Paul Moore reports on the state of the art fuel management system at Rio Tinto's Amrun project, plus reviews best practice for fuels and oils as well as some site applications

High octane mining

The best examples of fuel management in mining are from the most recent and state of the art projects using the most up to date fuel systems. Rio Tinto's new Amrun Project is to produce some 22.8 Mt/y of bauxite for the local production of aluminium, as well as direct export to markets north of Australia. Some $1.9 billion is being spent to expand production from one of the world's premier bauxite deposits, which has the potential for expansion to around 50 Mt/y. Global fuel management major **Banlaw's** involvement is the design, engineering, and supply of two fuel facilities.

"Banlaw was engaged at EOI stage. Rio Tinto has some history with Banlaw solutions from other current operations. This allowed for references from existing sites to be obtained, and the benefits of choosing Banlaw once again to be made evident. Banlaw crafted a design solution, customised to meet what was a complex specification (from a technology and assurance standpoint). Banlaw specialists in the fields of mechanical, electrical, software, automation, hazardous areas as well as machine and facilities maintenance were all involved in the planning process. Leveraging our team's wide range of skills, Banlaw proposed a creative blend of technologies to deliver the required project scope at a competitive price-point. The Banlaw proposal also focused heavily on the environmental considerations of the project site itself with a view to enable ease-of-deployment and long term reliable operation."

The project includes Banlaw's FuelTrack™ Dry Break Auto ID dispensing hardware (for heavy vehicles) and Banlaw FuelTrack™ Splash Fill Auto ID dispensing hardware (for light and medium vehicles). The fuel management software used is Banlaw ResTrack™ RMS (Resource Management System) with Banlaw FuelTrack™ Advanced Controllers and Banlaw FuelTrack™ Tank Side Controllers. Infrastructure includes unloading skids, transfer skids, dispensing skids, LV bowsers, bulk air eliminators, temperature-compensated metering, self-bunded tanks, loading arms, filtration solutions and custom process control systems (PLC, MCC, SCADA).

The engineering involved was extensive: the design of two distinct fuel farms from a mechanical, electrical, and operational/process perspective, plus the engineering of two tank facilities, each with two tanks deployed immediately, and the ability to add two additional tanks to each facility in the future (400,000 litres to 880,000 litres of diesel storage). All fluid management functions are deployed on prefabricated skids. The skids are pre-assembled, prewired, pre-tested and ready to drop-and-go. "On-site commissioning is as simple as connecting inlets, outlets, and power. The skids are self-bunded, and incorporate custom pipework as well as pumping, filtration, metering, air-elimination, and fuel management functions." Significant PLC and motor control functionality enables advanced remote process control, and the automation of stock management.

For supply itself and unloading two unloading skids are equipped with a single pump and specified to unload 1,100 lpm of diesel. Both skids incorporate a bypass line for unloading using the tanker pump when needed, and are self-bunded. Two Banlaw Bulk Air Eliminators are incorporated into the unloading skids (one for each fuel farm). "This functionality removes free air from bulk fluids, dramatically increasing metering accuracy, and protecting flow meters in the process." The unloading skids incorporate a user interface for the Fuel Management System to capture delivery manifest information and allow inwards transactions to be initiated.

The storage tanks include three 110,000 litre

For Rio Tinto Amrun, Banlaw crafted a state of the art fuel management solution solution, customised to meet what was a complex specification from a technology and assurance standpoint

self-bunded tanks delivered to site which are appropriately engineered, and constructed of all-Australian steel. The tanks incorporate filtered tank breathers with local analogue display. Automatic tank gauging consists of a Banlaw Precision ATG that monitors all tank levels and temperatures in real time, interfacing directly with the fuel management architecture. There are also Overfill Protection Systems (for each tank). The primary method is actuated valves on the inlet of each tank triggered to close based on a configurable high level signal from the guided-wave radar level probes. The secondary method is a SIL-rated high/high level probe connected to a safety-rated controller. This triggers a fail/closed valve, and also disables the pumps on the unloading skid. For transfers there is a diesel generator transfer skid which pumps fuel on request to the diesel generator day tanks. Automated requests from the power station are PLC controlled. An NMI-certified Coriolis 'mass flow meter' is incorporated into the transfer skid. The NMI/Custody Transfer certified meter allows highly accurate reconciliation of diesel consumed by third parties.

