Best-Practice Gearbox Lubrication

By **Angus Macdonald** - January 1, 2010

In this article Lubrication Engineers shares the results of its R&D efforts and their knowledge of how to improve gearbox reliability, resulting in significant savings and increased unit life.

Modern gears are performing heavier work and carrying greater loads than ever before. Gear manufacturers are redesigning, modernizing, and using finer steels to produce precision gears that will give better performance. Demands on global industry are often forcing users to raise production above rated machine capacity. This is done with the knowledge that gear life will be reduced, but that the increased cost will be offset by the increased production achieved. There is a demand from all industries for more power in smaller packages. Gears are used to transmit this power, and the same squeeze is on the gearbox—so how is it possible to increase the load capacity of gears?

Lubricant manufacturers have helped in addressing this need by developing better gear oils to help carry these increased loads safely. Lubrication Engineers, Inc., (LE) continues with extensive research and testing programs to develop higher-performance gear lubricants to stay ahead of the demands of industry. But it isn't just high-performance gear lubricants that can help industrial facilities to improve reliability and increase productivity. There are also important cost-effective reliability products on the market that can assist plants in reducing their operating and maintenance costs.

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Fig. 1: The SEW Eurodrive gearbox, with Des-Case breather mounted on top.

Gear Oil Selection

When selecting a gear oil for a particular application, there are ways that the risk of failure can be reduced. These are not necessarily gained through education or experience. The first requirement is thorough attention to detail.

It is easy to accept the machine manufacturers' recommendation word for word, but they can never anticipate all the conditions under which the gearbox may operate. The manufacturers' recommendation, therefore, must be a guideline and not necessarily the final word on the product to be used. Operating conditions must also be determined in order to make the best possible recommendation. Check for the following items:

• Location of machine: Is it out of the way or difficult to get to? Then it may not be lubricated as often as it should.
• Atmospheric conditions: What surrounds the machine in the way of heat, dust, moisture,

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chemical vapors, etc., that may affect lubrication?

- Housekeeping: Accumulations of dirt and other indications of poor maintenance.
- Overloading: Visible indications of operation above rated speeds.

Other important questions to ask involve the history of the machine. What previous difficulties have existed, and has the machine been overhauled? You also want to consider modifications: Has the machine been changed since being installed, and what affect do these modifications have? It's important to be familiar with the machine's current maintenance intervals, and what is done at such times; what lubricants have been and are currently being used, and whether the machine is performing properly; the machine's lubrication intervals, along with the manufacturer's recommendations; and the lubrication consumption rate, as well as any history of leakage. These questions will provide some direction relating to making specific lubricant recommendations.

