

# Keeping the cogs turning

Ever wondered what the difference is between oils and greases, what they do and how their selection affects machine performance? *MM* goes back to basics

*The lubricants available today are far superior to those used 20 to 30 years ago, thanks to research and development*

Out of sight can often mean out of mind. However, lubricants play a crucial role in virtually every machine that features moving parts. Their proper selection and application can extend service intervals, prevent breakdowns and unnecessary component wear, and improve energy transmission, which, in the long run, saves companies money by reducing their operating and maintenance costs.

Taking the time to understand the role of these products and how best to choose, store and apply them is therefore extremely worthwhile. Lubricants may only represent a fraction of your operating costs, but they can affect nearly 100% of your fleet's availability if they fail.

**"The slower the speed and the heavier the load, then the thicker and more tenacious the lubricant required"**

## WHAT ARE OILS AND GREASES?

Oils are mineral- (petroleum) and/or synthetic-based fluids that provide protection by forming a lubricating film between moving parts.

Greases are semi-fluid or solid lubricants made of a combination of base oil, additives and thickener (usually soap) – the thickener keeps the grease in place and retains the oil under non-stressed conditions (when the machine or component is not in operation) and releases the oil when stressed to provide a film of lubricant.

Grease is used in applications where a fluid lubricant cannot be effectively retained and provides an additional layer of protection against ingress of environmental contaminants. As a general rule of thumb, the slower the speed and the heavier the load, then the thicker and more tenacious the lubricant required.



Umut Urkun, industrial marketing advisor for Europe, Africa, MiddleEast at ExxonMobil, explains: "A grease can be thought of as a sponge soaked with lubricating oil. Upon application of external stresses, the thickener (sponge) releases the oil to lubricate the mechanical parts; when the stress is removed, the thickener re-absorbs a portion of the released oil for later use."

Typically, greases are applied to mechanisms where lubrication is infrequent or difficult, or where a lubricating oil cannot stay in position. Not only do they reduce friction and prevent wear and tear, but the right grease can protect against corrosion and acts as a seal to keep out dust, dirt and atmospheric contaminants.

Fluid lubricants are generally used in enclosed power applications, such as engines, hydraulic systems, and gear boxes, while greases are for more exposed applications, such as wheel bearings, bucket pins and swivel pins on excavation equipment, and wire ropes on draglines and shovels.

Some typical grease applications in mining include the lubrication of plain bearings (pins and bushings), roller bearings in mobile excavators and loaders (e.g. face shovels, backhoes and wheeled loaders) and open gears in large mobile excavators (e.g. electric rope shovels and draglines).

In most applications, oil is the preferred way to lubricate a component. However, greases are applied rather than fluids when a lubricant is required to

maintain its original position in a mechanism. This is especially the case where opportunities for frequent re-lubrication may be limited or uneconomical. This may be due to the physical configuration of the mechanism, type of motion, type of sealing or the need for the lubricant to perform a sealing function in the prevention of lubricant loss or entrance of contaminants.

Due to their solid nature, greases do not perform the cooling and cleaning function associated with the use of oils. Aside from this, they provide all other functions of a fluid lubricant.

## PRODUCT SELECTION

If you want to get the most out of your equipment – including minimising maintenance and maximising efficiency and longevity – it is important to use lubricants designed specifically for that machinery. This can be supported by oil-condition monitoring services from lubricant manufacturers, independent laboratories and some fleet-management companies.

"This type of platform enables proactive and predictive maintenance, helping to reduce breakdowns and provide peace of mind even when extending oil-drain intervals. It consequently contributes to cost savings," says Sendy Soeriaatmadja, global mining-sector manager for fuels and lubricants at Shell.

Mining typically involves more extreme operating conditions than most commercial and construction applications and requires high-performance lubricants specifically designed to withstand these conditions.

High throughputs and heavy loads running nearly continuously, high levels of contaminants, and high pressures and shock loads demand lubricants that can keep up, and not slow down operations. Lubricants need to extend drain intervals, reduce friction and energy consumption, and keep equipment up and running for as long as possible.

