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Managing Fuel & Lubes

Sizing Up a Fluid Situation

Fuel is always a major cost for mines — oil and grease, perhaps not quite so much, but the wrong lubrication choices and applications can be expensive. Fuel-service and lube vendors offer many product and service options to avoid problems, save money and maintain asset health and performance.

By Russell A. Carter, Contributing Editor



It's estimated that industry-wide, lubrication products account for about 5% of an operation's total maintenance spending. However, proper selection and use of lubricants can affect a much larger portion — perhaps as much as up to 30% — of maintenance costs through reduced downtime and better machine productivity.

Anyone who doubts the old proverb “the more things change, the more they stay the same,” can find absolute evidence of its truth in the current state of the mining industry. With the cumulative social and economic impacts of the COVID-19 pandemic far from clear, producers face unexpected and possibly unprecedented challenges involving everything from capital investment funding to material shortages and workforce upheaval.

And yet, the mission remains the same: To stay in business, they must put rock in the box, whether it entails loading hundreds of tons of rock and dirt by shovel into a haul truck for a trip to the crusher, or continual underground scoop, tram and dump cycles. In order to operate reliably, the machines used in either mining mode need fuel, oil and grease, along with filtration and fluids for cooling and perhaps even for exhaust aftertreatment as well. The OEMs that build these machines regularly update their new-product designs to provide easier serviceability and greater overall economy of operation, but each generation of engine, drivetrain and hydraulic-system improvements seems to bring stricter requirements for fuel quality and cleanliness, oil and grease formulations, and filter performance.

A Closer Look at Costs

When global economic events disrupt traditional supply lines and future demand for mined commodities becomes unclear, mineral producers instinctively look for ways to cut operating costs. In an industry that routinely runs fleets of haulers burning anywhere from 40 to 80 gallons of diesel fuel per hour — loaded by shovels with 4,000-gallon fuel tanks — fuel cost, economy and storage/handling efficiency often get spotlighted for management attention. And as mines increasingly employ larger but fewer trucks and shovels, for example, the impact of taking a unit out of production for lube-related service often gets measured against the risks and rewards of extending its service intervals to minimize the loss of output. Increased scrutiny of lube-related costs and consumption might also lead to a closer look at whether an operation is buying the most cost-effective products, along with where, how often and how much is being used.

This has become even more of a concern as technology progresses and the mining workforce evolves. Lubrication experts are quick to point out that misapplication or over-application of a product can cause almost as many problems as inadequate lubrication (see sidebar on page

38) and can often be attributed to lack of user familiarity and expertise. In fact, a 2019 study by Shell Lubricants UK indicated that mining companies lack confidence in their workers' ability to cope with new technology. The survey revealed that many companies are concerned about the specialist maintenance requirements of new equipment (98%) and some believe they will face difficulties upskilling workers to use these new technologies (48%). Thirty-eight percent said they are currently lacking trusted external experts who could provide support in introducing “Industry 4.0” technologies.

Tonya Donaldson, Shell Lubricants global marketing director for mining, said, “It's interesting to note that although 100% of those surveyed agreed that introducing these new technologies will have an impact on their choice of lubricants, only 46% feel they will need to place more emphasis on equipment protection and only 40% would focus more on longer oil life. Companies recognize that external support will be important to help improve maintenance practices, and 88% plan to use their lubricants supplier to help them progress.”

In another study conducted the previous year, Shell found that 60% of surveyed mining companies seemed to recognize that effective lubricant selection and/or management can help reduce costs. However, fewer than 10% of the businesses in the study understood that the potential savings can be six times greater than the expected average.

Basic Training

If worker inexperience or unfamiliarity with a company's commonly used lubrication products are concerns, a focused effort to clearly identify the various types of oil, grease and other fluids used in its production fleet or plant equipment might help,

along with providing fail-safe, reliable storage and dispensing systems and installing efficient, secure fueling-station equipment.