For lighter vehicles dispensing equipment includes two fuel bowsers: 1 x LV 40 lpm bowser and one MV 80 lpm bowser. These are equipped with Splash Fill Auto ID vehicle identification equipment and wirelessly communicate with the Fuel Management Controller, eliminating manual process steps. For heavy vehicles there

The Amrun project includes Banlaw FuelTrack Advanced Controllers and Banlaw FuelTrack Tank Side Controllers

is a heavy vehicle dispensing skid, self-bunded, with two pumps (duty/standby configuration) and two-stage filtration integrated into the skid. There is also a dispense metering skid, self-bunded, with flow meter and FMS control valves. This skid is located adjacent to a Banlaw-manufactured loading arm. Dry Break Auto ID dispensing nozzles make a direct electronic ID connection due to Auto ID technology being integrated inside of the refuelling hardware. This allows for process automation and industry best diesel flow rates for an expected fleet of 67 heavy vehicles.

The Fuel Management System itself has five Fuel Management Controllers providing local user interface, fluid security, collecting temperature compensated flow data, and triggering the activation of pumps and valves. Flow and temperature-compensated fluid measurements are captured throughout the site to enable industry-best reconciliation accuracy.

PLC-controlled automated stock rotation capabilities have been deployed to minimise fluid degradation within both storage facilities. Two 6 m Motor Control Centre (MCC) platforms provide powered-hardware control for the facilities and all Banlaw systems have been configured to interface with the site control network, allowing control room visibility and interaction with pumps, alarms, tank levels, and PLC systems (SCADA). Banlaw's ResTrack RMS (Resource Management System) is the overarching software for enterprise reporting, and the configuration of all fluid storages, moves, and access for fuel-consuming assets.

Go-live support includes Banlaw presence on site for the period directly after system activation. Banlaw technicians focus on the training of users to enable safe fuelling and fluid-management processes, establishing accurate FMS reporting, and ensuring all systems are functioning correctly.

The Service Level Agreement covers ongoing remote services support to reconciliation accuracy, identifies continuous improvement opportunities, and ensures software maintenance is conducted in a timely manner. Site visits are conducted quarterly. During these visits, meter calibration services (using NMI-certified master meters) are performed to ensure the reconciliation target of >99.5% accuracy is achieved. These visits also focus on safety checks, and improvement plans aiming to deliver cost reductions, and efficiency gains.

There were some environmental challenges to address. The area of operation is prone to cyclones, and therefore all structures need to be cyclone-rated. This was of particular importance for the Motor Control Centres (MCCs), due to the large platforms (around 6 m in length). Also during the 'wet season', humidity remains above 85% for months on end, and rainfall per year exceeds 2 m for the work site. Besides influencing in which months deployment of the fuel management project would be possible, these local conditions mean that tropics-rated (very high humidity) electrical motors needed to be used to ensure reliable long-term operation of equipment. During the 'dry season' there are some months with average rainfall of just 1 mm, and humidity averages 61%. For this reason, both storage and dispensing functions include particulate dust controls.

Finally, bauxite, the resource being mined, has significant corrosive properties. Tanks, pipework, skid frames and more have been specially treated to make them resilient to constant exposure to the minerals it contains.

"Large and long-term resource projects such as Amrun, engender a great deal of attention and also concern from the public and government. Governance and visibility is critical for all stakeholders. And therefore, systems which offer industry-best accuracy as well as the ability to report, learn, and react quickly have been selected across the board."

