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Synthetic or Conventional Oils

How to Choose p.15

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Choosing Between Synthetic Lubricants and Conventional Oils

Synthetic lubricants continue to gain market share, thanks to higher performance properties that, for many uses, trump higher per-drum costs. Demand in the United States has grown to $2.2 billion per year, and is a resulting benefit of stricter environmental and worker safety requirements.

Virtually all customers revisit the debate of "mineral oil vs. synthetic lubricants" on a regular basis. In certain situations, it is part of an overall demand planning exercise; other times, it's simply to assure the facility is receiving the best life cycle value. Acculube encourages this process, and assists customers in completing the math based on their specific situation, therefore finding the best program to fit their needs. Processes and products change, and the price volatility of crude at the producer level substantially impacts the equation; therefore a fresh look, at least annually, is worth the effort.

Mineral Oils

Many factors differentiate mineral oils from synthetic lubricants including what they can accomplish, their requirements for efficient functionality, and composition.

Naturally occurring crude is a cocktail of hydrocarbons. Even after aggressive solvent-based refining, thousands of hydrocarbon compounds - as well as organic compounds of oxygen, sulfur and nitrogen - remain. These three compounds in particular are problematic because they enable oxidation and acid development, as well as facilitate the formation of sludge, particularly in high-temperature applications.

The varying molecules of refined lubricants also have differing shapes, resulting in irregular lubricant surfaces at the molecular level. These irregularities generate friction within the fluid itself which increases power requirements and reduces efficiency.

Synthetics

In contrast, synthetic lubricants are engineered products created by chemical reactions through the precise application of pressure and temperature to a specific recipe of components. All of the components are high in purity with strong molecular bonds. As a result, the end product is a pure compound, less vulnerable to oxidation, highly resistant to breakdown, and uniform in molecular size. This molecular size uniformity keeps synthetics from jellifying when it's cold (they do not contain waxes), and its specific molecular structure keeps it from thinning-out under heat; therefore, the lubricant's protective characteristics are more predictable. The saturated molecules created from the synthetic process are also nonhydrophilic and won't emulsify or produce undesirable by-products in high-humidity environments.

Traction Coefficient

Molecular size is also key to one of the synthetic lubricants' operational virtues - its traction coefficient or internal fluid friction (resistance). Traction coefficient is the shearing or tangential force required to move a load, divided by the load. The coefficient number expresses the ease with which the lubricant film is sheared.

Compared to mineral oil molecules, synthetic lubricants, for example, have up to a 30 percent advantage over mineral oils for traction coefficient. This means the force needed to move a load is less, which means less horsepower to do the work.

In a gear reducer, the lubricant in the tooth mesh is sheared, and the lower the traction coefficient, the lower the energy dissipated due to lubricant shearing. The difference is realized by low amperage draw on the motor and reduced lubricant /gear temperature.

Changing to a low-traction synthetic will reduce power consumption in a spur/helical gear by 0.5 percent for each reduction, and up to 8 percent for high-reduction worm gears.

Gear Wear

The issue of gear wear is also a consideration. A study cited in *Machinery Lubrication* magazine[1] implied synthetic lubricants make gears more efficient than mineral oils. A polyglycol showed the highest efficiency (18 percent more than the high-performing mineral oil). Synthetic hydrocarbon (SHC) gear oil also increased the efficiency of the best gears by eight to nine percent. The performance of synthetic lubricants in food-grade applications in accordance with USDA-H1 food contact is also a benefit. Food-grade synthetics are sometimes believed to be inferior in performance to mineral oil lubes, a belief the study dispels.

Service Life

A popular topic concerning the difference between mineral oils and synthetic lubricants is service life. Synthetic lubricants as a class don't show their age, particularly at high temperatures, and have a longer service life. Often, the change interval is several times longer for synthetics at identical operating temperatures; however, the exact number depends on operating conditions, the additives and the specific synthetic used.

