Acoustic/Ultrasonic Lubrication

Abstract

World class lubrication programs are shifting away from Time Based Re-Greasing schedules to Condition Based Re-Greasing schedules. Choices for tools include simple high frequency ultrasonic detectors and audio stethoscopes to digital data collectors that can directly interface with the grease gun. Lube techs face new challenges as they harness the power of ultrasonic inspection. This short course de-mystifies the technologies and techniques surrounding the acoustic lubrication as an effective lubrication practice.

Introduction

The term "airborne ultrasound" when used with pdm is refers to the practice of using an ultrasonic receiver to listen for air leaks, bearing analysis, steam trap troubleshooting, and electrical scanning for arcing, tracking, and corona discharge. Airborne ultrasound (pdm) typically refers to sound above 20 kHz. Most airborne ultrasound receivers today center around 40 kHz.

Case History #1

While selling ultrasound equipment, I came across technicians that had relied on Time Based Re-Greasing schedules. Many of these technicians were merely following the recommendations of others before them, as to how much grease to pump into the bearing. One such case history I recall happened while I was demonstrating how to trend motor bearings with an ultrasonic instrument.

The engineer and I placed headphones on our heads that were attached to the same ultrasound instrument. The instrument we were using was set to 30 kHz and "linear mode" (time averaging). A contact probe was placed next to the zerks fitting to listen to the bearing for sound quality as well as to record the sensitivity setting and decibel reading for trending purposes. At this time I noticed the bearing sound resembled that sound of a dry bearing.

The engineer asked, "What does a dry bearing sound like?" I call this "[1]***audioception***," imagine a bearing with no grease, spinning next to your ear. The scratchy sound of the metal balls rotating and hitting the race and the other balls is what the ultrasonic receiver through a [2]piezoelectric transducer translates by heterodyning the signal and then converts that signal to a low-frequency sound that can be heard through the headphones.

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[1] Audioception: **a :** to take an audio signal (wave file) into one's mind <*conceive* a prejudice> **b :** to form a conception of **:** IMAGINE

[2] A piezoelectric transducer (ultrasonic transducer) can receive or send ultrasound. However, this ultrasonic receiver instrument only receives the signal. This signal vibrates the transducer, which creates electrical energy. The signal or sound is amplified and then heterodyned. This heterodyned signal is converted to a low frequency signal that can be heard through the headphones.

Procedure
The lubrication practice that I am accustomed to is to pump a half-stroke of the grease gun and watch for a response on the analog meter either "up" or "down". If the needle on the analog meter moved upward, after a half-stroke of the grease gun, you should then wait 15 seconds for the needle to return to the original setting or lower before proceeding. If the needle does not move downward or back to the mid-range after 15 seconds, suspend lubricating at this time. It is assumed that the bearing has enough grease. If the needle moves lower than the mid-range after a half-stroke or several half-strokes, then the procedure is to continue until the needle does not move downward, but starts to move upward again. Again at this time the 15 second rule is implemented before proceeding or ending the lubrication practice.

The sensitivity of airborne ultrasound can best be illustrated by imagining someone taking an electric pencil and scratching a ball of a bearing. After placing this bearing back in service and performing vibration analysis (20 kHz or lower) on the bearing, the scratch will not be detected. However, if the ultrasonic receiver and contact probe are then interfaced with the vibration analyzer providing a high-frequency demodulated signal, the scratch can be detected.

I asked the technicians to retrieve a grease gun so that we could lubricate the bearing. The technicians smirked and replied, "Jim, can't you see we just greased this bearing, it is evident by the fresh grease on the 14 inch fill tube?" I asked the men to bear with me. Both of us, the engineer and I, were listening to the bearing as I made an adjustment to the instrument raising the sound level to a point that was mid-range on the analog meter. I then asked the technician to pump a "half-stroke" of the grease gun. As we watched the analog meter for a response either up or down, ***no*** response was noted.

In fact after several half-strokes of the grease gun no sound difference was heard. But, after the 18th half-stroke the needle on the analog meter went to "zero" and the sound in the headphones disappeared. Just because the grease had finally reached the bearing and lubrication was now taking place. The job was not over. At this time I raised the sound level back to a mid-range on the analog meter and proceeded to have the technician pump half-strokes again. After 3-4 more half-strokes of the grease gun the needle moved upward and stayed after 15 seconds. The sound quality of the bearing had gone from a scratchy sound to sound that resembled an air leak or the sound of rushing air.