Banlaw concludes on the project overall delivery: "Robust processes around governance and assurance mean that a premium fuel management capability has been delivered. Rio Tinto specifications demand a higher quality-level than those outlined in the Australian Standards. The aim is a seamless installation and commissioning process onsite, however very tight standards compliance is also assured. Rigorous QA and testing has been conducted prior to the delivery of equipment, and all-Australian steel has been used in the fabrication of tanks and structures. Technologies selected for Amrun are resilient to humidity, dust, cyclones, corrosive environments, and constant utilisation in a heavy-industrial environment. Systems have been specified to offer reliable and safe long-term operation. This focus on quality and durability should minimise downtime due to the availability of fuel, or the degradation of diesel impacting the mining fleet. From go-live the site will manage an expected 300,000 litres of diesel per week, with superior safety and environmental controls, along with reconciliation accuracy levels in excess of 99.5%. The choice to develop two distinct fuel facilities at this point in the project offers a great deal of flexibility in terms of how vehicle traffic is managed in the near term, and for future expansion to be supported."

Total Power and Schneider Electric's joint approach

As stated, fuel is a large expense for many large-scale industrial applications such as mining and often, fleets use cheaper fuels in order to save, but suffer from lower efficiency and higher emissions. To improve operations for these applications, **Total Power** of San Diego, California, offers a cost-effective synthetic, oxygenating fuel additive that optimises combustion. By using the fuel additive, companies save on fuel and maintenance costs while reducing their carbon footprint.

Although fuel additives help improve certain industrial operations, fuel management is often overlooked. By understanding when, where, and how much fuel is used in these operations, companies can take control of costs, optimise efficiency, and reduce their environmental impact.

A mining customer was unable to account for up to 100,000 gallons of the one million gallons of diesel fuel it consumed on average each month. The company asked Total Power to help find a way to better manage fuel dispensing and monitoring. To date, no fuel management system had been able to provide data reliability and integrity for the multiple mining sites, and the company did not have a good handle on its fuel consumption.

Although Total Power was very experienced in the realm of optimising fuels for mining and other heavy-duty industrial applications, it had not developed a fuel management system – nor were its personnel aware of any system that would do all that was needed. Total Power needed a partner that could help develop a customised fuel management system that would meet the mining customer's needs and scale to work for any size customer application. Thus, a new product line for Total Power – the FMx Fuel Management System – was born.

"It would have taken a lot more time and effort to develop this system without **Schneider Electric**," said Boris Dantus, Vice President of Total Power. "That is the beauty of the partnership. Schneider brought expertise to the table, so we could get a jump start on what needed to be done."

Because no system existed that would meet the unique needs of Total Power's customers, engineers from Schneider Electric's Industry Solutions group helped to architect a turnkey system from scratch. "The mining company was skeptical about a new fuel management system because they'd tried other solutions in the past and they all failed," Dantus said. "Previous attempts had been unreliable and a waste of money." The biggest hurdles with past fuel management systems had been poor data integrity and hardware reliability in dirty, dusty, high-temperature environments.

The Total Power/Schneider Electric team set out to develop a practical system to collect data securely and accurately in rough environments. Schneider Electric's experience in working with customers operating in harsh conditions, such

as oil/gas wells and water lift stations, gave the company a first-hand understanding of how to develop a rugged package. Total Power has a heritage of research driven innovation with a very deliberate scientific approach to product development, so partnering with Schneider Electric's experienced design team was a natural fit.

"The design team's proactive and inquisitive attitude led me to believe that this partnership was the right choice," Dantus said. "It allowed us to make the decision to go down the path of developing this product with Schneider Electric. It was a slam dunk for us."

"The designers took time to consider all of the client's needs and variables. Using a diligent, step-by-step approach, the Total Power and Schneider Electric teams looked at each fuelling system, each piece of equipment, and the environment. For example, the system needed to function in weather ranging from 20 to 120 degrees and despite ice, rain, dust, and snow in desert conditions."

"It couldn't be an off-the-shelf plastic box, because it had to withstand day-to-day operations," Dantus said. "We witnessed customers trying an off-the-shelf fuel management product, and it never worked." Equipment in many fleets – from massive haul trucks to pickups and bulldozers – varies in size, shapes and brand. This posed a challenge, because each gas tank, windshield, and equipment ID was in a different position, so there was no cookiecutter way to embed identification sensors. Engineers developed a system using Schneider Electric's ClearSCADA™ remote monitoring software, Accutech™ wireless sensors, SCADAPac™ remote terminal units (RTUs) and programmable logic controllers (PLCs) in a protective housing rated for challenging remote environments.

