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MINING & QUARRY WORLD



With ground-breaking technology, Epiroc develops and provides innovative and safe equipment, such as drill rigs, rock excavation and construction equipment and tools for surface and underground applications. The company also offers world-class service and other aftermarket support as well as solutions for automation, digitalization and electrification. Learn more at www.epiroc.com.

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LiuGong “move it up a gear” with their european dealer conference and F-Series excavators launch

Over 100 LiuGong dealer partners from across Europe met in Zaragoza, one of Spain's most historic cities and the location for SMOPYC exhibition, to share LiuGong's exciting plans for 2022. Under the theme, “Moving Up A Gear” LiuGong again demonstrated how their accelerated approach to creating even greater value for their customers and dealer partners will continue at a pace in 2022.

“It's amazing and quite emotional, to be able to meet our dealer partners face-to-face for the first time since November 2019” explained Hakan Ilhan, Vice President, LiuGong Europe. “With new product launches right across our range, from the all-new F-Series excavators to our new Dressta TD-15M series-2 dozer, it was great to be able to switch off our web-based calls and touch, feel and experience these amazing machines in person.”

The 2021 dealer conference was supported by DIR, Spain's exclusive dealer for LiuGong. DIR represent the perfect example of LiuGong's approach to its business partners and with LiuGong's support, have

enjoyed rapid expansion since their establishment in 2019.

“LiuGong provided us the perfect business opportunity” explained DIR's CEO David Iglesias. “They have excellent products, built, tested, and supported in Europe, but they also have a long-term mindset focusing on building relationship and trust. Over the last 4 years, they have really helped us to establish LiuGong as a potential future leader in the Spanish market.”

LiuGong's Dealer Conference was scheduled to coincide with SMOPYC, Spain's leading construction equipment exhibition, where LiuGong & DIR showcased their latest F-Series excavators, the all-new 915FCR, 922F and 926F. These new models join the existing line-up of F-Series excavators that were launched last year which include the 9018F, the 9027F and the awesome 95-ton powerhouse, the 995F.

Harry Mellor, LiuGong's Product Manager for Excavators for Europe explains: “With the F-Series range, we have listened to our customers & operators and have



delivered a range of machines that are easy to use, easy to own and easy to maintain. It's not rocket science, it's just customer focus matched with intelligent design.”

Designed by LiuGong's UK based, Red Dot Award winning design team, the F-Series excavators take customer centric design to a new level. They benefit from spacious, modern, high-visibility cabs with the highest levels of comfort and ergonomics. Visibility and safety are enhanced with the inclusion of 360-degree cameras. Ground level maintenance makes daily checks and servicing faster, safer, and easier. When it comes to power and control, the F-Series machines come with Stage V compliant

engines and full electro-hydraulic systems. LiuGong have a reputation for tough excavators and this will be further enhanced by the extended maintenance intervals enjoyed on the F-Series range.

Aside from the new F-Series excavators range, LiuGong have been moving up a gear across their product portfolio particularly in wheel loader product line and Dressta crawler dozers. Notable highlights from the SMOPYC exhibition were the new Stage V 890H wheel loader and the new TD-15M series-2 crawler dozer. The TD-15M benefits from a new high visibility cab design, increased power output with improved operator control thanks to electrohydraulic joysticks and easy maintenance designed in. Pushing 173 kW (232 hp) and with a drawbar pull of 472 kN, the TD-15M is perfect for roads and highways, landfill sites, forestry and general construction.

“We are thrilled about our new product launches and about the potential for our business here in Spain with DIR and across Europe with all our dealer partners” said Chairman, LiuGong Europe Howard Dale. “Our continued growth in Europe will be the result



of close co-operation with dealer partners with proven aftersales

infrastructure, supported by our industrial capability in Poland and our world-

class parts distribution center. Our proximity to our customers will significantly reduce shipping costs and provide faster delivery on a majority of our genuine LiuGong parts.”

With exciting new products in the pipeline, continued investment in people and network infrastructure and a consistent focus on delivering a leading brand and customer experience, LiuGong's dealer partners who attend the dealer conference and visited the

SMOPYC exhibition clearly shared LiuGong's optimism for 2022.

According to DIR's CEO David Iglesias. “The pandemic may have caused, and may continue to cause some disruption, but we, together with LiuGong are practical people, we adapt quickly, and we find solutions for our customers quickly too. We have already started to move up a gear in our business and we will continue to accelerate that progress.”

Komatsu Europe announces sale of FrontRunner Autonomous Haulage System to Boliden

A European first, the Swedish company acquires the system for its Aitik mine fleet

Komatsu Europe is pleased to announce that Komatsu FrontRunner, an Autonomous Haulage System (AHS), will be deployed on 11 930E-5 ultra-class haul trucks at Aitik, one of Europe's largest open pit copper mines, located in northern Sweden and owned by the Swedish company Boliden.

Boliden is a metals company with a focus on sustainable development. The company's core competence is within the fields of exploration, mining, smelting and metals recycling. The introduction of FrontRunner at Aitik will mark the first time the system is rolled out in Europe. Together with Hesselberg Maskin AB, the local Komatsu distributor, Komatsu Europe will also provide training and support throughout the project.

The FrontRunner system is expected to be a significant upgrade to Boliden's fleet at its Aitik mine: this Komatsu system offers automation

that can yield substantial benefits for a mining operation. Combining the reliability and durability of Komatsu electric drive trucks with the power of innovative autonomous haulage technology has helped mining customers worldwide increase productivity and reduce total cost of ownership while promoting zero harm.

Komatsu FrontRunner is a well-proven system, with

over 4 billion tonnes moved since its first commercial deployment in 2008 at CODELCO's Gabriela Mistral (Gaby) copper mine in Chile.

Komatsu's approach for FrontRunner AHS brings together ultra-class dump trucks with Modular Mining's industry-leading DISPATCH® Fleet Management System, the preferred management system in nine of the 10 largest mining operations

in the world. The system enables 100% compliance to its proven optimization methodology.

The essential minerals needed to power modern society are getting harder to find and tougher to mine, and customers trust mining companies to deliver these resources. Komatsu focuses on helping mining companies meet those needs productively and responsibly.



Orica lights fuse on fresh wave of mining transformation with data, AI and cloud

For 140-plus years Orica has carved a reputation as one of the world's leading blasting companies, supporting mining customers in more than 100 countries.

Explosives are still its stock-in-trade – but the company is rapidly expanding its digital capability – creating data rich and AI-infused tools that enable step-change improvements in customers' productivity, safety and sustainability.

Over the last four years, Orica has grown its digital team fivefold, and from a standing start it now has more than 200 customers for its digital solutions – building a whole new offering and revenue stream for the company.

As Rajkumar Mathiravedu, Vice President of Digital Solutions, notes, Orica has always been about “better blasting” – its digital capability now takes it “beyond blasting” – but always with customer needs considered front and centre.

Leveraging advanced workflow, measurement, modelling and data science technologies, Orica is developing high impact

solutions across mining's entire value chain, from orebody intelligence to blasting and processing, widening the company's footprint with both existing and potential customers.

FRAGTrack™ is just one example of Orica's growing portfolio of digital solutions – a Microsoft Azure backed system that automatically measures rock size and fragmentation following a blast in a mine or quarry.