Lubrication labeling systems are available from a number of sources. Chevron, for example, offers its SmartFill Program, a system based on a workplace organizational methodology that originated in Japan called 5S Visual Management. If applied correctly, clear visual signals throughout a facility identify where all tools and supplies are supposed to be located. These visuals range from simple diagrams or labels to detailed process flow maps and directional signs.

SmartFill comes with a customizable lube room chart to identify which lubricants belong in the storage area, and corresponding SmartFill labels in two sizes: large labels for bulk tanks, totes or large volume storage solutions, and small labels for hoses, top-off containers and component fill points. The SmartFill approach is to match the lubricant product displayed on the chart to the labels and assist in the “chain of custody” process. The lube room chart and labels should include the following:

- Product name;
- ISO grade;
- Color coding and symbols for easy visual identification for top-off containers, fill points, etc. (optional);
- Product hierarchy based on usage priority;
- Supplier part number or internal part number;
- Shelf life, which helps with first-in, first-out inventory management in the lube storage room; and
- ISO 4406 Lubricant Cleanliness specification (optional).

Noria Corp., a lubrication consulting and training company, recommends that instead of using manufacturer brand names for tagging equipment and lubricants, companies should consider using codes from the ISO 6743 Lubricant Identification System (LIS). This avoids the necessity of retagging equipment and storage devices if operations lubricant suppliers change.

Once labeled, lubrication products should be stored and dispensed with equal care. Whitmore Manufacturing's new Lustor lubrication storage and dispensing system offer a scalable solution. “World-class maintenance and oil cleanliness requires processes and equipment that are both robust and easy to use,” said Doug Reid, vice president of product development. “The new Lustor line helps

companies extend the life of their fluids with a compact, durable and easy-to-use unit that fits almost any industrial location. It provides high-quality filtration and the modular design allows customers to add on additional units to cover as many lubricating oils as they want.”

“Without protection, operational fluids are degraded, leading to higher fluid replacement costs and ultimately shorter life for the valuable equipment companies rely on. In the future, as machinery becomes more advanced, prevention and protection will be an even higher priority,” Vice President of Global Sales Joel Garrett said.

The systems, according to Whitmore, are designed for customization and expandability. Three different configurations are offered: a wall mount with no reservoir, for use with drums or totes, and 65-gallon (250-liter) or 130-gallon versions. Optional equipment includes custom fluid ID labels, 3 µm or 20 µm filters, pneumatic 5:1 pump, spill containment and color-coded quick connects.

Another option for reducing the possibility of human error in lubrication applications comes in the form of automatic lubrication systems such as those offered by Graco, SKF, GreaseMax and others. Graco, for example, in January launched its Compact Dyna-Star (CDS) automatic lubrication system designed specifically for heavy-duty earthmoving machines in extreme work environments. The CDS controller can be paired via Bluetooth with a smartphone app to allow maintenance personnel to quickly monitor a wide range of lubrication metrics, including levels, pressure, configurations and more.

Graco said its automatic lubrication systems are now available as a factory option on a variety of Komatsu America's earthmoving equipment. The automatic lubrication systems feature either a G3 Electric grease pump, MSP divider valves and a GLC-2200 controller, or an Electric Dyna-Star grease pump, GL1-X Injectors and a GLC-2200 controller. The system is also available as an after-market field install kit, which includes all the core components along with the necessary hoses, fittings, mounting hardware and protective guarding required for proper installation.

Longer Life

Potential lube-related savings can be uncovered in a range of maintenance-related areas, linked not just to the brand and type of lubricants used, but also to increased opportunities for extending the service life of those products. In a case history focusing on GE electric-wheel assembly lubrication fluids, Donaldson Corp. found that each rear wheel assembly on a haul truck represented an initial cost of \$250,000 or a replacement cost of \$600,000. According to General Electric, the expected life of a rear wheel motor is 24,000 hours. In order to achieve or surpass that figure, fluid cleanliness is essential.