Synthetic lubricants have a lower friction coefficient in a gearbox, better film strength and a better relationship between viscosity and temperature (viscosity index, VI). This indicates synthetic lubricants can be used at lower viscosity grades and lower temperatures. When this is the case, the gap between the service lives of minerals and synthetics significantly increases.

Related to the oil change interval is the issue of product loss through evaporation and disposal. Both sludge and residue form more readily with mineral oil products. Evaporative losses are lower for synthetics due to the lack of lighter hydrocarbon structures. Disposal is more costly with some synthetics, but it is nowhere near enough to compensate for change-out intervals that are three to five times more frequent.

Safety

In regard to safety and insurance risks, the flash point for synthetics as a class is always higher, and reduced flammability is a key driver for synthetics' growing popularity in high-temperature applications.

Disadvantages

Synthetics, like most other lubricants, can have disadvantages. Material compatibility issues can occur with certain seals, metals, paints, coatings and plastics. Many ester-type synthetics do not perform well in the presence of water and can decompose or break down (hydrolysis). They also can cost more on a per-drum basis, though not necessarily on a life-cycle basis.

Summary

Synthetics are clearly superior in the extreme zone where temperatures, high loads or flammability are overriding factors. They also perform well in applications where needs are specific and complex. Synthetics are engineered to meet targeted performance benchmarks, and a synthetic formula can be (and probably has been) engineered for almost every combination of properties used in industry. **ML**

Reference

1. Lauer. "Synthetic Gear Oil Selection." *Machinery Lubrication* magazine, May-June 2001.

DENNIS A. LAUER, P.E.

After attending the United States Air Force Academy, Dennis Lauer received his Bachelor of Science in Engineering degree from Penn State University. He also received his Master's in Business Administration from the same university. Mr. Lauer was the Director of Technical Marketing for Hilti Incorporated in the United States. Hilti is a construction tool and fastener manufacturer with headquarters in Liechtenstein. After that position, he became the Head of Engineering for Lubrication Engineers, an independent industrial lubricant manufacturer located in Fort Worth, Texas. Currently, Mr. Lauer is the Vice President of Engineering for Kluber Lubrication North America L.P. Mr. Lauer is a Registered Professional Engineer in the states of Pennsylvania, Oklahoma, Texas and Missouri and is the author of many articles for trade journals and co-author of several books on lubrication technology. He is a member of the NSPE, STLE, ASTM, AGMA and AIST.

Improving Energy Efficiency with Proper Gear Oils

By Mark Crombie, Manager of Application Engineering—Klüber Lubrication North America LP, Londonderry, NH

Many factors come into play when selecting gear oils, including the projected life of a gearbox, its seals and the desired performance of the gearbox within an application.

Typically, end users rely on their OEMs to determine the best gear oil, so it is important for OEMs to value gear oil as a machine element much in the same way that they value hardness of the gears, bearing selection, materials and geometry. Like all of these other physical components of a gearbox, the right gear oil will allow the gearbox to achieve optimum performance. As a result, end users will enjoy the benefits of lower wear rates, lower operating temperatures and, best of all, greater energy efficiency.

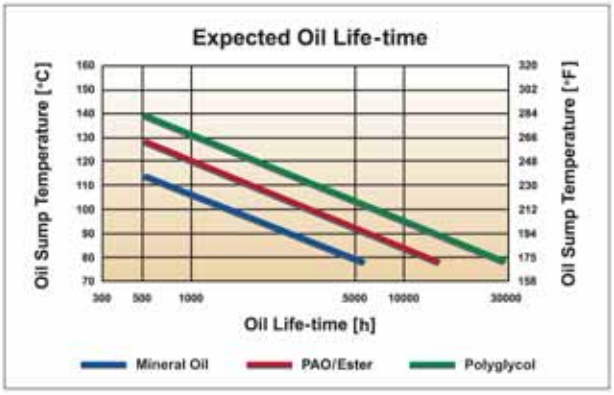
Synthetics are Best

Whether a gearbox is designed for use in a food manufacturing environment or in an industrial machine, the lubricant selected for use in the gearbox must be chosen for optimum performance under a specific set of operating conditions.