Incorporating DNP3, an open standard, event driven protocol, provides the data integrity that backfills information in the event of a power outage. Equipment in fuelling lanes are identified using long range RFID, replacing traditional RFID readers on every nozzle and fuel tank. This automated system eliminates the potential for human error and keeps operators moving without delays. The collected data is used for asset allocation and asset management. Analysing fuel consumption and distance driven can result in asset implementation changes that optimise operations. In addition, the system provides close to a 9% increase in data accuracy. For an operation with millions of dollars in fuel at a single location, data accuracy is important to control costs.

This system tracks fuel movements with high data granularity. The key is the data integrity and simplistic automation of a manual process, allowing the mine to track fuel use and invoice contractors more accurately for the fuel used. Prior to the project, the mine could not account for 10% of the fuel they were billed. This mine consumes roughly one million gallons of fuel each month. The project therefore resulted in significant cost savings for the client.

Petro-Canada – and low viscosity oils

Paul Moore spoke with Brian Humphrey, OEM Technical Liaison, **Petro-Canada Lubricants** about the wider oils and lubricants market. He had this to say: "The mining sector has many unique requirements compared to on-road and other off-highway industries. Equipment spends a significant proportion of its time idling or working at high power levels. The industry average idling time is 40% according to manufacturer Komatsu – and the role and expectations on the engine oil are also higher, as the equipment is expected to perform optimally 24 hours a day, seven days a week."

He adds: "Required to work in the harshest of conditions and extreme climates, lubricant choices in the mining sector are made as long-term decisions. With the impact of downtime being so significant, this segment is careful to ensure that decisions do not impact the uptime and reliability of the operations. This has resulted in the growing interest and conversion regarding the new API CK-4 standard of heavy duty lubricants. API CK-4 oils are relevant for the mining industry as they offer improved resistance to oxidation and aeration, as well as increased shear stability plus all the performance of the previous API CJ-4 category. Off-highway engines can entrain higher levels of air than other vehicles, so improved aeration control is extremely important and crucial at the bearings, which require an oil film to protect them."

He says the benefits of low viscosity oils are clear for mining operations located in colder regions. Oils such as API CK-4 SAE 10W-30 and 5W-40 can move more easily though the engine and flow faster at colder temperatures, preventing engine wear during start-up. Low viscosity oils also reduce the work rate of the engine saving fuel, which is an essential benefit for engines that regularly idle.

"Uncovering any maintenance issues due to prolonged idling such as water or soot build up, a used oil analysis program can surface problems before they become serious and expensive to repair, making it a crucial tool in a maintenance team's arsenal. This is a significant benefit for operators in the industry as significant periods of unplanned downtime can make a real difference to the company's bottom line."

Oil analysis is typically a three-step process: taking a representative sample from the equipment in question, sending the sample to a qualified used oil analysis lab, and interpreting/acting upon the recommendations of the results. This is most effective when performed at regular intervals, as it allows for a performance database to be generated, and for trends to be established and identified. These patterns, unique to each specific vehicle, can then help identify the potential to extend oil drain intervals – a process that should always be supported by recommendations from the OEM manual and advice from technical experts

TOTAL on extending oil drain intervals

Oil drain intervals (ODI) have generally been pre-determined by the OEM and designed as such to provide protection to the compartments based on a wide variety of conditions. **TOTAL** told ***IM***: "Over recent years there has been a growing trend within the mining industry to extend ODI beyond the OEM recommended service intervals. Considering hydraulic systems, extending ODI are perceived to be one area where value can be easily delivered to the mining or power generation industries. This can be achieved if carried out correctly but it is important to understand the key risks involved with ODI extension as well as understanding what other tests are required to get a clear idea of the overall health of the oil especially in large volume hydraulic systems."