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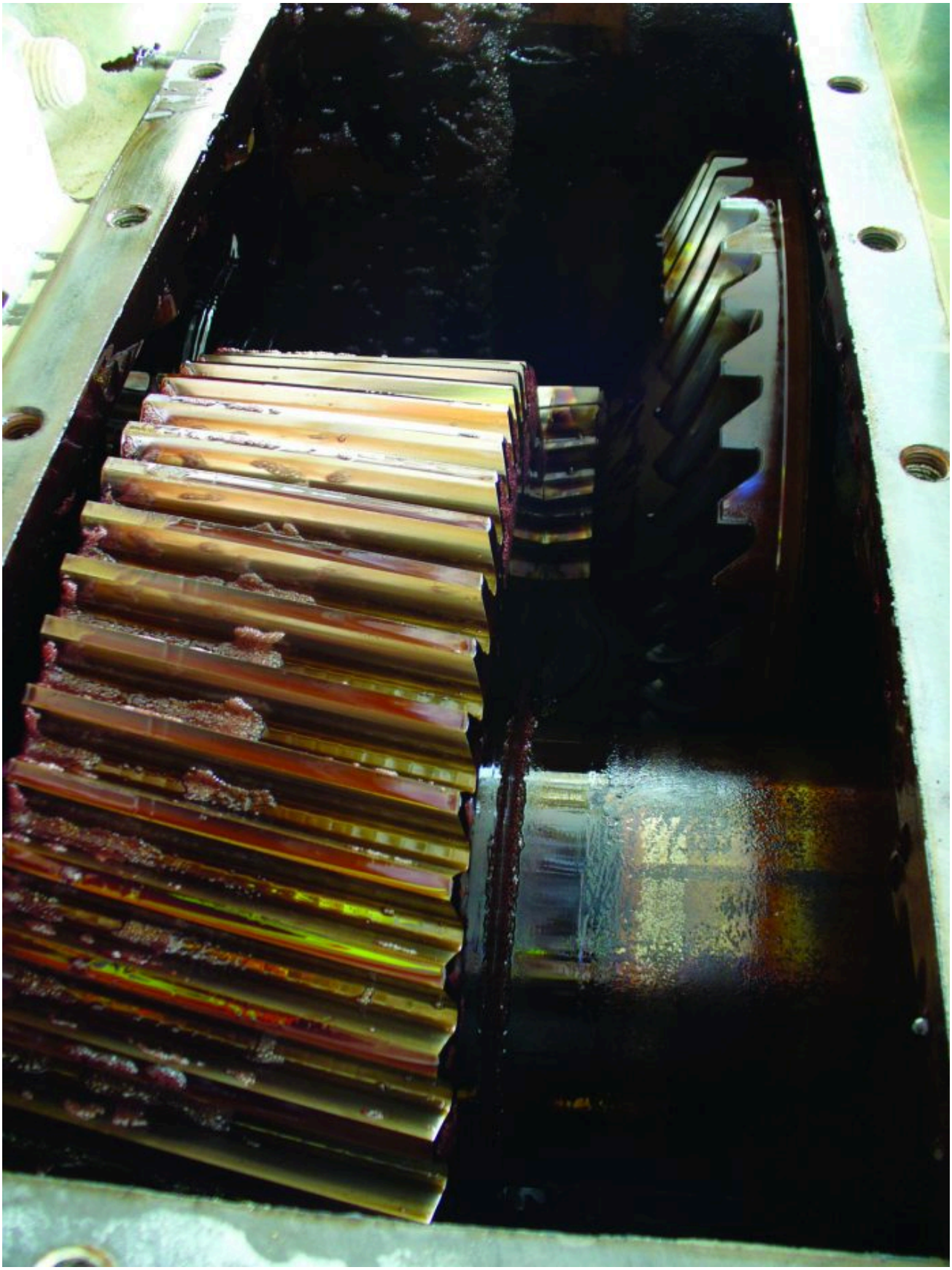

Fig. 2: Internal view of the SEW Eurodrive gearbox.

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Failure/Wear Analysis

During the first inspection of a set of gears that are properly installed and lubricated, the combined action of rolling and sliding will smooth the working surfaces of the teeth and give them a highly polished look. Under continued operation trouble may occur that will show up as a breakdown of the tooth surface. The type of failure will often indicate the reason and recommended remedy. Some examples of severe gearbox operating conditions include:

• Rapid fluctuations in operating temperatures, high speeds, and heavy loads.
• Any operating environment that causes condensation inside the gear case or oil reservoir, resulting in formation of sludge and causing the gear oil to foam.
• Operation in moist or dusty environments, or where chemical fumes are present. In such instances, set change intervals accordingly.

Gear oil changes as needed are critical during the first few weeks or months of operation of gear cases. Rather than setting arbitrary change intervals, manufacturers should regularly monitor by oil analysis the condition of the oil to determine stability of the lubricant. After checking for dirt, metals, water, acid number, and viscosity the operator can determine when the interior of the oil reservoir needs cleaning. The careful inspection and proper cleaning of all types of gear sets are also valuable in obtaining maximum service life with LE's DUOLEC™, ALMASOL®, MONOLEC®, and SYNOLEC® gear lubricants.

Prepping the Gearbox

In order to obtain the optimum performance from new gear lubricants, it is necessary to properly prepare the enclosed gear reservoir. First, drain oil presently in the box as completely as possible while the unit is still warm. This helps remove contaminants and oxidized oil that can impair the performance of the new gear lubricants. If contaminated oil remains in the gearbox, foaming can occur.