Mathiravedu explains that unless the size of the rocks is known accurately and instantly, they could create downstream inefficiency or delay. Using a stereoscopic 3D camera, the Internet of Things (IoT) and AI infused vision technologies, FRAGTrack™ identifies the size of rock fragments in three dimensions in real time – knowledge which allows mine operators to deliver the right specification for processing, ensure the rocks go into the right truck and take them to the right mill for processing at the right time, reducing delay and improving productivity.

A digital lens has also been applied to Orica's core business of blasting

with its BlastIQ™ platform. Traditionally blasting involves a three-step manual process – the blast engineers plan the blast by nominating the size and location of a drill hole; that hole is drilled by another team; and then the explosives are loaded by a third team, leveraging digitally connected trucks on-site.

If there has been overnight rain and the drill hole has been flooded, or the size of the hole is different to the one envisaged by the blast engineer, by the time the explosives are loaded into the hole, the blast may be very different than the one planned.

BlastIQ™ links all three steps in the process via a digital workflow. Any changes – such as water levels in the hole or the size of the drill hole – are communicated immediately to blast engineers who can adjust calculations and automatically update the team and trucks loading the explosives. “It's a very simple value proposition for the customer – the right energy in the right hole every time,” says Mathiravedu.

These are just two of

the digital solutions Orica's digital team is developing to ensure better blasting and expand the company's horizons beyond blasting.

Azure selected as strategic cloud platform

Orica has selected Microsoft Azure as the strategic cloud foundation for its emerging digital portfolio. Azure's performance, reliability, scalability and security provide trusted foundations for innovation while access to Azure IoT, a growing portfolio of Azure cognitive services and an extensive library of AI tools helps accelerate Orica's digital innovation says Mathiravedu.

He's also keen on the industry cross pollination opportunities that the Azure ecosystem affords. Mathiravedu notes; “We are seeing Azure being deployed in lot of oil and gas applications and some of those can easily be applied in mining.”

Meanwhile he's keeping a close eye on how emerging Azure capabilities, such as Azure Space which allows satellite information to be made easily accessible, could further expand Orica's innovation horizons.

The company is already working on open digital platforms that integrate Orica expertise, customers' own data with machine learning to create intelligent production workflows that in real time reveal to mining engineers what they are working with at a particular site and provide live design recommendations. “Whether it is hard, medium, soft, and how the rock changes and where the most valuable ore is located. So what it really means is now you can actually optimise the right explosives energy specific to the desired outcomes,” says Mathiravedu.

“This has a huge impact from a sustainability



Orica will continue to build its digital capacity and skills, working closely with Microsoft to help develop digital skills of its 13,000 employees.

perspective. By using the right energy to break the rocks, we're optimising the chemical energy. We are materially reducing the water and electricity, which is used for grinding and processing later, while readily managing environmental factors such as dust and vibrations” he adds, noting that this solution is now in production with an iron ore miner based in Australia.

Sustainability is a core issue for Orica which has committed to zero net emissions by 2050. This dovetails with Microsoft's own sustainability ambitions which are to be carbon negative by 2030.

The mining sector at large understands the benefits of reducing emissions and is keen to engage in a fresh wave of digital transformation – hot on the heels of mine automation efforts – that will improve sustainability across the industry.

Orica's cloud based digital platforms are designed to allow information to be shared openly across mining ecosystems – from geological exploration, through blasting, extraction and processing – integrating sensor and IoT data with AI infused analytics to provide mining customers with the insights which will allow them to go “deeper, steeper and cheaper” says Mathiravedu.

Leveraging the cloud, IoT, edge-processing and machine learning algorithms Orica focuses on delivering real-time data-driven insights to help customers optimise energy use, drill patterns and maximise efficiencies both on the mine site and throughout the

downstream value chain.

According to Srikant Kadambi, Energy Lead, Microsoft Asia; “Orica has unparalleled domain expertise and global industry knowledge. Combining that with Microsoft Azure capabilities & the ability of our teams and ecosystems to deploy these technologies at production scale allows us to work together to create literally ground-breaking – pun intended – solutions for the whole mining value chain.

“We bring to the table our whole Azure ecosystem, access to libraries of AI tools developed for different industries, and skills and expertise that we can share with Orica as it continues to grow its digital capability.”

Orica strengthens digital capability

Orica has also opened a Digital Immersion Centre in Brisbane – a specialised facility where it can work with development partners, including Microsoft, and customers to promote innovation, spur collaboration and also establish an Orica data and analytics centre of excellence.

This centre of excellence brings together data science, artificial intelligence, modern cloud computing and Orica's 140 plus years of domain expertise.

The Immersion Centre will also act as an incubator for any Orica digital businesses.

Mathiravedu explains that the digital team is building solutions to support existing Orica customers, as well as new customers from right across the

sector's value chain. Open by design, these platforms are tailored for a range of applications focused around efficiency, productivity and safety as well as to help support customers achieve their own sustainability targets. “We do not want to be constrained only to existing Orica customers. We want to be available to the entire mining value chain,” he says.

And he's committed to always applying a customer lens to innovation – understanding first what the customer needs are and then working to deliver a suitable solution in partnership with them.

To achieve that, Orica will continue to build its digital capability and skills, both within the company's dedicated digital team and more broadly across the entire business. Orica plans to work closely with Microsoft to help develop the digital capabilities of its 13,000 employees worldwide.

“We're calling it a community of practice – a digital community of practice. Again, this is where Microsoft comes in. Can we do this at scale? Can we do it faster? And what are the things that you have learned in your experience that we could probably use?”

Mathiravedu stresses that besides a keen customer appetite for innovation, there is strong internal support for Orica's digitally focused transformation and continued investment in open, secure and connected digital platforms focused on better blasting and a growing raft of opportunities beyond blasting.



Orica is developing high impact solutions across mining's entire value chain, expanding the company's horizon.

Martin Engineering continues program to support Susan G. Komen® Foundation

The global leader in bulk material handling technologies and training has announced the completion of this year's annual program to support breast cancer education, screening, treatment and research around the world. Martin Engineering continued the effort rolled out in 2017, contributing a portion of its sales revenue from the company's popular air cannons and truck vibrators during the month of October to support the Susan G. Komen® organization, inviting customers to "go pink" and honor all those affected by the disease. The company donated \$50 for every Martin truck vibrator and \$100 for each 70-liter air cannon, with the units' traditional paint scheme replaced by the iconic pink color adopted by the organization.

"We're excited to get this program back on track after the COVID year in 2020," said Vibration Business Development Manager Susie Orlandi. "Every contribution is a small step that supports those in need today, while the researchers continue their work for a cure." This year the firm supplemented its regular annual donation with \$8,950 from the fundraising campaign.

"October is National Breast Cancer Awareness Month in the U.S.," she continued. "As

a family-owned company of four generations with over 900 employees making up our extended family, Martin Engineering is acutely familiar with the impact breast cancer has on individuals, families, friends, colleagues and communities. This disease affects such a large number of people that just about all of us have been touched by it in some way."

In addition to its donations, Martin Engineering also created a team to participate in the 2021 Komen Peoria MORE THAN PINK WALK® on October 2nd to raise awareness and encourage contributions to this worthy cause. Orlandi led a group of cancer survivors at the event and took part in the opening ceremony, representing Martin Engineering as an Action Pillar Sponsor.

"Support from efforts like this helps us get one step closer to a world without breast cancer," Orlandi added. "We chose the Komen Foundation so that the funds we raise will directly support breakthrough research and provide help for the women and men facing breast cancer. Whether it's emotional support via the helpline, financial support through the treatment assistance program, or help navigating their care journey, we know the organization will be there for them."



