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Thursday, 30 September 2010 01:14

Want to insure against the failure of these critical systems? Protect them with the correct lube prescriptions and protocols.

Does your computerized maintenance management system (CMMS) currently classify your driver/driven motor gearbox combination units as two separate assets—*motor and gearbox?* Or does it view them as a single combined asset, or as a sub-component of a piece of proprietary equipment? Does your lubrication PM work instruction for both motor and gearbox spell out the lubricant type and amount required, or is the statement to "Lubricate as Necessary" the only guidance you have? In either scenario, if you're not treating your motors and gearboxes as separate entities, each requiring its own detailed lubrication regimen, you have already ventured down the slippery slope to premature failure.

Assuring motor and gearbox reliability calls for a two-pronged plan of attack:

1. Good alignment practice

and, more importantly,

2. Effective lubrication practice.

The driver/driven combination of a motor/gearbox is an assembly of two specific entities—*one electro-mechanical (an always-serialized motor); the other purely mechanical (an often-serialized gearbox)*
—that must be treated individually when assessing their lubrication needs. When treated with care and respect, these entities can be expected to outlive their driven components.

This short overview focuses on the major symptoms of poor lubrication practices and some straightforward maintenance strategies for making your lubrication program more effective in protecting the health and well-being of your hardworking motors and gearboxes.

SICK SITUATION: If your grease-gun tip looks like this, DON'T use it on a motor bearing (or any other bearing, for that matter). Always clean grease-gun tips with lint-free rags.
(Photo courtesy of EngTech Industries, Inc.)

Motor lubrication
In simple terms, motors are electro-mechanical devices that turn electrical energy into

mechanical energy. The motor magnets and windings are wound on to a shaft simply supported by two or more bearings at either end of the motor frame.

SICK SITUATION: This photo of a medium-sized motor shows a dirty grease nipple, traces of two different greases (a gold-colored grease and a red one) and a broken guard. *(Photo courtesy of EngTech Industries, Inc.)*

These bearings—*usually rolling-element types such as ball, roller or needle bearings*—are the only lubrication points on a motor. They are almost always grease-lubricated. Most fractional- and small-horsepower motors make no provision for bearing lubrication (no grease nipples provided). A unit like this is typically designed to utilize the original grease lubricant filled within its sealed bearing cavity to provide lubrication throughout its service life. With smaller motors, loads are usually light; the lubricant rarely needs replenishment if a unit is balanced and aligned correctly.

Depending on the motor design and manufacturer, external grease fittings usually start to appear on motors rated 20 hp and above—*and always are evident on motors 50 hp and above*. When motors become more powerful and heavier, more static and driven load is placed on the bearing points, thus requiring grease replenishment on a more frequent basis. If a motor is to

operate at peak efficiency, its bearing cavities (the available space between the balls, raceways, cage and seals) should only be filled to 30-50% of capacity with lubricant. Without the air space this affords, the grease would not be able to penetrate and work within the bearing contact surfaces. Instead, a condition known as "churning" (in which the fluid friction of the grease tries to retard the easy moving action of the bearing) would be set up. In order to overcome this internal resistance, a motor must draw more power and the resulting frictional heat breaks down the lubricant properties, significantly reducing its working life.

Motors "designed" to be greased will have a grease nipple located on top of the motor at each end. Located 180 degrees from the nipples is a capped drain plug that's designed to be unscrewed and allow excessive grease to channel through the bearing and out of the motor during lubrication. If this drain is kept capped during the greasing process, excessive lubricant will channel directly through the bearings past the seals and into the motor windings—*where it will eventually "cook" as the motor spins.*

Unfortunately, motors with grease points suffer a disproportionate amount of premature failures caused by over-lubrication, mixing of lubricants and contaminant inclusion. Over-lubrication, by far the biggest sin, results from the mistaken belief that if a little lubrication is good, "a lot of lubrication is a lot better!" Motors are designed with a specific grease lubricant in mind—*usually one with dielectric properties so as not to ground out the motor if the grease mistakenly enters the windings.*
Maintenance teams must exercise great diligence in ensuring the correct grease is always used and not mixed with another type, since not all greases are compatible. Mixing incompatible lubricants is a sure way to greatly reduce a bearing's (and a motor's) life. Diligence must also be exercised in performing the lubricating procedure to ensure no dirt is introduced inadvertently into the bearing cavity due to an unclean grease gun tip or grease nipple. To ensure that motors don't run hotter than they are designed to run, and windings are never used as grease reservoirs, heed the following tips:

Motor lubrication tips...

- Ensure all maintainers are fully trained in how to correctly lubricate a motor.
- Remove grease nipples from all fractional- and lower-horsepower motors (20 hp and less) and run to fail.
- Identify the correct grease to use on the PM work order and with a tag affixed to each motor.
- Identify the correct grease requirement on the PM work order by number of shots, after ensuring all grease guns in the plant have identical output per shot.
- Investigate the use of automated single-point lubricators for roof fans and remote

locations.