Tony Negri, director of marketing, commercial lubricants, at Phillips 66 Lubricants, explains: "What often separates mining from other heavy-duty off-road applications are the extreme loads and frequently high temperatures encountered. Specialty products for ▶

## Grease vs oil

- **Grease:** A lubricant that is composed of an oil or oils thickened with a soap, soaps or other thickener to a semi-solid or solid consistency. Generally used in applications where the product has to stay in place and not leak out – such as anti-friction conveyor belt bearings, chassis lubrication, gear couplings or electric motors.
- **Oil:** A liquid lubricant – either mineral- or synthetic-based – that contains additives to enhance its performance. There are various types used in the mining industry including gear oils, transmission fluids, engine oils, hydraulic oils and air-compressor/pump oils.

**Lubrication Engineers' Pyroshield lubricant was developed to meet the needs of large, open gears** ▶ mining and other vocational applications sometimes require higher viscosities than would normally be used.

"Additionally, there are specialty applications designed by the OEMs such as the CAT FD-1 specification, which applies to only a very small sub-set of equipment. This application requires a specialty product to protect gears and bearings in axles, heavily loaded final drives and differentials."

Mining products are often designed to perform better in humid or dusty conditions than those for other industrial applications. "These products should have better rust and oxidation additives, increased protection against heavy loads and the ability to resist the effects of water," says Jim Carroll, vice-president of technical services at Schaeffer Oil.

Extreme temperatures are also an issue. For instance, mine operators in remote areas of Russia may require a product to perform at temperatures below -40°C without solidifying or freezing, and those in the Australian desert will require products capable of performing at +45°C without melting or thinning. This is where the real science of lubricants comes into play, with the use of synthetic components and additives.

So where to start? John Sander, vice-president of technology at Lubrication Engineers, explains: "The first thing to consider is which specific point on the machine needs lubrication – is it hydraulic, a gear, a bearing, etc?"

Next, the equipment manufacturer's recommendations; there are certain pieces of mining equipment that have very specific requirements for lubricant selection – for example, CAT TO-4 fluids, which are used in the axles and wet brakes of large haul trucks. These need to prevent wear but cannot be too slippery or they could affect wet-brake performance. Then, one must consider the normal LETS (load, environment, temperature and speed) of the application.

Filling oil drums at Fuchs



**"Selecting a poor lubricant can also result in expensive, unscheduled downtime"**

"A problem with selecting a product that is not aligned with the equipment manufacturer's recommendation is the potential to void manufacturer warranties. Selecting a poor lubricant can also result in expensive, unscheduled downtime. Even worse, with the size of mining equipment and the safety concerns associated, improper lubrication could even result in life-or-death situations."

The best and first option for selecting lubricants is to refer to the operating or maintenance manual for the equipment in question. These recommendations are from the manufacturer based on the internal componentry and load factors. In addition to viscosity, performance specifications will also be recommended.

"Major oil companies will list on the technical data sheet all the industry specifications a particular lubricant meets. This data should be used when selecting a lubricant or grease to verify that it meets the OEM requirements," says Negri. "These are normally industry standards that lubricants can be tested against. The incorrect selection can lead to problems including sluggish performance, premature lubricant degradation or, in extreme cases, component failure."

In addition to the above, it is important to consider which lubricant is currently being used in the piece of equipment, as compatibility can affect the choice of new lubricant, and also how the lubricant is applied; manual or automatic lube systems can dictate the type of lubricant that must be used.

Matthew Reiner, technical advisor at Lubrication Engineers of Canada, provides some examples of product selection. "When selecting a lubricant for open-gear applications, several qualities are important. The lubricant must have excellent extreme-pressure (EP) and anti-wear properties in order to protect against the extreme temperatures generated along the pitch line," he says.

"Resistance to 'throw-off' and good adhesive properties, i.e. film strength, are also very important in protecting the gear at contact points. A free-flowing lubricant is beneficial to maintenance personnel, as it will not harden in the shroud and will allow for effective in-service monitoring and inspection. The inclusion of a solid-film lubricant is also crucial in adding a further layer of protection for the gear surfaces. Finally, a lubricant that is environmentally friendly and readily disposable is vital to protect people who encounter the lubricant on a regular basis."