In the example, which involved a project at two surface mines, it was found that after 500 hours of operation with new fluid, analysis of wheel-assembly lubricant showed its ISO cleanliness code increased to 25/23/18 with iron concentration at 250 ppm or more. Following treatment using a kidney loop cart with



Appropriate lubrication storage equipment and clear labeling of products, through tags, signage or color coding, can reduce the possibility of human error in handling and application.

Donaldson Blue DBB8665 filters, the processed fluid registered ISO codes between 18/16/13 and 20/18/14, making it possible to extend drain intervals. The mines used two auxiliary rear wheel kidney loop carts on individual wheel motors while other preventative maintenance

services were performed, typically taking less than 3 hours to complete. The reduction in contamination such as dirt and iron, said Donaldson, could provide up to a 1.7x extension (40,000 hours) for the life of the component, based on Noria Corp.'s Life Extension Table.

Another cost-related option that can pay off is the choice of whether to use synthetic or mineral hydrocarbon-based lubricants. As Total S.A., the French multinational integrated oil company, pointed out, synthetic lubricants are designed for specific applications and are usually more

Lubricant Application Technique Critical to Equipment Protection

By Ron Reiniger

Every moving component on a mining machine needs the right amount of lubricant to ensure optimal performance, extend equipment life and reduce operating costs. This is particularly true for protecting shovels, where proper application practices are critical. A common mistake that can lead to unscheduled downtime is over-lubrication.

Whether it's poor communication between shift changes, lack of reporting, or misinterpreting how the product should be applied, any one of these scenarios can result in over-lubrication, which in turn can lead to unexpected maintenance costs and increased downtime for repairs.

The process of over-lubrication is akin to that of spray painting. One coat of spray paint on a metal sheet results in an even finish. However, if the next coat is applied too quickly, the finish will start to drip and run off the surface. The same applies to shovel gears or sticks, where over-lubrication would cause the fluid to sag and drip, leaving the metal exposed to contact. These issues can easily be avoided with proper application and general maintenance practices. Below are some techniques to consider when lubricating key points on mining shovels.

Open-gear Lubrication

A shovel's open gears often operate in corrosive, hostile conditions that subject equipment to temperature extremes, precipitation and abrasive dust. This adds to the difficulty of achieving optimal lubrication. Many of these factors are out of a maintenance manager's control, but the quantity of lubricant applied to an open gear is not, and tight control here can help mitigate wear caused by exposure.



The higher levels of wear protection provided by correct application of lubricant products on critical shovel parts can extend the life of those components and reduce the possibility of costly unexpected rebuilds.

It's critical that mine operators understand the product they are working with. For example, Vultrex, Petro-Canada Lubricants' line of grease-based Open Gear Lubricants (OGL), enables users to apply less compared to other products. When properly applied, the tooth face of the gear will show a tenacious film of lubricant that will be black or dark grey in color and velvety in appearance.

Though these recommendations apply year-round, there are specific seasonal considerations to keep in mind. For example, colder climates typically need additional lubricant to keep the protective film workable on metal surfaces. In warmer climates, less product is applied to reduce the amount of fling-off, reducing messy and excessive lubricant consumption.

Shovel Stick Lubrication

Shovel sticks have lubricant needs very similar to those of open gears. In cases of over-lubrication, the plating effect is reduced on the metal running surfaces. This makes the stick surfaces more susceptible to harm from weather elements and hostile conditions. When properly lubricated, a stick should have minimal lubricant build-up toward the bucket and on non-running surfaces. This enables the lubricant to better resist adverse weather and the effects of a working environment that can range from very wet to dry and dusty conditions.

Roller and Rail Lubrication

Lubricant application practices for house rollers and rails are like those for open gears. The lubricant film determines the amount of product to apply. A stubborn, black velvety film will be created when the correct amount of lubricant is used. In colder climates, it is not necessary to increase the amount of lubricant applied. Pouring oil onto the rollers to reduce the typical "asphaltic lubricant" snap, crackle and pop is not necessary. Because the lubricant is oil-based, it will not dry out or freeze, which will make the equipment quieter.