Acoustic Lubrication Practice
After years of selling airborne ultrasound equipment and training companies in the proper use of airborne ultrasound instruments, I developed an acoustic lubrication adaptor for one company that could be interfaced with an ultrasound instrument. The adaptor could be attached to the contact sensor to sense the decibel changes while lubricating a bearing. This method I feel is substantially superior to other methods for several reasons. One reason is when the adaptor is mounted to the zerks fitting or other lubrication points the contact probe, has little or no sound attenuation loss. A second reason is that an instrument that has a digital display of numerical or sensitivity meter can compensate for

a technicians loss of hearing. Many devices in the marketplace today use sound only and no indicator, depending solely upon the technician's sense of hearing as to whether or not to pump grease. Several of these manufacturers even suggest that the technicians pump grease until a "difference" is actually heard. This suggests that every bearing being lubed needs lubrication and this could prove to be detrimental to the motor.

Recommended Practice
CAUTION:
ONLY USE THIS PRACTICE TO SERVICE A BEARING. THIS IS NOT INTENDED TO BE A PROCEDURE FOR NEW OR NEWLY INSTALLED BEARINGS.

- Calibrate grease gun: No matter whose ultrasound instrument you are using, the grease gun should always be calibrated. Use a one-ounce container (shot-glass), pump grease into the container using half-strokes while counting the number of strokes it takes to fill the container. Typically, "7" full strokes or "14" half-strokes are required to fill an ounce container.
- Always be sure the area and fittings are clean. Wipe away dirt or grease before and after lubricating.
- Know the lubricant to be used. Do not mix lubricants or grease.
- Designate a grease gun to be used with an acoustic grease adaptor and clean the adaptor each time the adaptor is moved to another grease gun.
- Use half-strokes as opposed to full strokes when using a manual level grease gun.
- When using a battery pack or pneumatic handheld grease gun use a timing method such as 1001, 1002, etc… while holding the trigger to simulate half-strokes of a grease gun.
- Make sure that drain plugs are accessible, open, and unobstructed.
- Know the type of bearing being lubricated.
    - A sealed bearing cannot be re-greased.
    - Shielded or double shielded bearings can be greased, but done slowly as to not over-pressurize the cavity and push the bearings seal against the cage.
- Use a grease gun with very little or no loss of movement of the pump handle.
- Periodically, clean and/or route the inside diameter of the pipe supplying the grease to the motor.

Note:
Dry grease build-up can clog and reduce the inside diameter of the supply line limiting the amount of grease supplied to motor.

- If grease or lubricant is seen exiting the bearing, schedule the bearings replacement.

When Using an Ultrasonic Instrument

- Use an ultrasonic instrument that has an indicator which indicates decibels or level of sound either as a numerical value or as a slide indicator.
- If applicable, find a mid-range setting with your instrument. This allows you to see movement or change of sound level while lubricating as well listening to change.

- When possible, use a dedicated lube adaptor or sensor designed to limit the loss of sound attenuation while lubricating the bearing.
- Allow for the minimum amount of time (15 seconds), for the bearing's internal sound and pressure to reduce or lower before proceeding with lubrication.
- Trend or record the decibel levels for future reference.

Over-Lubrication

Acoustic lubrication is a practice that I believe will reduce over-lubrication of a bearing. Recently, I was training a company how to apply the acoustic lubrication procedure. While greasing the bearing of an electric motor the technicians noted that after just three half-strokes of the grease gun the decibel level moved upward two-to-three decibels and did not return to a mid-range or lower level. Afterwards the technician noted that one of the other shift workers had actually greased the bearing just the day before. Take into consideration the sensitivity of the airborne ultrasound instrument and remember that every three decibels doubles the sound level.

> *To give you some perspective, a desktop PC is 48db and a library —where no one's allowed to talk — is 40db." So, if we double the power, we can use the fact that the logarithmic scale of 2 is 0.3, and this would be a gain of 0.3 bel or 3 dB. Remember, doubling the power is a 3 dB increase.*

Used as a Service Procedure

Do not use acoustic lubrication as a new motor greasing procedure. Only use this procedure as a re-greasing or servicing procedure. Another customer called me to discuss the acoustic lubrication as a new installation procedure to grease newly installed bearings. What he discovered was that the new bearing never emitted enough sound. When applying the grease using the acoustic lubrication procedure, he found that he would "blow or rupture" the seal of the bearing before a notable change or increase could be heard. Afterwards it was determined that several hours of "run-in" time was needed before an adequate amount of sound would aid in determining when to stop greasing.