The current practice particularly within the mining industry tends to be to hook up the hydraulic system to kidney loop filtration units during the scheduled maintenance plan for said equipment. Whilst good practice, the function of kidney looping is to essentially remove particulate particles and even moisture from the system. The removal of such contaminates helps to reduce wear of oil wetted components. In addition, laboratory test packages associated with routine oil analysis of hydraulic oil samples tend to cover only the following tests: spectrometric analysis (wear metals); viscosity; moisture and cleanliness. "Some oil analysis laboratories will also carry out Fourier Transform Infra-red spectroscopy (FTIR) on samples but most would be reluctant to admit being able to accurately predict oxidation and overheating of

ANAC (ANAlysis Compared) is a service of TOTAL that provides a complete range of analytical monitoring systems for in-service mining oils

the hydraulic oil based on the FTIR results."

TOTAL adds: "As such, on receipt of an oil analysis report, many Reliability Engineers (RE) or Maintenance Professionals make a call that the lubricant health is satisfactory based on low wear metals, stable viscosity and of course, the ISO cleanliness code. The decision to extend the oil past the oils 'use by date' is not based on a holistic picture as the health of the lubricant in this instance, cannot be based on those three indicators."

By this, maintenance teams and reliability engineers review the oil analysis reports placing a large emphasis on cleanliness results. "If the ISO cleanliness results are at an acceptable code, then the call to extend the oil is made. In some instances, the hydraulic oil type selected by the company may invariably be a standard mineral hydraulic oil where some OEM's and lubricant companies would only suggest a 2,000 hour oil drain interval. In some instances, companies have been known to extend the ODI of large hydraulic excavator systems well past the capability of the hydraulic lubricant with the decision made based on viscosity and cleanliness of the lubricant. This approach, whilst initially leading to reduced oil consumption savings, does not take into cognisance the actual health of the oil which in time will lead to equipment issues resulting in increased maintenance activities and operational cost. A very important test measure not included as a standard measure in routine analysis of hydraulic oil samples is anti-oxidant content."

When oils are exposed to the process of oxidation, oxidative products are formed. "Increases in oxidation could be as a result of excessive operating temperatures or even from a process known as 'microdieseling' which occurs when entrained air bubbles implode when being passed through high pressure zones within the system. This results in very high localised temperatures of the oil resulting in oxidative by-products being formed."

Lubricants contain anti-oxidants to combat the process of oxidation but additives are sacrificial in nature and ultimately get "used up". When the anti-oxidants within the lubricant gets too low, then oxidation of the oil accelerates. "This, together with an ineffectual method to remove these oxidative by-products, ultimately leads to varnish formation. These varnish deposits will tend to drop out of solution and at the areas that are coolest in the hydraulic or turbine system thus leading to equipment unreliability, for example, sticking of servo valves. The formation of varnish does not happen overnight but rather is an accumulation of continued over-extension of the hydraulic oil, sometimes taking more than 5 years before the presence of varnish within the hydraulic system becomes apparent."

Test results from routine used oil analysis do not detect the level or anti-oxidants in the oil and cannot determine potential formation of varnish. Similarly, routine used oil analysis cannot be used as the main justification for extending oil drain periods. "In the case of hydraulic systems using a standard hydraulic oil, it is important for maintenance professionals to liaise with the laboratory to include other tests. As a minimum, Acid Number (AN) or Total Acid Number (TAN) must be included in the routine suite of tests. In addition, at 2000 hours operating time on oil and every subsequent 1000 operating hours on the oil thereafter, tests to confirm anti-oxidant levels left in the lubricant should be carried out in order to determine the overall health of the lubricant. By closely monitoring physical and chemical characteristics, a call can be made that the oil is at or nearing the end of its useful life. This can be determined by closely monitoring any increasing trend in TAN which is also likely to be accompanied by very small incremental increases in viscosity. This trend, together with decreasing anti-oxidant levels in the oil means that the hydraulic oil must be replaced."

In addition and as a supplement to the above, laboratories can perform Membrane Patch Colorimetry (MPC). Here, a set volume of oil is passed through a filter membrane, also referred to as a patch. The patch is then compared against known reference patches and a number assigned to the patch. The higher the assigned

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Paul Moore spoke to Simon Ward, Key Account Manager, Exports at Chevron Lubricants about its role and position in the mining market

Q The oils and lubricants market in mining is a competitive one, with several global and numerous regional players. As a company how does Chevron make its products stand out from others in terms of capability and customer service?