SICK SITUATION: Although this overfilled gearbox does have a maximum-level lubricant indicator, it does not have a minimum-level indicator. ***(Photo courtesy of EngTech Industries, Inc.)***

Gearbox lubrication

Gearboxes are, essentially, simple, self-contained mechanical devices that allow power to be transmitted from an input shaft to an output shaft at different speeds through the meshing of different-sized gear sets held on each shaft. The gears and shafts are supported on bearings contained within a sealed "box" that also serves as a reservoir for the lubricating oil. Gearbox dimensions can range from palm-size to room size and, with few exceptions, are oil-lubricated.

Depending on the style and size, gearboxes employ a number of methods to move the lubricant over the gears and bearings, the most popular being:

- ***Splash lubrication...***This is the most common gearbox lubrication method. It involves filling the reservoir part-way with lubricating oil to ensure partial coverage of all the lower mating gears. At speed, these gears use surface tension on their teeth to "pick up" lubricant and

transfer to other gears and bearings through meshing and by "flinging and splashing" the lubricant in all directions within the sealed reservoir.

- ***Pressure or force-fed lubrication...***This lubrication method is typically found on mid- to large-size gearbox assemblies. It employs a gear-driven pump, usually located inside the gearbox, to work in conjunction with the "splash" method. The pump picks up lubricant through a pick-up filter screen and pumps it at pressure through an internal piped delivery system to bearings and gears that would be difficult to service with traditional "splash" lubrication. A replaceable or washable filter and pressure-relief valve are employed within the system to further protect the gearbox wear surfaces from harmful particles.

- ***Mist or atomized lubrication...***This method of lubrication is usually reserved for the largest of gearboxes. It involves a vane pump that picks up lubricant from the reservoir and "flings" it at a plate, causing it to atomize into a fog. This fog then saturates all the mechanical components within the sealed gearbox.

In all cases, the lubricant provides surface-wear protection, corrosion protection of metal surfaces and cooling of gearbox internals. No wonder that the correct choice of lubricant is essential to its longevity. Typically, gearbox lubrication problems manifest themselves in two main ways:

- ***Reservoir sludge...***This malady often shows up after the mixing of incompatible lubricants, during oil changes or top-up procedures. It can cause additive packages to deplete faster than designed, resulting in a drastic viscosity change. Water introduced through a cleaning process or condensation within gearboxes subjected to varying heat cycles can mix with the detergents and soaps in the lubricant, creating a thick soap sludge. Oxidation of a lubricant that has been subjected to extended use, overheating or contamination can cause the lubricant to thicken into a damaging sludge that is difficult to pump around the gearbox.

- ***Hot gearbox...***This situation frequently results from excessive dirt on the outside of a gearbox, which then creates a thermal blanket that wants to "cook" the oil inside. Incorrect lubricant viscosity, caused by the mixing of lubricants or wrong lubricant choice, will cause excessive heat through fluid friction (too thick), or boundary metal-to-metal contact friction (too thin), both of which cause the oil to overheat and prematurely fail. Too little lubricant in the reservoir results in boundary-layer friction. Conversely, overfilling of the reservoir will create a churning and foaming of the lubricant

Both conditions will significantly reduce the life of the lubricant and, correspondingly, the service life of the gearbox. They both require more power to be drawn from a motor—*which wastes precious energy* .

To get the longest and most productive service life from your gearboxes, keep the following lubrication tips in mind:

HEALTHY SITUATION: This small-hp motor/gearbox combination unit has a sight gauge (to right) that clearly indicates high/low gearbox oil levels. ***(Photo courtesy EngTech Industries, Inc.)***

Gearbox lubrication tips...

- Ensure all maintainers are fully trained in how to correctly perform gearbox lubrication.
- Attach a label to the reservoir, clearly indicating the correct lubricant manufacturer, product name and viscosity to be used. Clearly indicate the same information on the PM work order—without exception!
- If the reservoir is regularly cleaned with water, ensure the fill cap and breathers (if applicable) are waterproof and in place at all times, or position a water deflection shield over the reservoir.
- Always ensure the correct lubricant is being used for the application's ambient temperatures. When changing lubricants, make sure the cap and breathers are always reinstalled, and that the lubricant is transferred using dedicated clean equipment.
- Use oil analysis to determine when the oil is starting to "break down" its additive package

and in need of change.

- Make gearbox cleanliness an essential part of your PM program.
- Consult the gearbox specification manual, or with a lubricant expert, to ensure your lubricant viscosity choice is correct.
- Make sure the gearbox reservoir incorporates a visible sight gauge that is clearly marked with the upper and lower reservoir limit lines—much like a dipstick.
- Consider the use of synthetic lubricants for your gearboxes. They will run cooler than mineral-based oils. (The use of synthetic lubricants in gearboxes has been shown to reduce energy consumption by as much as 4%.)

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EDITOR'S NOTE: Ray Thibault is on vacation. He'll return with a feature article in LMT's November/December issue.