According to the National Breast Cancer Foundation®, about one in every eight women will be diagnosed with breast cancer in her lifetime, along with thousands of men. At this point, doctors don't know the exact causes, and it's rarely possible to determine why one person develops the disease and another doesn't. But research has identified a number of risk factors, along with early detection techniques and advanced treatments.

The Susan G. Komen Foundation was created in 1982, launching its famous Race for the Cure® shortly thereafter. The organization has contributed to a number of advancements, including the identification of genetic links, less-invasive surgical techniques and advanced drug therapies, as well as advocating for more federal funding of additional research and early detection programs.

The foundation has invested over \$3 billion in more than 60 countries since it was formed -- helping to reduce breast cancer-related deaths by an estimated 40% -- with an emphasis on supporting those with the fewest resources. With treatment options, community outreach, advocacy and other programs around the world, the organization has played a critical role in virtually every major advance to combat breast cancer -- transforming how the world talks about and treats the disease and helping millions of breast cancer patients become cancer survivors.

"Programs like this generate media exposure

and get people talking," Orlandi added. "Many of our customers agreed to join us in this fight, placing orders at this critical time to contribute to its success."

Martin Engineering has been a global innovator in bulk material handling applications for more than 75 years, with its industrial vibrators and air cannons both improving safety and productivity in mining, coal handling, cement manufacturing and a broad array of other industries. The firm specializes in advanced technologies for improving the performance of conveying systems, high-temperature processing, storage and transport of bulk materials.

The company has a legacy of support for the Susan G. Komen foundation over the years, thanks to a similar family history. "The Komen family has roots in the Peoria area, much like our own," added Martin Engineering Chairman Ed Peterson. "So, we've always felt a special connection to the cause."

Martin Engineering is a global innovator in the bulk material handling industry, developing new solutions to common problems and participating in industry organizations to improve safety and productivity. Headquartered in the USA, Martin Engineering products, sales, service and training are available from factory-owned business units on six continents. For more information, contact info@martin-eng.com or visit www.martin-eng.com.

Weir Minerals' new Trio® TC84XR live-shaft cone crusher improves safety, functionality and reliability

Weir Minerals has upgraded its range of Trio® TC live-shaft cone crushers. The Trio® TC84XR features all the robust design elements that have made live-shaft crushers a fixture of the mining and sand and aggregate industries for generations, while also incorporating the latest technology to ensure it remains integral to flowsheets long into the future.

'The Trio TC cone crushers' live-shaft design has been proven to perform in heavy-duty secondary and tertiary crushing applications. We wanted to build on this strong foundation. My team followed a comprehensive design process – we've reviewed and tested every inch of this crusher. While the TC84XR may seem familiar on the outside, we've upgraded its design and control functionality. The motor is larger and it has a much higher crushing capacity compared to equivalent sized crushers,' Mark Utecht, Weir Minerals' Director of Communion Engineering said.

'The result: we now have an incredibly robust, powerful and technologically advanced crusher that is easy to operate, has a low wear rate and uses less energy, which ultimately lowers operating costs,' he said.

While many OEMs have made the decision to discontinue their live-shaft cone crushers, Weir Minerals has resisted this trend, believing that – because every mining and sand and aggregate operation is different – there can't be a one-size-fits all approach.

Instead, Weir Minerals partners with its customers and empowers them to choose the machine best suited to their crushing needs.

There are some applications and situations where pedestal (fixed-shaft) style crushers may be the

more appropriate solution, which is why Weir Minerals continues to manufacture the premium Trio® TP pedestal style machine.

Weir Minerals is the only global equipment manufacturer that offers both the TC live shaft and TP fixed shaft style machines.

'The combination of the Trio TP and TC fixed and live-shaft cone crushers ensures that Weir Minerals continue to offer their customers the right technology, regardless of their site structure, operating conditions or application,' Mark Utecht, Weir Minerals' Director of Communion Engineering said.

Trio® live- and fixed-shaft cone crushers are made for modern mines and quarries with advanced hydraulics, wear resistant material and the latest technology.

'This is really exciting for our customers, as they now have a real choice. The combination of our TC and TP series allows us to have an honest conversation with our customers on the options available to them and make a technological recommendation which truly meets their needs,' Ekkhart Matthies, Weir Minerals' Global Application Director said.

Replacing existing live-shaft style machines on site with the Trio® TC84XR crusher is now a straightforward process because it has very similar dimensions and is a comparable weight to its live-shaft predecessors. And because it produces the same product, downstream changes aren't required, which isn't the case when replacing a live-shaft style machine with a fixed-shaft style machine.

In other words, there is no need to re-design existing circuits.

Technology upgrades
The recent technology

upgrades in the Trio® TC84XR crusher have improved its safety, functionality and reliability.

'At Weir Minerals, we understand and appreciate the important role live-shaft cone crushers play in today's challenging crushing applications. Combining decades of experience and first-hand customer feedback with innovative designs, the highest quality materials and latest in control technology we believe that our new Trio TC84XR cone crusher is the most reliable and robust live-shaft cone in the market today' Ekkhart Matthies, Weir Minerals Global Application Director said.

Engineered to perform in the most extreme applications, the Trio® TC84XR crusher is robust and easy to maintain and operate. It reliably delivers high crushing force and high horsepower in primary, crushed ore and quarry rock applications.

The ability of the TC84XR crusher to handle variable feed and crush pebbles is also partly a result of its large motor; it's been designed with higher power capability than comparable cone crushers. Ultimately, this translates to a higher potential crushing force and therefore increase in production.

Another feature that allows it to handle variable feed, as well as deal with tramp material safely, is the fully-automated tramp-release and setting recovery system. The tramp release hydraulics can also be used to safely clear the crushing

chamber should a sudden disruption in plant power cause a shut-down of the cone crusher.

The socket assembly has been redesigned to improve sealing, which has optimised functionality and manufacturability by reducing the machining setups of the socket and seal rings. The Weir Minerals comminution team has also redesigned the countershaft assembly to remove welding and machining, while simultaneously improving venting and the dust seal.

The Trio® TC84XR crusher, like the range of TP series cone crushers, can be fitted with ESCO® wear parts, designed with superior ESCO® alloys, they can be custom designed based on your specific requirements. With over 100 years of casting expertise and in-house engineering and metallurgy, ESCO transforms what was already a robust machine into one that, in the toughest conditions, is unsurpassed.

All Trio® equipment is supported by the Weir Minerals unmatched global service centre network – with over 160 facilities worldwide. Further information can be found at <https://info.global.weir/trio>



New 650 model expands the innovative Cavex® 2 hydrocyclone range

Improvements in efficiency and bypass demonstrated by the latest addition to the Cavex® 2 hydrocyclone range translate to operational savings for brownfield sites and reduced capital expense for greenfield projects.

When the Cavex® hydrocyclone was introduced to the industry over 20 years ago, it set the benchmark for the rest of the market. As the first commercial high-efficiency hydrocyclone, it has been providing mining customers across the globe with guaranteed performance and a name that they can trust.

The recently launched Cavex® 2 took this product range a step further with enhanced performance and design. The Cavex® 2 hydrocyclone marked a new era in separation technology, with its LIG+™ advanced laminar spiral inlet and size of the feed chamber, delivering performance unlike any other cyclone on the market and 30% more capacity.