A poorly selected open-gear lubricant would probably result in greater than optimal lubricant consumption, excessive pitting on the gear surface, and increased friction and pinion temperatures, resulting in greater electrical consumption and the need to dispose of hazardous waste lubricant.

When selecting a lubricant for hoist ropes, a high film strength and base-oil viscosity will protect against heavy loads and shock loading, and will also reduce wear by minimising friction as the wires come in contact with one another. In addition, a very tacky lubricant will cling to the surface of the rope and will require less lubricant to be applied. A translucent lubricant that does not build up on itself will allow for quick and convenient inspection of the integrity of the rope.

A poorly selected hoist-rope lubricant would probably result in significant build-up on the rope surface, premature rope failure, greater than optimal lubricant consumption and the inability to inspect the rope in service without having to remove the existing lubricant.

### SYNTHETIC VS MINERAL OILS

While the primary function of a lubricant is to protect equipment, technological advancements now mean that companies can select 'synthetic' (man-made) oil-based lubricants that also provide other benefits such as improved fuel economy, longer life, fire resistance and high/low-temperature and oxidation resistance.



Synthetic-based lubricants can offer improved performance over their mineral oil-based counterparts in specific applications; they tend to have a wider operating range, offer extended oil

### Synthetics: a word of caution

Many manufacturers and users describe lubricants using the term 'synthetic' as though they are a generic type of product. However, what they are referring to is a description of the lubricant's base fluid or oil.

There is a prevailing misconception that just because a lubricant is formulated using synthetic base fluids, it will perform better.

The reality is that there are various

chemistry types that are used to formulate synthetic lubricants.

Each type has properties that make it the best for certain applications, but not necessarily all applications.

Therefore, depending on the application, the use of the wrong synthetic lubricant could be more harmful to the equipment than selecting the appropriate mineral oil-based lubricant.

change intervals and lower bulk oil operating temperatures compared with mineral-based products of the same viscosity.

Paul Littley, executive manager of R&D at Fuchs Lubricants, explains: "Synthetic lubricants also offer improved oxidation resistance at higher temperatures and improved flow characteristics at low temperatures, and can shed heat build-up better than petroleum products, which can help to protect components from overheating. Due to their molecular structure, synthetics can also provide an improved coefficient of friction, meaning less force is required to move a load, and therefore less energy is consumed."

Synthetic lubricants are typically more expensive than mineral-oil products on a cost-per-litre basis, but they can provide an overall saving when looking at the lifetime use of the product and improvement in efficiency, so it is important to evaluate all options carefully and on a long-term basis.

Mineral-oil-based products may have a slightly more limited operating temperature range, but for many mining applications, formulations combining the proper additives with a highly refined mineral-oil base can result in a lubricant with sufficient performance and a lower price.

The major advantage of all synthetic base oils is their chemical uniformity, as ►

**"Synthetic lubricants can offer improved performance over their mineral oil-based counterparts in specific applications"**

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► they are synthesised under controlled conditions in a factory rather than produced through extraction or refinement. In contrast, mineral base oils are complex mixtures of naturally occurring hydrocarbons and some may contain impurities.

Soeriaatmadja of Shell says: "With some mineral oils, the lighter, volatile elements can evaporate from hot surfaces, leaving deposits in vulnerable areas such as piston-ring zones and leaving the oil too thick to flow to where it is needed. In comparison, synthetic lubricants are made from base oils which contain compounds that do not originate from crude oil, but are man-made. Additives are then mixed with the synthetic base oil to improve its performance. Achieving the right blend is what sets a quality lubricant apart from its competitors."

## ADDITIVES

Additives are chemicals used to enhance the existing properties of the lubricant contributed by the base oils, suppress undesirable properties of the base fluid or impart new properties to the base fluid, and prevent degradation



*Mining equipment, with its often continuous, heavy-duty operation, puts great stress on lubricants*

*Photo: Fuchs*

of the lubricant under certain conditions.

