do not continue greasing. Possibly, someone before you had lubricated the bearing. But, you say, “This...”

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bearings is still 13 to 14 dBs above baseline? What do I do?” Well, you make a call to a vibration technician to analyze the motor.

Can you see where the goal of your CBM program to spot future motor/bearing failures can be achieved by adding acoustic lubrication? One engineer documented savings of 37 percent less motor maintenance after implementing acoustic lubrication into the CBM program. Isn’t it time for your organization to realize savings, as well?

**References**

1. Referenced from the Uptime Elements Passport – Asset Condition Information (ACI) booklet
3. Inflection Point when used in acoustic lubrication is a point at which the decibel changes upward and not downward.
4. Brinelling is a process of wear in which similar marks are pressed into the surface of a moving part, such as bearings.

Jim Hall is the Executive Director at The Ultrasound Institute (TUI). Jim has been in the ultrasonic market for over 25 years and has trained many Fortune 500 Companies in the use of airborne ultrasound, including electrical power & generation, pulp & paper and automotive & aviation. Jim has been a contributing editor for UPTIME Magazine (ultrasound segment) since the magazine’s inception.

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