This latest generation of cyclones boasts innovative design features, delivering an impressive improvement in volumetric capacity and reduced turbulence – all while occupying a similar footprint as the original Cavex® or competitor cyclones. Its enhanced

performance is unmatched by any known hydrocyclone in operation today and helps customers improve the sustainability of their operations.

A new size enters the market

The Cavex® 2 650 is the new hydrocyclone size to be released in the Cavex® 2 product line, and it is set to deliver unparalleled results. Like all Cavex® 2 cyclones, the 650 model has undergone years of research, lab testing and in-field testing to ensure it can withstand the rigours of heavy-duty industrial and abrasive applications.

Featuring the advanced performance and design that Cavex® 2 cyclone is recognised for, the 650 model addresses the continual demand for increased operational and circuit capacity, and offers customers process improvements combined with digital technology.

Towards a more sustainable mining future

It is important to note that enhancements of the hydrocyclone performance go hand in hand with improving the environmental footprint of the equipment.

By reducing bypass returning to the mill, fewer fines are returned back to the mill in closed-circuit milling process, thus

reducing the need for energy to be used to further process particles that are already small enough to move on to the next stage. This frees up mill capacity, previously used up with fine particles, for the size reduction of larger particles.

As a hydrocyclone that can make a finer separation, the Cavex® 2 650 can operate at a lower pressure for further energy savings or a higher feed density for water savings while maintaining the existing cut size from the hydrocyclone.

And finally, using equipment with a higher volumetric capacity required fewer units to be installed upfront as well as fewer consumable spare parts used over the life of the hydrocyclone.

Advanced benefits

As with all Cavex® 2 hydrocyclones, the 650 delivers significant benefits to mining customers including:

- Increased operational and circuit capacity up to 30%
- Maximised plant recovery by reducing the quantity of misclassified particles with an average improvement of the alpha parameter more than 10%
- Improvements in bypass with an average of over 15%
- Opportunity to retrofit Cavex® 2 650 cyclone into existing cyclone cluster footprints
- Less turbulence during the separation process due to the LIG+™ inlet and elongated chamber design
- Enhanced performance with a Synertrex®-enabled monitoring system which can detect roping or blockage conditions in advance for continuous,

efficient operation of the hydrocyclone

- Improvement of environmental footprint.

Proven materials and design

The new Cavex® 2 650 hydrocyclone comprises a robust metal casing with a unique elongated chamber design. The additional length guarantees turbulence is decreased inside the cyclone, allowing for additional volume and increased efficiency during the process.

To satisfy all process conditions and slurry types, the Cavex® 2 650 hydrocyclone comes with a range of material technology options including industry-leading Linatex® premium rubber, the industry standard and ever-reliable R55 rubber, neoprene for high levels of hydrocarbon and ceramic.

The Cavex® 2 650 hydrocyclone can be customised to suit almost any application with a variety of spigots, vortex finders and cone angles. Weir Minerals' expert team will tailor the hydrocyclone to suit your unique application and goals.

Applications and industries

The new Cavex® 2 650 hydrocyclone is ideally suited for use in a range of heavy-duty, industrial, abrasive industries and processes including:

- Mining
- Aggregates
- Utility/FGD/General industrial
- Classification and separation (Mining)
- Classification and separation (Aggregates)
- Mine dewatering systems
- Tailings management



Successful trials in global operations

Successful results from mine-site trials confirmed that Cavex® 2 is the most efficient and powerful hydrocyclone on the market today.

The latest Cavex® 2 650 hydrocyclone trial with a customer took place in Chile. The testing was conducted in a large copper ore mine which had a SAG mill in a closed circuit with the cyclone cluster. The trial tested one Cavex® 2 650 in a 6-place cluster of existing Cavex® cyclones and saw an improvement of up to 48.5% in circulating load and 31.7% in water bypass versus the original cluster.

A lab water test with the same hydrocyclone fittings as above also yielded positive results: a 211mm inlet and 260mm vortex finder delivered 16% more capacity at 100 kPa, and 17% more capacity at 250kPa.



These improvements in efficiency and bypass translate to increased savings for brownfield sites where the existing hydrocyclones do not have enough capacity and are maxed out, while greenfield projects benefit from savings in capital expense.

The Cavex® 2 650 hydrocyclone is the second in a range of standard sizes that Weir

Minerals are planning to release, with more sizes in development to expand the current product range. The commitment to onsite trials, research and development means the expert Weir Minerals team always pursues new improvements to ensure that Cavex® hydrocyclones stay at the forefront of the industry.

The new Cavex® 2 650 hydrocyclone will be

available globally, with assembly in local regions.

Weir Minerals have unrivalled expertise when it comes to hydrocyclones, and Cavex® 2 has set the standard for cyclone performance and efficiency. If you would like to know more about the new Cavex® 2 650 hydrocyclone or the rest of the Cavex® 2 range, please visit: <https://info.global.weir/CAVEX2>

Strategically taming the data flood

Bodo Schlenker has been Divisional Director Software Solutions at BEUMER Group since April 2021. The graduate computer scientist can draw on many years of comprehensive experience. As such, he will strategically align the Software Solutions division with the ever-growing market requirements in terms of digital offers, in order to create added value through smart software solutions with the highest quality standards, innovation drive and a sense of sustainability.

After graduating, Schlenker started his career at a software company for automation and warehouse management systems. He then worked for an international specialist for automated

intralogistics systems, where he was Director of Product Development and Operations for logistics software. In another position, Schlenker was Senior Director of Corporate Product Strategy at one of the leading manufacturers and suppliers of forklift trucks and warehouse technology as well as supply chain solutions.

Thus, BEUMER Group focuses strategically on innovative software solutions, modern IT architecture, connectivity and big data, and is thus occupying the technology trend topics of the coming years. In interaction with all business areas for the various industries, BEUMER Group is strengthening its competence in digitalisation.

The aim is to achieve the best possible results in optimising customer processes, for example in e-commerce, in the CEP sector or in baggage sortation at airports. With its special ability to connect and network the physical and digital worlds through

connectivity and data analytics, and to ensure continuous material and data tracking, BEUMER Group aims to set standards in topics such as holistic system optimisation, improved user experience, preventive maintenance and active asset management.





In our hands

Never before have the environmental issues facing the world presented a greater challenge or held such a dramatically high profile. It is widely accepted that action urgently needs to be taken by the biggest industrialised nations to slow the global warming process but what contribution can we make personally? Here, Andries Smilda, a director of Netherlands-based Dunlop Conveyor Belting, looks at the issues facing everyone involved in the conveyor belt industry and the part we can play in helping to prevent catastrophe.

WE ALL HAVE A PART TO PLAY

There has been enormous media interest surrounding the United Nations COP 26 meeting held in the UK this year. Hopefully, it is a sign that most world leaders are at long last starting to take the threats posed by climate change to the future of our planet and our way of life seriously. However, such is the scale of the problem that a concerted



Every industry, company and individual have a part to play.

and genuine effort is needed, not only by world leaders but also by every industry, company and individual. In other words, we all have a part to play.

I passionately believe that each and every one of us has a responsibility to do whatever we can, not only for the benefit of the present generation but also the generations to come. It is not for me to preach about what we do in our private lives to protect the environment. However, in our working lives we all have varying levels of influence. I am proud to say that several years before it became 'fashionable' from a company image point of view, we made a conscious decision in Dunlop to pursue environmentally friendly strategies. This focussed on three key areas: product life cycle, the environmental impact of our products and our production processes.

