Sound: The "Ultra-Optimal" Lubrication Program

Chad Chichester, Dow Corning Corporation

Ultrasonic surveillance is a simple way to help optimize your lubrication strategy.

The Secret to Correct Lubrication

The success of a facility's lubrication program boils down to one basic concept: delivering the correct amount of the correct lubricant to the correct place at the correct time.

This may sound simple enough, but anyone who has spent time in a maintenance or reliability role knows that this "basic concept" is anything but basic.

A technology known as *ultrasonics* provides pump and system maintenance professionals with unparalleled insight into the condition of the lubricant in an operating unit of machinery. This allows technicians to better place the correct lubricant in the correct amount at the correct place at the correct time.

As the name "ultrasonics" suggests, the technique involves the monitoring of sound produced above the sonic frequency range. The sonic range, or the frequency range the human ear can hear, ranges roughly from 100-Hz to 20-kHz; frequencies above 20-kHz are considered ultrasonic.

As lubrication quality diminishes during machinery operation, friction creates vibratory energy at a frequency around 30-kHz, creating a kind of ultrasonic beacon. Devices have been developed to measure and record ultrasonic signals, as well as "shift" or heterodyne the ultrasonic signal down into the audible or sonic range. This allows technicians to hear the otherwise inaudible, tell-tale signal of inadequate lubrication.

The Correct Amount of Lubricant at the Correct Time

Ever had a motor winding failure result from grease in the windings, or a bearing failure shortly after re-lubrication?

Whether a bearing is re-lubricated too frequently or a lubrication technician subscribes to the "if some is good, more is better" philosophy of lubrication, over-lubrication is as serious an issue as under-lubricating. Even programs founded on the use of lubrication interval charts and equations can have over-lubrication woes.

The trouble is that it is difficult to know how much lubricant is already in the bearing when the scheduled re-lube comes due. Subsequently, it is also difficult to know how much lubricant to add, especially when consideration is given to the diversity of machines found in an industrial environment. Multiple machine manufacturers, thousands of different sizes, and varying shaft speeds make matters even more difficult and any "rule of thumb" impossible to follow.

By taking periodic ultrasonic measurements and trending those values, maintenance practitioners gain insight into the actual condition of the lubricating system in the machine during operation. Typically, bi-weekly or monthly ultrasonic readings are taken and trended. Ultrasonic emission increases of about 7-dB indicate the lubricating oil has depleted to a point where friction has notably increased.

Ultrasonic technology is extremely useful in preventing

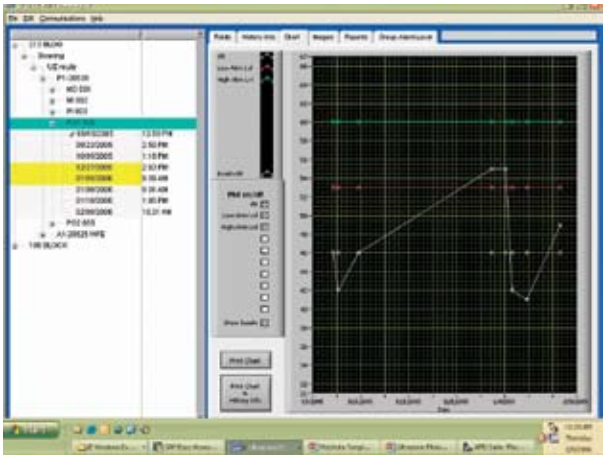

Figure 1. Ultrasonic readings taken on a dry screw vacuum pump show a 7-dB increase and subsequent drop-off.

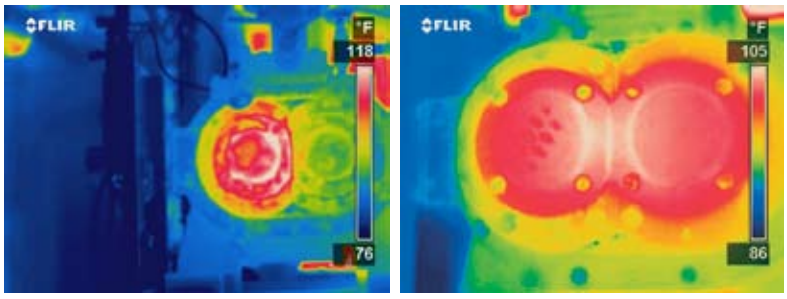

Figure 2. Infrared images taken before and after re-lubrication.

over-lubrication. As the grease is pumped in, ultrasonic levels reduce to a point at which a squirt of grease results in a slight increase in dB. After the slight increase, the dB level resumes its decline until an additional squirt results in another slight increase followed by another decline. Subsequent squirts of grease are added until the ultrasonic levels increase and do not decline. This indicates that the bearing cavity is filled to the point that the rolling elements are continuously plowing through the new grease.

Additional adding of grease will over-lubricate the system. This can lead to increased frictional heat and cause the oil to bleed out of the bearing cavity excessively, resulting in inadequate lubrication at the bearing and eventual bearing failure.

The Correct Lubricant to the Correct Place

In pump and system applications, correct lubrication means having the appropriate base oil and additive properties under operating conditions at the desired point of lubrication. Simply putting a grease gun to a zerk and pumping in grease only implies lubricant is getting to the desired location. The intent is not to lubricate the zerk, or the tube leading to the bearing cavity, or for that matter the bearing cavity itself. The goal is to lubricate the bearing.

Ultrasonic monitoring during the lubrication PM procedure gives the maintenance professional assurance that lubrication has reached the correct location (i.e. between the rolling element and the bearing raceway at operating temperature).

Once the lubricant is delivered, its primary function is to reduce friction by separating surfaces. It is logical that if a lubricant is not performing its primary function of reducing friction, ultrasonic levels will be elevated. In severe cases, constituent parts intended to be separated by the lubricant using principles of hydrodynamic and elastohydrodynamic lubrication (EHL) may touch, producing high levels of wear and fatigue.

Noise produced when moving parts touch may not show up in the ultrasonic range. Metal-to-metal contact will produce vibratory energies around 4-kHz, which are sonic, not ultrasonic. Also, if the base oil viscosity is too high at operating temperature, the theory of elastohydrodynamic lubrication (EHL) implies that thicker EHL films are produced.

Rolling elements will deform as they attempt to plow through the rigid oil film, generating friction and subsequent 30-kHz energy, which can be measured with an ultrasonic device. Conversely, base oil viscosities that are too low will result in the loss of separation. Hydrodynamic and EHL films may become thinner than surface asperities themselves, resulting in metal-to-metal contact and increased friction that can be monitored using sonics and ultrasonics, respectively.

Conclusion

Maintenance professionals responsible for a facility's lubrication needs face challenges ranging from simple lubricant storage to procurement and application engineering. Often, fundamental concepts of lubrication get lost in the cultural practices and plant procedures intended to provide reliability.

The bottom line: lubrication happens in the bearing at the machine. Ultrasonics help the maintenance professional deliver the correct amount of the correct lubricant to the correct place at the correct time.

P&S

Chad Chichester is a Molykote application engineer for Dow Corning Corporation, 2200 Salzburg Street, Midland, MI 48640, 989-496-8025, chad.chichester@dowcorning.com, www.dowcorning.com.