A Chevron products and services are distinctive in a variety of ways. We run extremely rigorous research, development and field testing on all our products, which enables OEMs and customers to have the confidence in our products so necessary in demanding environments. We have industry leading Group II base oil and ISOSYN technology and production in-house, are pioneers in the coolants industry, and offer customers outstanding global logistics supply, oil analysis programmes and direct access to technical account managers. Taken with our premium quality products, it's the total package that makes Chevron Lubricants a valuable partner in the mining sector.

Q Are there any particular Chevron oils and lubricants brands or grades that have seen particular success in mining?

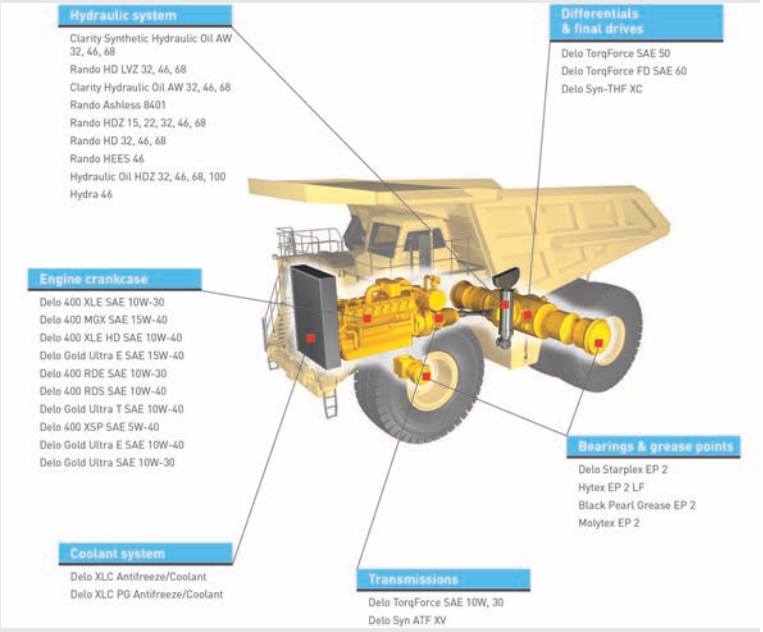
A The Chevron Delo heavy duty motor oils, Delo ELC, Rando hydraulic oils and TorqForce transmission, final drive and hydraulic system oils are a few of the leading products in this space, all of which are marketed under our Texaco brand in Europe, the Middle East and Africa. The Chevron product range is such that we are able to offer customers a completely holistic approach, ensuring that they benefit from the specific lubricants and coolants that match their individual needs and applications, no matter what challenges they face in daily operations.

Q To what extent as a company have you produced customised oils and lubricants to stand up to the unique conditions experienced by machines in mining?

A As an example, our TorqForce products are geared to meet and in fact exceed CAT's TO-4 spec. We also have heavy duty motor oil products that allow our mining customers to extend drains safely and effectively. And we are also able to help customers extend the rebuild life of critical components.

Q To what extent do you offer oil analysis and monitoring to mining customers?

A At Chevron we have been proponents of oil analysis for many years, particularly in sectors such as mining where equipment reliability is so key. Our LubeWatch oil analysis programme allows customers to easily monitor their equipment performance in a way that is suitable for their business. We offer five basic testing packages as well as a wide range of more specialised testing procedures. All our results are available to customers within 48 hours of receiving samples and sent out via email or downloadable through online portals. The results come with recommendations for action where necessary and we also offer training and in-field advice and support for component failure or wear particle analysis. Feedback from customers shows us that not only does oil analysis reduce downtime and help with the scheduling of maintenance work, but it also gives the added assurance of oil and system integrity when running on an extended oil drain programme.



Q Russia and Africa have been important and growing markets for Chevron oils and lubricants in the mining sector. What factors have made you successful there?

