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## Alternatives to conventional gearbox oil have benefits

By Mario DiBartolomeo and Andrei Gongescu

*Synthetic and semi-synthetic gearbox oils offer a number of advantages, making them useful in a variety of typical and extreme operating conditions. In many cases, a properly formulated additive package can be the key to success.*

More and more, manufacturing plants are expected to run production lines for a longer period of time, resulting in greater demands being placed on gearbox performance.

Gearbox failure or inefficiencies due to increased friction and wear, as a result of inadequate lubrication, can lead to costly equipment and manufacturing downtime. Therefore it is important to choose a gearbox oil that will help maintain a high level of gearbox efficiency and longevity in manufacturing processes.

The proper selection of lubrication can add thousands of hours of extra life to a gearbox — while optimizing power consumption, improving output efficiency, lowering heat and noise, decreasing downtime, improving the gearbox's ability to withstand shock loads, and other tangible cost benefits.

The use of a conventional gearbox oil (an oil which is not exposed to the same refining process as a premium oil) combined with a simple, inexpensive version of additives for extreme pressure (EP) and/or anti-rust and oxidation (R&O) will provide adequate lubricity but for a very short period of time before breaking down.

As a result, the use of such oils can become very expensive in the long run; the sludge and wax build-up (paraffin crude) of these less-refined base oils will mean constant oil changes, increased machine downtime, increased noise levels, reduction in gearbox life, and possible expensive maintenance repairs due to unexpected extreme loads, high temperatures and contaminant conditions.

## Synthetic oils

Synthetic gearbox oils (base stock oils made in a laboratory from simpler, short-chained molecules) such as polyalphaolefins, polyol esters and polyglycols, provide a more interesting option for effective gearbox lubrication. The viscosity index (VI), or the ability to hold the viscosity over a wide temperature range, is higher for synthetic oils versus conventional which makes them particularly well-suited for applications where high and low temperature conditions are encountered. As well, the flash points for synthetic oils are higher and the pour points are lower resulting in improved usability for a broader range of applications and increased overall performance.

Care must be taken when using synthetic gearbox oils, however. Not all synthetic-based oils are compatible with all metal and sealing materials; for example, polyglycols used in aluminum or aluminum alloys under dynamic load may accelerate wear, and phosphorous esters may either break down some elastomers and/or react with paint. In addition, when a contaminant such as water is introduced to certain synthetic oils, a hydrolysis reaction may occur. To prevent this, customized additives are available to provide greater stability.

## Semi-synthetic oils

Semi-synthetic gear oils, which combine compatible synthetic and mineral base oils in a blended product, offer an interesting alternative for effective gearbox lubrication.

Many studies that compare synthetic base oils to conventional often overlook the advantages of semi-synthetics which, when carefully refined and blended with enhanced additive packages, offer a degree of performance that will rival synthetic oils, and without some of the downsides including the higher costs and the potential risks of chemical incompatibility and toxicity. As well, the refining process for semi-synthetics eliminates the vast majority of impurities, waxes and inconsistencies that usually limit conventional oils in many types of applications.

Among the most common additives used in gearbox oils are anti-wear and extreme pressure (EP) additives which reduce wear and severe surface damage. They can be a combination of organic compounds such as molybdenum disulphide ($MOS_2$) and/or phosphates. The chemical reaction resulting between these additives and the metal surfaces in a gearbox forms a protective lubricant film between the gear teeth, preventing metal-to-metal contact and protecting the gearbox against conditions of extreme load and pressure. This allows a gearbox to run for

extended periods of time under normal conditions without the worry of downtime and helps to extend overall gearbox life.

Other common additives include oxidation inhibitors (such as zinc compounds and phenols) which help to prevent a gear oil from oxidizing in the presence of heat and air, and boundary additives (polar materials such as fatty oils, acids and esters) which help to reduce the coefficient of friction and to protect gearboxes against wear. Other examples include corrosion and rust inhibitors (metal phenolates, zinc dithiophoshates), detergents (calcium and magnesium, solfonates), dispersants (alkysuccinimides), viscosity index improvers (polymers and copolymers of olefins, dienes), antifoaming compounds, and metal deactivators.