Additives can make up anywhere from 0.1% to 35% of a lubricant formulation. Additives that can be used to enhance lubricant performance include: anti-oxidants, rust and corrosion inhibitors, antifoam agents and demulsifiers.

The use of pour-point depressants and shear stable viscosity improvers can suppress the undesirable effects

associated with low temperatures, while EP additives, anti-wear additives, frictional modifiers, detergents and dispersants, metal deactivators and 'tackiness' agents can impart new properties to the oil or grease.

Most lubricant companies have their own proprietary additives that provide extra enhancements to their own products.

## SUPPLY CONTRACTS

Many mining companies choose to have ongoing supply contracts with a lubricant provider/providers to ensure a constant and reliable supply of products for their machines. The nature and duration of these contracts will obviously vary depending on the size of the mining company and its operations, as well as the number of machines onsite, location, operating conditions and frequency of maintenance.

Typically, contracts are either renewed on a yearly basis or every 3-5 years. However, if you do choose to establish a supply agreement with a manufacturer, then it is important to review the performance of the lubricants and your machines frequently to ensure the best fit for constantly changing operating requirements.

John Hayes, lubrication consultant at Lubrication Engineers in Pennsylvania, US, cautions: "Supply contracts can become a convenient method to avoid proactive operations and maintenance decisions. We routinely witness adherence to purchase contracts to the detriment of mine productivity, equipment life and operation."

Lubricant-supply contracts can help to provide stability and reassurance of service levels, although this can vary by country, so check which specific services are provided in your region before signing up. ►

**"We routinely witness adherence to purchase contracts to the detriment of mine productivity, equipment life and operation"**

## Grease selection

Urkun of ExxonMobil talks us through some things to consider when selecting a grease.

"The first factor to keep in mind is whether the base oil has the appropriate viscosity," he explains. "The base oil is one of the most important characteristics of a grease. The focus should be on building an oil film between two mating surfaces to separate the surfaces and prevent them from touching. This reduces friction and can help to prevent wear caused by direct surface-to-surface contact. Selecting the right-viscosity oil is critical to this."

"Higher-viscosity greases are usually used to improve heavy-duty, high-load or higher-temperature applications. A grease with a lower base-oil viscosity will have enhanced pumpability, and therefore be more effective at protecting equipment when operating in low-temperature conditions."

The additive technology contained within a grease should be the next factor to be considered. "Most performance-enhancing additives found in lubricating oils are also used in grease formulation and should be chosen according to the demands of the application," says Urkun.

"For example, heavily loaded anti-friction roller bearings would require extreme-pressure (EP) additives, which would not be required to optimise performance of lightly loaded high-speed elements."

Grease consistency is a further factor that must be analysed as this may affect its flow and dispensing properties.

Thickener type should be selected based on performance requirements as well as compatibility when considering changing product types. Each thickener brings certain performance benefits, such as water resistance, pumpability and the ability to operate at high temperatures.

Mixing different types of greases can sometimes lead to compatibility problems. Grease incompatibility results from chemical reactions between the thickener or additive systems of the dissimilar greases. In some cases, grease incompatibility can lead to equipment failure or damage of the lubricated components.

To ensure you select the right grease for your applications, it is important to choose a reputable supplier who has a proven track record in the mining industry.



### Lubricant ► STORAGE

evident around  
a wire rope at  
Consol's  
Loveridge mine  
in West Virginia  
Photo: Lubrication  
Engineers

Even the highest-quality, highest-performance lubricant is no better than the lowest-price and lowest-performing if it is improperly transported, transferred or stored. All packaged lubricants should be kept clean and dry, ideally in a temperature-controlled warehouse. Bulk storage should be in clean, well-maintained tanks with proper venting. Improper storage, handling and transfer of lubricants can introduce contaminants to the system and lead to shortened product life and decreased performance.

Martyn Rushton, executive manager, mining – EAME & CIS at Fuchs Lubricants, says: "All lubricants have to

comply with the relevant oil-storage regulations, including correct labelling. A well organised and dedicated oil-storage area is recommended as an important factor to ensuring effective lubrication."