PRODUCT LIFE CYCLE

There is no denying that manufacturing industrial conveyor belts uses a lot of energy and materials. Consequently, it produces a big carbon footprint. The impact on the environment caused by discarded industrial rubber belting is huge. And the problem is growing. Annual sales of conveyor belts in Europe alone are conservatively estimated to be more than 500 million euros. In terms of the physical volumes involved, again very conservatively, that represents some 150,000 tons in weight. The amount of conveyor belting we use (and discard) represents the single biggest influence on the industry's carbon footprint. Consequently, it also represents the single biggest opportunity where every single user of conveyor belting can contribute to reducing that carbon footprint. And every little bit helps as they say.

To fully appreciate why the length of the life cycle of rubber conveyor belts is so important it is first necessary to understand the background. Rubber constitutes at least 70% of the material mass of both multi-ply and steelcord



Less than 10% of rubber belts are recycled.

belts. Because of its adaptability, most of the rubber used in conveyor belting is synthetic. Relatively little natural rubber (NR) is used, which is important because natural rubber production from the rubber tree (*Hevea brasiliensis*) is expected to be the leading cause of deforestation in mainland Southeast Asia in the near future.

The most commonly used type of conveyor belt are rubber 'multi-ply' belts, which make up some 85% of industrial conveyor belt used in Europe. This type of belt has multiple layers of polyester/nylon (EP) fabric that are used to create a sturdy carcass. This, in turn, is protected by a thick outer coating of rubber. Most multi-ply belting will have between two to four layers of fabric. This means that some 45,000 kilometers of non-biodegradable polyester and nylon fabric is being created and ultimately discarded every year, which is more than the circumference of our planet.

The raw materials such as polyester/nylon fabrics and the components used to create synthetic rubber are pretty much all directly or indirectly derived from crude oil. In fact, a typical conveyor belt is effectively 45% oil. One ton of scrap rubber will usually contain some 500 litres of oil.

In Europe, nearly 95% of all used car tyres are now recycled. By comparison, the amount of used conveyor belting being recycled is believed to be less than 10%. There are many reasons for this disparity. Recycling conveyor belts is an appreciably slower, more complicated and expensive process. There is also much less demand for the polyester and nylon fabric inner plies and certainly no practical use for the metal cables found in steelcord reinforced belts.

No matter how much we would like it to be different, the harsh reality is that under foreseeable market circumstances, recycling industrial conveyors is not only ecologically problematic, but also not viable. This is precisely the reason why producing and using conveyor belts



The amount of conveyor belting we use and discard represents the biggest influence on the industry's carbon footprint.

that have the longest possible working life is now more important than ever before.

INCREASE THE LIFE, REDUCE THE WASTE

To be honest, from an environmental point of view it is a happy coincidence that historically, our company's approach to the market has always been to supply conveyor belts that provide a much longer operational lifetime than those of our competitors. Quite typically, this can be double the usual lifetime. In the case of imported belt we can easily be looking at three or four times longer. On this basis, the amount of belting that needs to be manufactured simply to replace worn-out belting could be reduced by up to 50%. This also means that the amount of belting that is discarded could also be halved. The impact this could have on the environment is truly amazing because it represents



some 75,000 tons of conveyor belting that would not need to be made and transported thousands of kilometers each year. It would also mean that some 75,000 tons of rubber, polyester, nylon and all the associated chemicals would not have to be disposed of, most of which would be buried in the ground.

A FRIGHTENING STATISTIC

The average modern day container ship produces the equivalent of 16.14 grams of CO₂ per metric ton of goods shipped per kilometer. The average distance between Asia and Europe is in excess of 6000 kilometers. This therefore means that some 100 kilos of CO₂ is emitted into the atmosphere for every ton of imported conveyor belt.

What can you do?

ANSWER: Adopt a policy of buying belts that have been manufactured as physically close to your operation as possible.



If we can persuade people to buy better quality, longer lasting belt, albeit at a higher up-front price, instead of buying 'economy' low grade belt then it will create two extremely significant benefits. Not only will it be an enormous help environmentally, but it will also reduce medium to long-term cost for the user due to the substantial reduction in 'whole life' cost. 'Everyone wins' as they say!

What can you do?

ANSWER: Base your conveyor belt purchasing policy on lowest lifetime cost.



THE ENVIRONMENTAL IMPACT OF OUR PRODUCTS

The second aspect that we focus on in Dunlop are the chemicals and ingredients used to create rubber and the lasting environmental impact that they could have on the environment, both in the short term and in the future. There are literally hundreds of different chemical components such as anti-degradants, anti-ozonants and accelerators. These include primary amine-based sulfenamides such as N-cyclohexyl-2-benzothiazole sulfenamide, and thiazoles, such as 2-mercaptobenzothiazole. It is an inescapable fact that to make some rubber compounds it is necessary to use chemicals that are extremely dangerous. Fortunately for us all, at least as far as Europe is concerned, control mechanisms are already in place because there are very strong regulations designed to protect humans, wildlife, and the environment in the form of **REACH**.



WHAT IS REACH?

REACH was established by members of the EU with the specific aim to improve the protection of human health and the environment through the better and earlier identification of



SVHC – Substances of very high concern.

the properties of chemical substances. To briefly explain, REACH Regulation places direct responsibility on industry to manage the risks from chemicals and to provide safety information. Manufacturers and importers are required by law to gather information on the properties of the chemical substances they use and register the information in a central database in the European Chemicals Agency (ECHA) based in Helsinki.

The Regulation also calls for the progressive substitution of "substances of very high concern" (SVHC's) when suitable alternatives have been identified, which is a positive and progressive thing. What I also find positive is that REACH regulations regarding SVHC have become increasingly stringent and demanding. For example, Article 31 of REACH (requirements for safety datasheets) now demands that if a product contains SVHC that is more than 0.1% of the total weight of the finished product then the manufacturer is compelled to both register its use with the European Chemicals Agency and provide their customer with a safety datasheet.

Because we manufacture our own rubber and make every belt ourselves makes it easier for us to comply with these stipulations compared to most other belt manufacturers because we have full control over everything that we do.



The combined weight of SVHC should not exceed 0.1% of the actual product weight.



Non-European manufacturers are free to use unregulated raw materials including those that contain Persistent Organic Pollutants (POPs).

ACCOUNTABILITY AND RESPONSIBILITY

As far as I am aware, Dunlop Conveyor Belting were the first major manufacturer of conveyor belts to achieve REACH compliance. Sadly, many European conveyor belt manufacturers have chosen to ignore the legal requirements of REACH, either completely or at least partially because of the impact on production costs.

What worries me most of all is that the majority of belt used in Europe nowadays is imported so it is virtually impossible to know how much SVHC and Persistent Organic Pollutants (POPs) such belts contain. Manufacturers located outside of EU member states and the UK are not subject to REACH regulations or even to EU regulation concerning the use of Persistent Organic Pollutants (POPs). This means that they are free to use unregulated raw materials even though those same materials may be entirely prohibited or at least have strict usage limitations within Europe.

What can you do?

ANSWER: Always ask for written confirmation from the manufacturer or supplier of the belt you are buying that it has been produced in compliance with REACH EC 1907/2006 regulations. It really is as simple as that.



PRODUCTION PROCESSES

As I have already mentioned, manufacturing industrial conveyor belts uses a lot of energy and raw materials and therefore produces a large carbon footprint. Having worked in the industry for more than thirty years I cannot deny the fact that reducing the size of that carbon footprint by any significant amount in the short term is extremely challenging. Fortunately, there are things that can be done.