Second, do not use a volatile, chlorinated solvent or solvent-type flushing compound to wash out the gearbox. Any solvent trapped in the voids of the reservoir will cause corrosion. Also, the presence of even a very small amount of solvent-type flushing compound will reduce the viscosity of a gear oil. Further, without a coating of oil for even a short time, "flash rusting" of internal parts of the gearbox can take place.

Third, to properly flush the gearbox, use one of the new gear lubricants, or a light viscosity of R&O compressor/turbine oil, filling to one-third the recommended operating oil level.

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Circulate under no-load conditions for 15 minutes and drain.

Fig. 3: Maintenance manager taking temperature readings.

Fourth, if the used gear oil has oxidized badly with a dark color, burned smell, and is thick and slow to drain, use a light viscosity of R&O compressor/turbine oil. Fill to one-third the recommended operating volume and circulate under a no-load condition for 10 minutes, then drain completely and refill to one-third volume. Operate 15 minutes under a no-load condition and drain.

Fifth, remove any rust-preventative materials before charging with operating gear oil. Use the flush procedure explained in step three to remove rust preventatives, manufacturing debris, metal chips, and core sand.

Sixth, remove and clean gear oil filters if present in the system.

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Seventh, clean the vent plug and reinstall correctly. Ideally replace the vent plug with a dessicant breather, such as the range produced by Des-Case. This will help to prevent airborne and water contamination of the gearbox when it "breathes."

Eighth, when working with enclosed gearboxes or oiling systems that do not have a drain or circulating system, the used oil and flushing oil should be removed by suction. Use of pressure to force out or blow out this oil may damage seals. Some gearboxes have reinforcing ribs on the bottom. Be sure to allow for that when suctioning to remove the old lubricant.

Ninth, recharge the gearbox reservoir with the appropriate gear lubricant. Be careful not to overfill, because this can cause foaming.

Tenth, install an "oil sight glass" to the gearbox drain port at the bottom of the reservoir or with an elbow for drain ports located on the side of the gear equipment.

Any statement regarding the service life of gear oils should include information regarding operating, environmental, and mechanical conditions of the equipment. Even in the best of situations, gear and circulating oils will not last indefinitely. Therefore, from the standpoint of both service and economy, gear oil should be removed and replaced with fresh lubricant when the oil has deteriorated or has become contaminated. When severe operating conditions are present, change intervals may need to be shortened depending on oil analysis results.

Improving Gearbox Reliability

The number-one cause of failure in any mechanical application is due to contamination. Since every industrial plant has a sizeable investment in the equipment that is owned and an investment in the lubricant that is purchased to protect that equipment, it only makes sense to protect both investments from contamination. Lubrication Engineers supplies industry with a range of high-performance mineral and synthetic gear oils to more closely meet the requirements for various applications found in plants. The most popular gear lubricant contains DUOLEC, LE's proprietary dual acting wear-reducing and extreme pressure additive. Others contain ALMASOL, its exclusive solid wear-reducing additive. ALMASOL is an inert lubricating material which has an affinity for metal and a unique laminar-lattice construction that adds to the lubricating ability of the gear oil. Very often,

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LE's anti-wear additives contribute to reducing gearbox temperatures; essentially they improve oil-film strength and reduce friction, heat, and wear. Figure 1

LE's 1601-1609 DUOLEC vari-purpose gear lubricants contain the necessary load carrying and friction modifying characteristics required for today's wide range of differing gear trains, including certain worm or screw types. The 1600 DUOLEC series also provides many other benefits that this new gear additive technology is able to deliver, including an incredible FZG Test 14th Stage Pass, Timken OK Load of 75lbs, greater thermal stability, improved shear resistance, better water separation, and the ability to be filtered to low micron levels without harming or removing additives. LE's quality and durability in high-performance gear lubricants will mean greater plant productivity and, importantly, lower maintenance costs. Specialist gear lubricants provide extended equipment life, less downtime, and fewer repairs.