The most important consideration regarding the storage of lubricants is to keep them in a dry, contaminant-minimised, temperature-controlled environment. Ideally, lubricants are stored indoors in the horizontal position (bungs at 3 and 9 o'clock positions) on proper storage racks, allowing the containers to be rotated and used on a first-in, first-out basis. Bungs must be kept tight at all times and drum covers should be used whenever drums are stored in the upright position.

Desiccant breathers on drums or storage tanks will reduce contaminant ingress significantly, and filtering oils before transferring them into any piece of equipment will minimise the risk of contaminants entering a piece of machinery.

Angus Macdonald, vice-president at Lubricants Engineers International, comments: "Every mine has a lube room or some central area where lubricants are stored. Contamination issues often start there and are already a problem by the time the lubricants are introduced

into the equipment. A lubricant storage and dispensing upgrade is a great continuous improvement project and has the potential for a tremendous positive impact on your organisation."

Improving your lubricant storage room encompasses several activities and benefits, including:

- Consolidating the lubricant inventory and reducing the amount of space needed for storage;
- Identifying and colour-coding lubricants to enhance visual recognition and efficiency;
- Reducing mistakes by operators;
- Reducing or eliminating contamination before it creates problems; and
- Improving safety and decreasing waste by eliminating spills.

If lubricants must be stored outside, shelter them from rain, snow and other elements. Drums should lie on their sides with the bungs in a horizontal (3 and 9 o'clock) position below the lubricant level. This will greatly reduce the risk of the seals drying out and the ingestion of moisture caused by breathing. If the drums must be placed upright in outdoor storage, employ drum covers or tilt drums to drain the moisture that gathers on the top away from the bungs.



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Caroll says: "Containers should also be clearly labelled to ensure proper product identification. Avoid using labelling methods that are not legible or may wear out over time. Colour coding labels simplifies the process, reducing the risk of misapplication. If a colour-coding system is employed, be sure that alpha or numeric information is also present to account for colour blindness."

Finally, lubricant equipment such as transport containers, hand pumps, transfer carts and filter carts should be labelled to match the lubricant that is used. Where mixing is unavoidable, verify compatibility in advance with the lubricant supplier. Extend the identification process to the machine's lubricant fill ports.

Using identification tags or colour codes helps to ensure that the proper lubricant is added to the reservoir fitted with the proper dispensing tools. If dispensing equipment must be used for a variety of lubricants, employ a proper cleaning or flushing procedure that emphasises the removal of the previous lubricant and other contamination to minimise risk.

### RESEARCH & DEVELOPMENT

The lubricants available today are far superior to those used 20 to 30 years ago. Advancements in the base-oil refining methods used to produce high-quality American Petroleum Institute (API) Group II and Group III base oils, and the use of polyalphaolefin synthetic base fluids in formulations, along with advancements in additive technology such as EP additive systems, rust and oxidation inhibitors, and the increased use of frictional modifiers have resulted in lubricants that provide exceptional protection against wear, and energy savings.

Negri says: "The biggest improvement in lubricants has been the development and increasingly frequent use of higher-quality base oils. API Group II, Group II+ and Group III base stocks have become mainstream for most premium oil manufacturers. Synthetic base stocks and the many advantages that they provide have solved more difficult lubrication problems that would have simply resulted in failures years ago."

The introduction of more refined oil bases has been mainly driven by increasingly strict engine emissions regulations. A large portion of emissions result from the volatile ingredients in engines oils. "Therefore, because the engine-oil market is the largest lubricant market, it has driven changes to the



refining industry," explains Sander. "As a result, these highly refined base fluids have now become available for use in the industrial lubricant sector as well."

In addition to the further development of base oils, future lubricant developments are likely to include the incorporation of biodegradable and renewably sourced products into the mining field. Bio-based lubricants and greases are environmentally friendly, ecologically responsive and non-toxic. The use of re-refined base oils in lubricants and greases provides a smaller carbon footprint by producing fewer greenhouse and toxic emissions, consuming less energy and reducing the demand for crude oil. ♣

*R&D is essential for developing improved lubricants to meet the needs of mining operators and environmental regulations*

*Image: Fuchs*



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