A The factors that have helped our success in those specific markets are the same as those we adhere to all across the world. Chevron Lubricants prides itself on the quality of its products and services. We offer customers consistency, not only in our products, but also security of supply. Our logistical capability in remote regions is imperative to customers and that is managed either directly or via world class distribution partners. In addition, we offer customers the peace of mind of technical support both locally and globally via our key account managers. Our products are tested through complex and long running field tests, ensuring that they perform even under the very tough and diverse conditions experienced by our customers, which can range from the dust and heat in West Africa to the hard terrain and extreme temperatures in Russia.

Q Can you give any examples of major mines that have opted to use Chevron products as their principal source of oils and lubricants and have they given feedback as to why?

A This year will see Chevron celebrate 25 years of strategic partnership with Kumtor Gold at their Kyrgyzstan operation, in the Tien Shan mountain range, 400 km east of the capital Bishkek. The relationship has been maintained over such a long period thanks to Chevron's ability to not only provide reliability in the products which support the facility, but also in the logistical support necessary for supplying a plant in such a remote location and altitude. This relationship is based on one of absolute trust, Chevron has worked with the team at Kumtor since the mine opened in 1993, and understands that our lubricant supply, which covers everything from heavy duty trucks to mining equipment, is so critical it's one of the few elements that could stop production. We've provided the engineering team at Kumtor with on-site training to help increase operational efficiency and shared best practise with them every step of the way. This customer-focused approach is critical to the way Chevron operates and we believe of great benefit to those in the mining sector looking to optimise reliability, durability and operational excellence.

number, the higher the amount of varnish precursors present in the oil.

ANAC (ANAlysis Compared) is a service of TOTAL that provides a complete range of analytical monitoring systems for in-service oils, available for any automotive and industrial application. For management and technical monitoring of mining, construction and transportation vehicles as well as industrial equipment, ANAC offers a full range of in-depth analysis processes for in-service oil including Membrane Patch Colorimetry.

ExxonMobil on better oils management

Advanced lubricants and greases play a crucial role in ensuring the consistent protection and performance of mining equipment, helping safeguard against financial losses and safety risks. However, constant exposure to the elements, extreme temperatures and heavy loads present a unique set of lubricant challenges. Sarp Degirmenci, EAME Offer Advisor at **ExxonMobil**, offered some insights on how best to choose and use lubricants: "Synthetic and mineral lubricants are both made from crude oil but synthetic products are formulated using more advanced refining processes, which have higher purity and quality. This means they can deliver a range of performance benefits including longer oil life, wider operating temperature range, resistance to deposit formation and enhanced wear protection." Taken together, these benefits can help extend equipment life.

One of the key considerations when choosing a lubricant is its viscosity. Getting this wrong can increase equipment wear and energy consumption, while reducing lubricant life. "When temperatures rise, viscosity falls, and when temperatures drop, viscosity increases. The degree to which this happens to an oil is called its Viscosity Index (VI). A low VI can result in an oil having insufficient resistance to temperature changes, which can have a detrimental effect on its performance and can result in costly and avoidable wear. Synthetic lubricants with a high VI can help protect mining equipment across a wide range of operating conditions."

Most applications have specific viscosity requirements, so mining operators should always check original equipment manufacturer recommendations. However, it also advisable to talk to oil supplier's field engineers in order to ensure the use of the best performance lubricants.

Lubricants can also help protect against cold start issues. "Mineral oils are especially prone to increases in viscosity when temperatures fall. When this happens it compromises a lubricant's ability to perform, which can lead to start-up wear and costly maintenance issues. Synthetic lubricants can be formulated to resist a change of viscosity in extreme temperature conditions – both low and high. Your lubricant supplier will be able to recommend oils suitable for low temperature applications."

Specialist lubricants are engineered to help optimise the performance and productivity of mining equipment. "For example, high performance hydraulic oils can improve the cycle efficiency of shovels, excavators and haulage equipment while helping cut energy consumption and maintenance issues. Tests have shown that a switch to Mobil DTE™ 10 Excel can provide up to 6% efficiency gain in hydraulic pump performance."