MORE EFFICIENT MACHINERY

The production process used to manufacture rubber industrial conveyor belts has not changed fundamentally for a great many years. Consequently, much of the



machinery is old and not always as energy efficient as it could be. Particularly during the past decade, we have invested many millions of euros replacing outdated machines and building new production lines using the most technically advanced equipment available. I must admit that we have had an added incentive because anything that reduces our carbon footprint by increasing efficiency also improves the overall efficiency of our business. Our steelcord production line is a good example of this because it combines what were previously separate production stages into one smooth process. Apart from the product quality benefits, this also means that it uses less energy.

WHEN LESS IS MORE

The demands being placed on modern day conveyor belts, especially those used in 'heavy industry' such as quarrying, mining, wood, and waste for example, mean that belts must be stronger and tougher than ever before. Traditionally, this has meant making belts with multiple plies, so they are becoming increasingly heavy. Naturally, thicker, heavier conveyor belts contain a lot more rubber and fabric. There is therefore a parallel increase in the carbon footprint and ultimately, an increase in potentially unrecycled waste. However, at Dunlop we believe that this upward trajectory is avoidable. In fact, we do not just believe it – we know it!

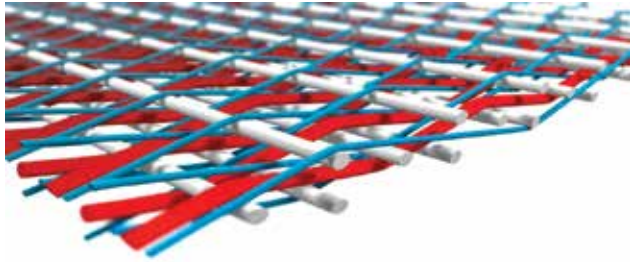
THE HOLY GRAIL?

Despite increasingly thicker, heavier belts, it is estimated that up to 80% of conveyor belts are scrapped prematurely due to damage. The challenge presented to the Dunlop R & D team therefore consisted of two major objectives. Firstly, to design a belt that was much more capable of resisting impact, ripping, and tearing. Secondly, to make sure that the belt could be competitive in the market, which might well be regarded by the conveyor belt industry as the equivalent of looking for the Holy Grail. Ironically, our engineers found that the answer to the pricing issue lay in the volume of raw materials needed and the complexity of the production process.

Because we had already developed extremely hard-wearing, long lasting rubber cover compounds, our engineers and technicians went back to the drawing board and concentrated on the carcass construction.

Instead of persisting with the multiple ply carcass construction they created a single ply carcass using an

CONVEYOR BELTING, INCREASING THE LIFE, REDUCING THE WASTE



The big secret – a super-strength 'breaker weft construction' fabric made only by Fenner Dunlop.

amazingly tough patented fabric that is exclusively made in our sister company's in-house fabric weaving facility in the USA. The specially woven fabric uses crimped warp polyester yarns to provide high strength and low stretch combined with strong 'binder' and 'filler' yarns to create strength and stability under load. The result was **Dunlop Ultra X**, a unique single-ply, super-strength belt that has more than **3 times** greater longitudinal rip resistance, up to **5 times** better tear resistance and a far superior resistance to impact compared to traditional 3-ply or even 4-ply belting.

From a production point of view, having a single-ply construction helps to maximise efficiency because there are fewer calendar runs. Another advantage is that having no rubber skim between the plies not only results in a thinner, stronger carcass that is less prone to delamination, it also reduces the amount of rubber needed thereby keeping the cost down. Yet another advantage was the ability to make longer production runs at maximum width, which further maximises production efficiency and minimises the amount of power consumed.

SINGLE PLY CONVEYOR BELTS – THE WAY FORWARD

In Dunlop we sincerely believe that the development of a single ply conveyor belt that not only significantly outperforms its thicker, heavier, multi-ply counterparts but also have dramatically less impact in terms of its carbon footprint is a genuine and very exciting game changer.



The way forward – single ply belts that are superior to traditional multi-ply in every respect.

Although some might throw their hands up at the very thought of using a single ply belt, it should be remembered that single ply solid woven belting used in underground mines for several decades. I am not advocating single ply belts simply because we already have a belt that can do all these things because there is nothing to prevent other conveyor belt manufacturers from following the same path. Replacing thick, multi-ply belts with single ply belts that are much more durable and long lasting yet use so much less energy is certainly the best way forward in every respect.

What can you do?

ANSWER: The first step is to accept that thicker, heavier belts are not the solution for conveyors where belt damage is a problem. As you no doubt expect, I am naturally going to recommend that you explore the possibility of using a single-ply construction belt that supplies the necessary tensile strength and resistance to accidental damage. At the very least, fit conveyor belts that have been specifically engineered for the purpose rather than a constant stream of low grade 'sacrificial' belts. This will lead to extended operational lifetimes and consequently less waste in every respect.



IN OUR HANDS

Please trust me when I say that the actions I am proposing are not simply some kind of theoretical dream. To my mind, every individual and company has a responsibility to do whatever possible to prevent even more damage being done to our environment. The problems facing our planet today will become even more serious for our children and our children's children. Their future is in our hands. Thank you.



ANDRIES SMILDA

About the author: Andries Smilda is Sales & Marketing Director of Dunlop Conveyor Belting in The Netherlands. After completing his studies in Chemical Technology in 1984, Andries joined Dunlop Conveyor Belting, where he has worked ever since and has become one of the most experienced and highly regarded senior managers in the conveyor belt industry.



Reinforcing Progress

The world relies on mining for raw materials to drive human progress. And mining companies rely on us to drive their progress underground. By reinforcing their mines, safeguarding their people and protecting their investment, we help keep their mines open to supply precious metals and minerals to help the world advance.

We reinforce progress – for our customers, and for the world.

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Septentrio GPS/ GNSS for mining in the toughest environments



Deep in the amazon jungle, in November 2021, mining works are underway. Jim Elkins flew from Arizona to visit the mine, answering an urgent call for help: GPS receivers aboard the drill rigs were not working. Jim is a specialist in mining and automation, working for Flanders, a US-based company with expertise in electrical machinery and control systems. Flanders pioneers machine control technology that takes mining efficiency to the next level. The drills rigs at the mine create holes with centimeter precision, ensuring optimal fragmentation of rock. This makes subsequent jobs like stone extraction and removal faster and easier.

ROBUST GNSS WORKS IN ANY ENVIRONMENT

Difficult environments such as areas close to the equator, or to the poles can pose a challenge for GPS receivers. These places tend to experience the most intense ionospheric scintillations, which are fluctuations in electron density in the ionosphere. Such scintillations effect GPS/ GNSS signals that travel from space to Earth causing degradation of accuracy or even positioning loss. To fix the GPS problem in the amazon mine, and to resume the mining process, Jim helped install the ARDVARC control system, replacing all the GPS receivers aboard the drill rigs with Septentrio AsteRx-U GNSS* receivers. These receivers are robust inside and out. Housed in a tough



The ARDVARC control systems use AsteRx-U receivers, which run advanced GNSS+ algorithms including IONO+ for robust operation in areas of intense solar activity.

IP67 enclosure they run Septentrio's proprietary GNSS+ algorithms including IONO+, which ensures high accuracy positioning even during ionospheric scintillations. With AsteRx-U receivers onboard the drill rigs resumed their work immediately, preparing the ground for the next blast.