Bearing and Bushing Lubrication

Proper lubrication of bearings and bushings is just as important as for larger components. The same application practices apply: monitor the quantity of grease applied and avoid over-lubrication. As a multi-service lubricant, Vultrex is an ideal solution for bearing and bushing lubricant needs.

The key to preventing over-lubrication is to ensure all maintenance personnel and operators are trained in proper lubrication techniques. Petro-Canada Lubricants can provide a shovel technician to support its customers, offering on-site solutions that extend equipment uptime, reduce maintenance costs and give the best return on investment.

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resistant to oxidation, the undesirable series of chemical reactions involving oxygen that degrade the quality of an oil. Although this means synthetics will likely last longer and lead to potential cost savings through oil-change interval extension, they are also more expensive than mineral-based oils.

Total regards its ability to identify opportunities that provide measurable value to its customers as an integral part of its continuous improvement process. This process involves the customer and Total working collaboratively to identify and implement targeted actions, including the use of synthetic lubricants when warranted over mineral products in relevant applications. After compiling certain baseline information such as current oil drain interval and average hourly energy consumption, Total processes the data using a Total Cost of Ownership (TCO) tool to identify lubricant performance levels and related cost to determine an optimal solution for the customer.

Although this process can point out opportunities for sizable lubrication-related savings to its customers, Total warns that certain variables can complicate the picture, such as:

- Consistent contamination of a compartment containing a synthetic lubricant, making additional oil drains necessary and resulting in increased costs.
- Overall energy savings achieved will depend on contamination levels as well as the number of subsequent oil drains needed to reduce equipment wear as a result of this contamination.

In other words, the ultimate decision as to whether synthetic lubricants can replace mineral-based products should only be made after consideration of situational factors specific to each customer.

To support its customers that opt for synthetic products, Total Lubricants now has a suite of synthetic blend diesel engine oils especially designed for off-road applications. Total's Rubia Works 3000 FE 5W-30 is an ACEA E6 product that provides high-temperature and high-shear-rate viscosity protection. The new oil, which Total said is suitable for most Euro Stage IV or U.S. EPA Tier 4f engines, is claimed to increase fuel savings by up to 1.47% compared to standard SAE 15W-40 lubricants.

The Rubia Works 4000 range is formulated based on the API CK-4 performance classification to address severe duty op-

erating conditions found in off-highway applications. The range consists of three premium heavy-duty engine oils: Total Rubia Works 4000 15W-40, FE 10W-30 and 10W-40. The products meet engine manufacturers' SAPS (Sulphated Ash, Phosphorus and Sulphur) restrictions and help to extend diesel particulate filter service life.

All major oil companies offer similar lines, including Mobil (Delvac), Shell (Rotella), Chevron (Delo), Sinclair, Castrol and others.

Finding Ways to Save

When it comes to estimating fuel usage and setting fuel budget targets, mine operators face continual challenges. Fuel price and supply stability generally reflect overall regional and global economic conditions, but fluctuate significantly due to localized supply, regulatory changes or other related factors. Fleet fuel consumption also can vary as mining conditions change; a trend toward denser, heavier material being mined, for example, along with individual driver habits or adverse weather conditions can have significant effects. A study published by the Australian government's Department of Resources, Energy and Tourism on various aspects of diesel-powered haulage at surface mines reported that wet haul road conditions can result in a 25% increase in haulage fuel consumption compared with hardpacked, dry road surfaces.

Mine operators need to know the actual rate of fuel consumption by their loading and haulage fleets in order to conduct any sort of meaningful improvement program, whether it pertains to engine control module (ECM) tweaking or a possible change-over to synthetic motor oil for fuel savings. But direct measurement of fuel consumption is not a simple task, according to Cascadia Scientific, a Canadian company that claims it has developed a way to apply Machine Learning methods to the problem.