Lubricants can also help ensure the efficient running of compressors, open gears and mobile mining equipment, even in harsh environments. Doing so can contribute significant savings to a mine site operation. "For instance, a Brazilian mining company saved $4.2 million over four years by switching to high performance synthetic grease, Mobilith SHC™ 220. The lubricant helped extend roller bearing life on a fleet of 19,000 open gondola cars by 43% . Similarly, an open pit mine in the US saved more than $2.1 million annually by switching almost 50 of its CAT haul trucks to the high performance synthetic gear and bearing oil, Mobil SHC™ 630. The lubricant helped optimise the performance of the CAT 793 trucks, leading to a 5.5% increase in fuel economy and 326 hours more in-service time, contributing to enhanced on-site safety."

Finally, the use of a high performance lubricant can enhance equipment reliability and increase re-greasing and oil drain intervals. This cuts the need for hands-on maintenance, which decreases the potential risks for employees by limiting human-machine interaction. It also helps reduce the possibility of lubricant-related spills and leaks.

Regular used oil analysis, such as ExxonMobil's Mobil new Mobil ServSM Lubricant Analysis (MSLA), can help reduce unscheduled equipment downtime. The information it provides can help users detect problems, such as contamination, deposit build-up and wear, before they become a problem, improving equipment reliability. "With 25 testing options available, users can pick and choose the right test package for their operation. ExxonMobil also offers access to its technical service engineers 24/7 as part of the service. Routinely implemented, this enables mine operators to track lubrication trends and spot anomalies, such as changes in viscosity. These insights can help users take corrective actions, which can then be monitored by scheduled sampling backed up by ExxonMobil's technical expertise."

DYNAVIS® fluids proven in Indian test

DYNAVIS®-formulated hydraulic fluids from **Evonik** can improve efficiency and cut down on fuel consumption. In the coal mines and quarries of a leading Indian energy company near the city of Ranchi, hydraulic mining excavators extract coal and remove roofing slate. With the DYNAVIS®-formulated fluid tested against a reference fluid under realistic and challenging mining operating conditions, slightly lower peak oil pressure accompanied by less frequent pressure peaks within the hydraulic oil system were observed.

This saves energy and reduces, at stress phases, the temperature increase of DYNAVIS®-formulated hydraulic fluid in comparison to the reference fluid – and, in general, to every conventional fluid.

After idle times or engine stops, lower temperatures and reduced pressure increases could be observed. A hydraulic fluid, subjected to less temperature stress, suffers less wear and tear, contributing to a longer service life, thus substantially extending service intervals. As much as a doubling of service life looks achievable with the use of DYNAVIS®-formulated hydraulic fluid.

With the DYNAVIS®-formulated fluid in its hydraulic system, the large excavator moved 12.2 t of roofing slate per litre of fuel. With the reference fluid, the ratio was just 10.8 t. This equals an efficiency gain of 12.4%. Trip and time efficiency also improve. While the articulated trucks are filled faster due to a more agile excavator, thus speeding up the trips for every loading cycle, the excavator burns less fuel, resulting in more efficiency. These results come with a confidence interval of 80 to 90%.

The initiator of the test was a leading oil company - a DYNAVIS® licensee, supplying the entire Indian market. The excavator in question weighs 111 t and comes with 567 kW of engine output. 1,100 litres of hydraulic fluid are circulating in its hydraulic system. As usual in the mining industry, the excavator is operated almost continuously, in a three-shift service. When digging or loading, fuel consumption of more than 70 litres of diesel fuel per hour is recorded. Depending on the task and working conditions, this rate can vary widely.

The hydraulic fluid test regimen was planned, conducted, and evaluated by the Evonik Performance Test Laboratory. The reference hydraulic fluid of the large excavator was exchanged with a DYNAVIS®-formulated fluid – followed by the return of the reference fluid to complete the measurement process. Over the course of the day to day mining operation, 19 shifts were observed and recorded. The test was conducted under typical working conditions. Several dump trucks were deployed for the monitored excavator, carrying away about 75-85 t of roofing slate per truck trip to achieve the scheduled shift productivity. *IM*