"We've had Septentrio GNSS receivers in our control systems for the last 3 years and I've never had any complaints about accuracy or integration. The AsteRx-U is extremely accurate and operates in difficult environments in places like Brazil, western Australia, South Africa as well as North America."

Jim Elkins – Global Business Development, Mining and Automation, Flanders

The ARDVARC drill control system with the toughest GNSS

- Operates fully autonomously with auto-propel and autonomous movement from hole to hole
- Multiple machines are monitored by a single person from a safe distance
- AsteRx-U multi-frequency multi-constellation GPS/ GNSS receivers for positioning accuracy within 10 cm
 - IONO+ ionospheric scintillation protection in places of high solar activity
 - LOCK+ robust signal tracking during strong vibrations or shocks
 - AIM+ Advanced Interference Mitigation technology protects against RF interference known as jamming

*Global Navigation Satellite System including the American GPS, European Galileo, Russian GLONASS, Chinese BeiDou, Japan's QZSS and India's NavIC. These satellite constellations broadcast positioning information to receivers which use it to calculate their absolute position.

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Strategic mine planning is aimed at one goal: maximizing the value to be realized from extracting a mineral resource. This attempt at value maximization is operationalised via mine planners' suggestions, or "decisions," regarding a number of investment and scheduling alternatives, such as equipment sizes and placements, ore definition (cut-off grade determination), ore access mechanics (shaft location, pit size), and ore and waste removal sequences. The decisions are updated through time, usually annually, as new information becomes available.

It is a forward-looking exercise, being able to decide upon the value-maximizing suite of forward-looking decisions at any given time for any given deposit depends first and foremost on mine planners being able to measure the impact of the various decision alternatives on mine value. This relies upon formal forecasting of uncertain technical and economic outcomes associated with each decision, and the subsequent valuation of those uncertain outcomes taking into account risk tolerances of investors. Uncertainty abounds, and is a central component to both the forecasting and valuation exercises.

Engineers with strong operational and technical backgrounds gain substantial experience in mines employing a multitude of mining methods, exploiting all commodities on a variety of continents. In addition to this they are able to draw on a broad range of skills.

This experience and range of skills ensure that solutions and advice are not only practical and workable, but take

account of appropriate geotechnical, hydrogeological, economic and environmental considerations.

The majority of companies offering services in Mine Design and Planning cover scoping, pre-feasibility and feasibility studies as well as economic evaluations, detailed mine design and layouts, production scheduling and equipment selection, operating cost estimation and capital expenditure estimation and will also include pro-actively



reviewing improved mining methods outside the traditional approaches that may still be in existence.

Underground mining: The very nature of underground mining and construction activities is constrained by the specific behaviour of the encountered rock masses – during the construction phase and on an ongoing basis for as long as the facility is operated. To fully understanding the nature and characteristics of the rock mass is vital in order to properly plan the construction activity, mitigate any predictable risks, and react properly to unpredictable risks as they become apparent. Therefore, it is vital that people with specific knowledge of and expertise in the field of underground rock engineering are involved in the planning and construction phases and as required to give insight and advice during ongoing operations.

Underground rock engineering is a very specialized field, so it is essential that anyone used in a consulting capacity in this field has sufficient training, capability, experience, and expertise.

Ground Control:

Roof falls have been the single greatest hazard that underground miners face. Throughout the 20th century, roof falls accounted for approximately half of all deaths underground. While overall safety in coal mines has improved dramatically in the last 50 years, fatality rates continue to exceed other major industrial sectors. Fatalities due to ground falls still make up a significant portion of this rate. Currently, underground coal production is split almost 50-50 between large longwall mines and smaller, room-and-pillar mines. Most longwalls operate at depths of cover in excess of 300 m. Room and-pillar operations are still primarily at shallow depth, often working small, irregular deposits that were abandoned by earlier miners. Approximately 20% of the room-and-pillar coal is won on retreat faces. Today's underground coal industry faces intense competitive pressures from the \$4/ton Powder River Basin strip mine coal and from the pace-setting million-ton-per-month longwalls. Ground failures can hardly be afforded in this climate, yet they continue to occur.

The main purpose of ground control in a mining context is to ensure that all excavations made through rock and soil are kept safe and stable at all times (this practice can also sometimes be referred to by miners as slope management or strata control).

As underground mining operations go deeper and deeper and often take place in inaccessible locations, ground control becomes increasingly important and plays a significant role in keeping mines safer and more productive. Ground control is also applied extensively in civil engineering; for example, to minimize risks during tunnel construction and for securing slopes and embankments adjacent to bridge or road building projects.

In essence, ground control is the day-to-day application of rock mechanics to mining and civil engineering projects and ongoing operations, and it plays a vital role in the establishment and maintenance of a safe and stable working environment for mine or civil engineering project personnel.

DMT has many years' experience in designing mines all over the world. This experience spans virtually all mining methods, both surface and underground, for a multitude of commodities. Each year DMT completes numerous mine design assignments, many of which are undertaken as an integral part of a Scoping, Prefeasibility or Feasibility study; but DMT also undertakes detailed mine design (post Feasibility study) and design planning for mine optimisation purposes.

DMT's approach always focuses on understanding the complete mining context and characteristics of the deposit, and of recognising and addressing the specific constraints of each project in order to select the appropriate mining



method and a robust mine plan. Mining engineers are innovative and rigorous in their working practices and are at all times focused on producing practical mine designs and achievable schedules that make the most effective use of mine capital, in both short and longer term time frames.

Their extensive experience from mine planning through to mine decommissioning ensures that designs are innovative, cost effective and environmentally acceptable and maximise the economic benefit of each project.

- Open pit & underground mines
- Mine method selection & design
- Geotechnics & rock mechanics
- Equipment selection & logistics

Typical instrumentation used by DMT are:

GYROMAT 5000

The GYROMAT 5000 is the latest product for high precision direction measurement with an accuracy of 0.8/1000th gon, which corresponds to a deviation in arc of about 1.2 cm over a distance of one kilometer. The time needed for measuring a single direction is only about 6 to 9 minutes. The new piezo drive with a high resolution angle encoder and the new energy concept with a reliable energy storage system and replaceable battery make the system faster, more reliable and easier to maintain. The option to add a theodolite or a total station as required enables the instrument to be used universally for geodetic applications or control work, for example direction measurements under the surface in tunnel surveying or in metrology applications for determination of the geographical north direction.

Based on the high quality laser scanner Z+F IMAGER® 5006, DMT and Zoller+Fröhlich GmbH have developed the world's first explosion-proofed 3D laser scanner IMAGER 5006EX. With a rate of nearly 600.000 pixel/seconds the IMAGER 5006EX allows you to get fast and accurate 3D scans of the surrounding. Due to the ATEX certification, IMAGER 5006EX revolutionises measuring in explosive atmospheres such as in the chemical industry and mining. Services with IMAGER 5006EX especially

in underground mining and sewerage systems support numerous advantages that not only increase safety and productivity but also reduce costs.

The high measurement speed, remote operability and also the interchangeable battery POWER SUPPLY 5006EX, exchangeable in hazardous areas, make the IMAGER 5006EX suitable for use in difficult operating points and thus highly increase the productivity rate.