Carefully formulated additive packages, when combined with a semi-synthetic base oil, can offer the same performance and operating characteristics as a fully synthetic oil, without the compatibility concerns for gearbox sealing materials and metal components. A properly formulated additive package will typically:

Increase the Viscosity Index (140-150 for semi-synthetics versus 80-90 for refined mineral oils)

* Raise Flash Points (250ºC and above)
* Lower Pour Points (-40ºC and less)
* Increase load-carrying capabilities (up to and above 400 kg Load Wear Index, 4-Ball Wear test)
* Increase the shear strength of the lubricant film (12 stages passed under the FZG test)
* Improve water separation (80-90 ml Free Water, Wheeling Steel Demulsibility test)
* Offer multi-grade properties (one viscosity grade of oil can be used over a wide viscosity range)
* Increase anti-wear protection against extreme pressure and vibration
* Improve the tenacity of the lubricant film for increased metal-to-metal separation
* Lower the coefficient of friction

The operating benefits of additive packages, especially when combined with semi-synthetic gearbox oils, can also have dramatic effects on performance, efficiency, and longevity. Although results vary depending on application conditions, typical benefits include:

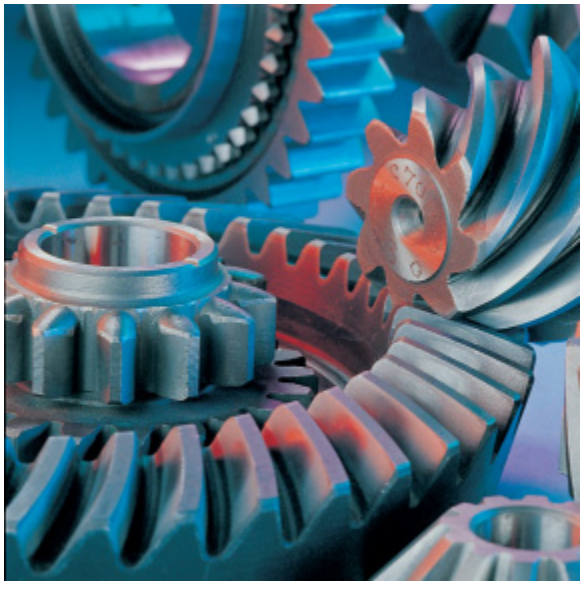
* Reduce (or eliminate) hydrolysis and corrosion.
* Increased oil longevity – oil change intervals can be increased by a factor of up to five times and 25,000 working hours
* Increased power output

* Lower energy consumption – up to 30% less in some applications
* Less component wear
* Less downtime
* Increased protection against unpredictable and extreme conditions such as high shock loads, pressures and spikes in temperature
* Improved protection against rust, corrosion and contamination
* Increased gearbox life and longer production run times leading to overall plant efficiency

Achieving the correct balance of additives can be a tricky task, especially when attempted in non-controlled situations. There are some potential risks including excessive doses and possible chemical interactions that can occur between additives or even the base oils. These risks can have serious detrimental effects on the performance of an oil and on a gearbox application. Reputable manufacturers will take these risks into account through vigorous testing and controlled manufacturing processes to ensure that the correct balance is achieved. By carefully selecting and matching a pre-blended gear oil that is suitable for the conditions of your particular application, it is usually unnecessary (and undesirable) to add oil supplements after the point of purchase from the original manufacturer.

Lubricant manufacturing is a chemical engineering process that is an art and science unto itself. As is the case with many products, you usually get what you pay for. Before dismissing a higher-cost alternative, investigate the content and quality of the product ingredients and the manufacturing process. Also, consider putting it to a test in your own operating conditions. You may be surprised at the performance differences you experience.

In the end, you must decide what you are hoping to achieve with the selection of a gearbox lubricant and trade-off the various factors including cost, base oil qualities and additive packages. In this day of smart competition, taking the time to make the right lubricant decision will pay off in the long run.



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