Most OEMs find that for ease of distribution, it is beneficial to use an H1 product because H1 synthetic gear oils are high-performance gear oils with the added benefit of being food-grade. Thus, they can be employed in both food and industrial environments. It is important to note that standards for food-grade gear oils are just as high as for other gear oils, and the synthetics perform better than standard mineral oils.

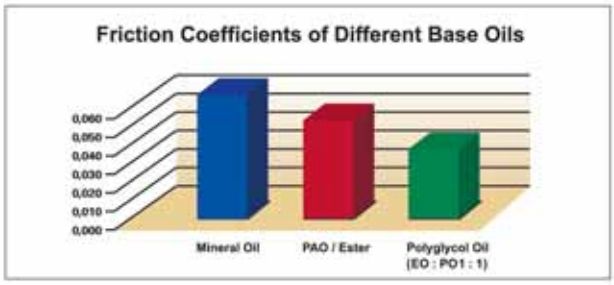
With regard to energy efficiency, some gear oils are more energy efficient than others due to their lower coefficient of friction. Polyglycols, for example, absolutely shine as the most efficient and lowest wear type of oils, particularly in high-sliding applications such as worm and hypoid gears. In these applications, PAGs offer a lower coefficient of friction within the gearbox, resulting in less power loss.

Synthetic oils are more energy efficient because they have better oxidation and thermal stability, which means the gear oil lasts much longer. One could expect to change a mineral oil every 5,000 hours, whereas PAOs or synthetic hydrocarbon oils can last approximately 15,000 hours before a change-out. In addition, PAGs can last as long as 25,000 hours at the same temperature.



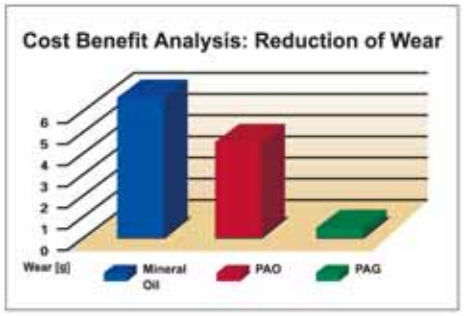
As you can see, how often a manufacturer is required to change gear oil depends on the chemistry of the lubricant being used. The slope of the lines in the previous graph represents what is known as the 10K rule. The 10K rule dictates that for every 10 degrees you increase the temperature of the lubricant, you halve its performance life.

Also, remember that oxidation causes degradation of oil over time. The Total Acid Number changes, and the additives are being used up. While changing the gear oil replenishes these additives and removes wear materials, it also adds maintenance downtime to the equation. Choosing a high-performance gear oil from the start will automatically reduce the amount of oxidation within the oil and decrease the required number of oil changes and downtime for equipment maintenance.



For OEMs, gear oil affects several design considerations, including the reliability of their final product. How much a manufacturer will increase the energy efficiency of a gearbox by using high-quality gear oil depends on the gear type.

The biggest increase can be realized in gear types that are challenged in normally lower efficiencies such as worm drives. Our worm gear test rig runs at approximately 60 percent efficiency with a mineral oil. With a PAO, efficiency goes up to 70 percent and with a PAG it rises to 78 percent. With the efficiency increases, the temperature of the gear box drops. This decrease in temperature increases the life of the gear system. This may not sound like a big deal if you have one or two gearboxes in your plant, but if you have hundreds of gearboxes, then that energy usage really adds up.



In summary, most OEMs and end users find that the extra cost of high-quality gear oil is worth the investment and that synthetic oils are proven to be the best. By choosing high-quality synthetic gear oil, end users will save energy and reduce operating costs through reduced maintenance, longer oil change intervals and less wear.