To protect the investment in these quality gear lubricants, Lubrication Engineers recommends that all industrial customers use a best-practices approach in "Reliability Centered Maintenance: Controlling Contamination." Reliability products currently in use by LE's customers include:

• Oil Safe lubricant transfer containers are critical to best-practice lubrication programs. Color-coded and fully sealing, these containers ensure the accurate delivery of clean lubricant from bulk storage to gearbox point of use every time. Proper labeling of all gearboxes then ensures that the correct lubricant is delivered in the correct quantities to the correct application in the plant. Expensive downtime is then avoided due to the incorrect application of gear lubricants.

• Des-Case breathers: Since humidity and moisture are also a contaminant this is a major problem for gearboxes. Oil within a gearbox is subject to fluid volume changes, as well as temperature and pressure variations during operation. These differential pressures cause air exchange through the breather/filter cap, allowing dirt and water to be drawn into the system. Installation of Des-Case breathers at these critical ingression points is a cost-effective means to prevent contaminants from entering the fluid reservoirs as differential pressures occur.

• Esco Oil sight glasses are reliability monitoring accessories designed for installation on any equipment with fluid lubricant systems to allow the customer to constantly visually monitor the color, clarity, and purity of the lubricant fluid. Plus they are an aid in eliminating any

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water contamination from the gear reservoir, as the water can be seen in the sight glass and drained off periodically.

Case Study: Lafarge Cement Plant

This plant—located in Calera, Alabama—has a SEW Eurodrive helical right angle separator gearbox on the top of a raw mill. It is driven by a 200hp electric motor and is constantly exposed to the elements, which are dusty, wet, cold, heat along with a lot of vibration. While using a synthetic hydrocarbon gear oil they were experiencing high operating temperatures of 82°C to 95°C (180°F to 205°F) depending on the ambient temperature and load on the gearbox. This particular gearbox was also suffering from foaming and seal leakage. Figure 2

The local LE lubrication consultant was able to recommend LE 1605 DUOLEC vari-purpose gear lubricant (ISO VG 220), which is an EP gear lubricant with excellent thermal stability. The customer partially drained the gearbox of the synthetic product, filled it with DUOLEC, and ran it for one month. They then fully drained the gearbox, installed a Des-Case Hydroguard disposable breather, and refilled with LE 1605 DUOLEC. After running production for two weeks they observed much lower gearbox temperatures of 76°C to 81°C (169°F to 178°F)—a maximum 14°C drop in temperature. The foaming and leakage issues had also been resolved due to the conversion to LE 1605 DUOLEC. "I am pleased and a bit surprised to see such a temperature drop," according to Derek McIntyre, maintenance inspector. Figure 3

Case Study: Hopewell Waste Water Treatment Plant

This plant, which is located in Virginia and runs 24/7, uses surface mixers with 14, 125hp lightning gearboxes. While using a commercial grade lubricant, the plant had to change the oil every six months. They were also experiencing foaming, degradation of additives, and the units were running hot. Maintenance Manager Bill Tiller wanted a gear lubricant that would last longer and help reduce overheating and wear. LE recommended LE 1605 DUOLEC vari-purpose gear lubricant (ISO VG 220) for this demanding application, and one of the gearboxes was converted for a comparative performance trial. The gearbox typically pulled 135amps, but after the conversion to LE 1605 DUOLEC it immediately dropped to 120amps. At six cents per kWh, Tiller estimated a $4,000 savings per year on each gearbox. This contributes to $56,000 in annual savings in electricity costs. In addition, the units stopped foaming and are now running cooler. The oil change interval is approaching three years, as

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opposed to the original six months. "We've seen significant savings using LE products," Tiller says, "along with oil sampling and filtration practices."

Conclusion

Lubrication Engineers provides consultative support for our valued customers worldwide via a global team in more than 60 countries. Industrial clients are enjoying increasing profits due to the reduced maintenance and operating costs relating to their gearboxes and many other applications. High performance lubricants alone cannot provide these savings; it is vital to prevent the contamination of gearboxes in plants in order to remove any possibility of expensive downtime. Reliable gearboxes result in increased profits.

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