According to the company, the three most common fuel measurement strategies employed in mining include measuring at time of fill, Engine Control Module (ECM) fuel consumption estimations and on-equipment fuel measurement. The first two, said Cascadia, can provide useful information but suffer from specific drawbacks: In the case of ECM-based consumption estimates, the models constructed by engine OEMs to measure consumption can start out being quite

accurate but can degrade in usefulness over time as an engine's fuel injectors age and foul, fuel pressures vary and cylinders start to lose compression. Tank-fill consumption estimates can provide very precise information on the exact quantity of fuel dispensed to a machine and consequently consumed but lack the "granularity" to target specific characteristics of mining machinery and daily operation. For example, a typical fueling strategy might call for a truck to be refueled once per day. Over the course of that day, the truck might complete 50 haul cycles of various lengths, vertical travel and payload, might be operated by four or more individuals, and could be idled between 10% and 40%. Cascadia believes drawing accurate conclusions about the specific contributions of these factors to fuel consumption with a measurement frequency of once per day is not possible.

For higher measurement accuracy, Cascadia offers its SmartRView platform, derived from technology that the company obtained in 2019 by acquiring the intellectual property of Blutip Power Technologies, which offered operators of high-horsepower diesel engines a way to solve fuel challenges through its fuel-savings-as-a-service business. SmartRView is a real-time, cloud-based telematics system that provides fuel data and analysis via an on-equipment measurement approach.

In addition to actual machine fuel consumption data, mine fleet operators need to know, at a minimum, how much fuel has been delivered, how much is in storage, how much is being dispensed and from where and when. In order to get a tighter grasp on fuel costs, industry experts generally recommend use of a fuel management system, either as a stand-alone product or as a module in a comprehensive fleet management system available from vendors such as Modular Mining, Hexagon and Wenco as well as OEMs like Caterpillar. (Modular Mining is a subsidiary of Komatsu and Wenco's parent company is Hitachi Construction Machinery.)

Likewise, an efficient, safe and reliable fueling system setup can contribute savings in a variety of ways. Sara King, vice president of Wyoming, USA-based FlowTech Fueling, told *E&MJ* that her company's Mobile Fuel Docks and Nonpressure Fuel Overfill Prevention systems can provide hard rock mining companies significant production gains with just a modest investment.



FlowTech Fueling estimates that its fuel overfill prevention systems have prevented spillage of more than 6.6 million gallons of diesel fuel by its customers since 2007, resulting in a total cost savings of \$19 million.

King cited an example: In 2018, FlowTech built two 60,000-gallon Mobile Fueling Docks at a copper mine in Arizona. The docks, she explained, are extremely customizable and easy to relocate as future mining operations require. Each dock is capable of refueling eight haul trucks simultaneously at a rate of 130

gpm. The docks also have a fuel-truck fast-fueling station capable refilling the mine's fuel trucks at 300 gpm. Fuel is filtered down to 10 microns before entering the storage tanks, and then to 5 or 3 microns before being dispensed. The double-walled tanks are equipped with an overfill prevention system to alert the

delivery driver when the fuel level in either storage tank reaches 90% full. In the event that the fuel level reaches 95% full, an inline valve automatically closes, preventing the tanks from being overfilled. The fuel storage tanks are also equipped with a secondary tank monitor, which triggers an alarm if fluid is detected in the secondary tank. The copper mine customer reported that increasing the number of refueling stations while also increasing the flow rate at each haul truck refueling station from 60 gpm to 130 gpm yielded a six-month return on investment for the entire Mobile Fuel Dock project.

King said due to the increased flow rates at the new fuel docks, the copper mine elected to outfit its haul truck fleet, consisting of 35 CAT 793's, with FlowTech's nonpressure fuel overfill prevention systems. These systems eliminate tank pressurization during refueling and make it virtually impossible to overfill the fuel tank. She concluded, "Our Mobile Fueling Docks combined with our nonpressure overfill prevention systems make it easy to increase productivity without compromising safety and environmental profiles."