When I see the grease coming out of the bearing

"When I can just see the grease coming out of the bearing." is the response I often get at trade shows when I ask an attendee how he/she knows when to stop greasing. Many technicians revert back to what they learned at a previous job or trade if they are not properly trained how to lubricate bearings. While training a group of men at a nuclear site on acoustic lubrication, I asked the room of 30 men, "Who has greased bearings on front-end loaders, tractors, or other heavy equipment?" Ninety percent of the room raised their hands in an affirmative manner. While providing practical training on-site many of those who raised their hand could not grasp the idea of half-strokes of the grease gun. Some tried putting their finger atop the motor to feel for a difference. At one major motor manufacturer, the senior lubricator/mechanic prefers to use his finger atop the motor to determine when to stop lubricating. Another motor manufacturer had numerous reports of motors being shipped without proper lubrication. I was asked to come and discuss acoustic lubrication. Having recently had a heart attack and having been a plumber at one-time in my life, I easily spotted their problem. Galvanized pipe was used to supply the grease from the grease drum to the line technician tasked with lubricating the motor. I

knew that most grease has paraffin within it and that paraffin over time may harden, very much like a kitchen sink drain pipe with grease build-up. I asked the engineer, “When was the last time they had removed and routed the supply line?” They replied, “Never.” Once the lines were opened, the internal diameter had been reduced by half. Therefore, when the technician became accustomed to using time as a factor as to how long he held the trigger on his pneumatic grease gun, he was responsible for not putting enough grease into the motor during motor build-up.

Stop unneeded repairs and downtime

Do you outsource your motor repairs? Have you ever received a call telling you that if you would only stop over-lubricating the bearings the motor would not need repaired? Don’t expect that call. As with illustration number 1a, this motor had the seal blown and the grease entered into the windings. As with illustration 1b, the end cap of the motor was also flooded with grease from a blown seal.

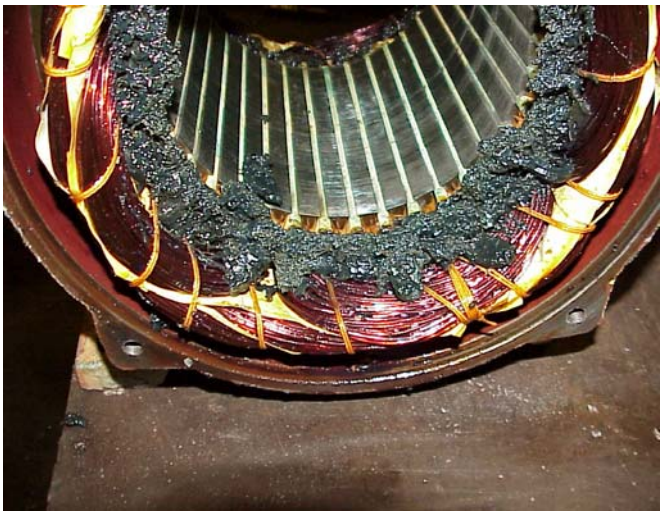

Illustration 1a.: Over-Lubrication

Illustration 1b.: Over-Lubrication

To sum it up

Acoustic lubrication is not a cure-all to end-all lubrication. It is, however, a methodology that can be learned and used to standardize within a plant a Best Practice. As with any new program, all personnel must be onboard, from management to the man or woman pumping the grease. It does take time to implement. Time is money and in today's world of cutbacks, reduction of force, and more for less, it may be hard to totally implement. I do believe, if implemented this practice will lessen downtime and reduce repairs.

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Jim has provided airborne ultrasound training for several Fortune 500 Companies in electrical generation, pulp & paper, petro-chemical and transportation (marine, automotive, aerospace). A 17 year civil service veteran, Jim served as an aerospace engineering technician for Naval Aviation Engineering Service Unit (NAESU).

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Illustration 2 a.: Before grease starting dB @ 49.6

Illustration 2 b.: After 5 half-strokes dB @ 45.6

Illustration 2 c.: After 2 half-strokes dB @ 31.7

Illustration 2 d.: After another 2 half-strokes dB started upward stopped greasing and rechecked decibels. Final dB was 19.2

Illustration 3 a.: Analog meter was set to "*50" (no picture) before greasing. After 5 half-strokes needle went to "39".
Note: This instrument is not in decibels, but a scale of 0-100 increments.

Illustration 3 b.: After 5 then 2 more Half-Strokes needle went to "22".
Note: Sensitivity Set @ 6.75 all throughout procedure. From 50 to 4 represents 46 decibels. Every 20 increments on this scale is 3 dB's.

Illustration 3 c.: After 2 more half-strokes needle started upwards and greasing was stopped. Needle settled at “4”.

Illustration 4 a.: Another ultrasound instrument that can be used for acoustic lubrication.