The world's first ATEX approved 3D laser scanner is certified for the device group I (firedamp mines) I M2 Ex d [ib] op is I Mb and group II (explosive gas atmospheres) II 2G Ex d [ib] op is IIB T4 Gb.

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Ground Monitoring: The earth is far from static; on the contrary, there is continual movement all the way from the surface to deep underground. While this movement is generally very slow, incremental and completely natural, it also can pose significant risks for those in the mining sector – especially those who operate underground mines.

In order to ensure high productivity rates and safety, in some applications, it is vital that a comprehensive ground monitoring system is in place to alert them of sudden, significant movements of soil or rock in or around the project, especially if this leads to excessive deformation or damage to the back or walls of the excavation, or any other event within the project that indicates a potential risk.

Being alerted by the ground monitoring system to all potential events (even small ones) as they arise means that engineering or technical staff can assess potential risk and take immediate and appropriate action, ensuring that



the mine or large excavation is kept safe and productive at all times.

With more than 30 years of combined experience by MDEng personnel in the application of specialized geo-mechanical instrumentation for the assessment of changing ground conditions in both active and non-active mining areas, we offer services relating to:

- Instrumentation system design for ground support assessment and re-design with data interpretation and analysis
- Monitoring of localized ground stability issues with data interpretation and analysis
- Design of instrumentation systems for real-time mine-wide ground stability monitoring
- Design of instrumentation suites for "in stope" hanging wall / foot wall closure monitoring with data interpretation and analysis

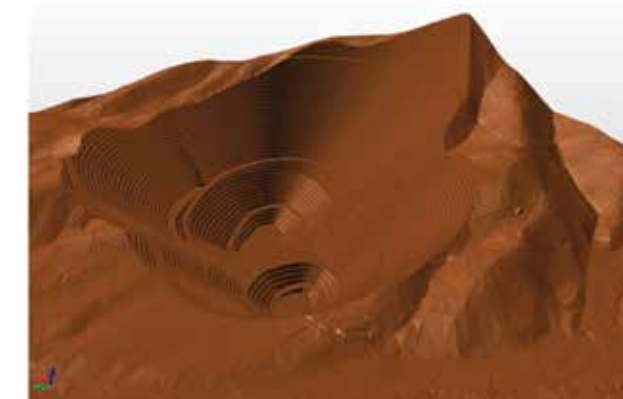
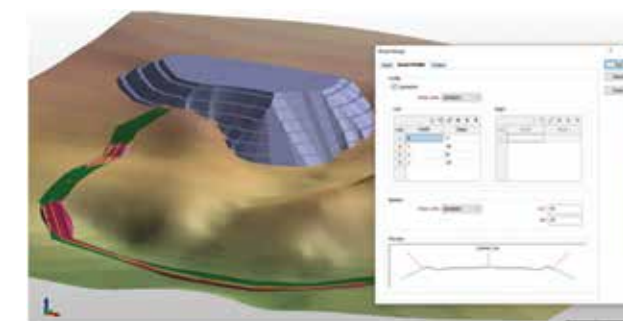
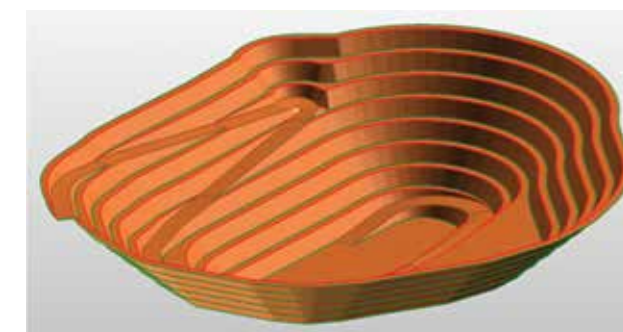
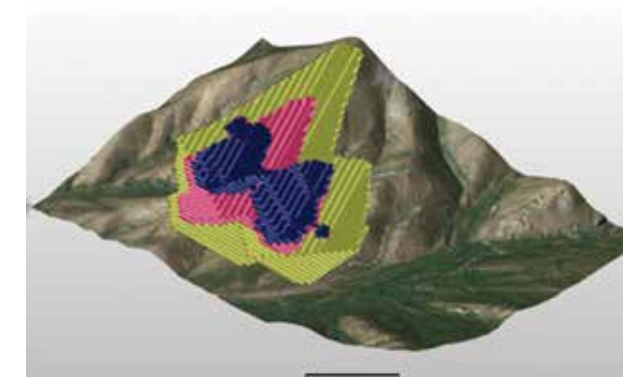
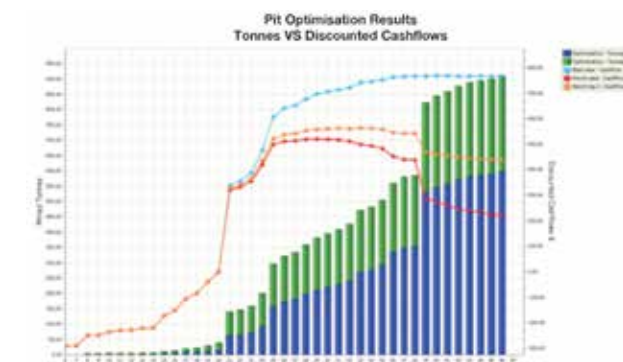
MICROMINE IS ANOTHER COMPANY WHO OFFER EXPERTISE IN 'OPEN PIT PLANNING' AND DATA ANALYSIS.

Historically Micromine software has been recognised for its strength in the realm of exploration and geology. Through the release of more recent versions, Micromine 2016 has become a truly end to end product that also provides users with a number of powerful mine planning tools that can be utilised by engineers, surveyor or other mine planners.

Open pit mine planning typically starts with optimising a block model. Micromine 2016's well established pit optimiser is an intuitive module that provides all the essential mine planning tools engineers require to optimise a block model. The Optimiser also includes an analyse mode and smart charting tool for identifying optimal pits and pushbacks.

Another important mine planning activity is open pit design. If you have an understanding of what a pit should look like, then you can design a pit in Micromine without any issues. Micromine 2016 open pit design tools make pit design feel easy, users have access to many features including; options that prevent typically validation problems with string, automatic realigning of pit walls, auto-build and auto-inclined switchback creation tools.

Micromine 2016 includes a vast range of inbuilt mine planning tools that can be used to prepare and assess different mine designs and plans, the road design tool which uses an input topographic surface and centreline string automatically generates cut and fill solids for



Imager 5006EX explosion-proof 3D Laser Scanner.



visualisation and reporting being one example. Mine planners can utilise this tool quickly assess the impact of different road locations and profiles on practicality and productivity. Another example is the waste dump modeller uses design constraints to automatically generate a waste dump. Mine planners can use this tool to quickly assess the feasibility to different dump designs cases.

RPMGLOBAL AND QUARTILE ONE FORM STRATEGIC PARTNERSHIP

RPMGlobal (RPM) has signed a strategic partnership agreement with Quartile One. This partnership will afford the mining industry with unique value: access to RPM's best practice asset management software aligned with Quartile One's proven data driven asset performance perspective across the mining value chain.

RPM and Quartile One began working together to support the implementation of AMT, RPM's Asset Management software, for a large heavy earth moving equipment fleet.

David Batkin, RPM's Executive General Manager of Technology Consulting and Partners stated, "It is essential to identify and work with the industry's leaders to deliver the best offering for the mining industry. AMT is widely recognised within the industry as the premier Asset Management Software and when deployed with the expertise of Quartile One, it allows an operation to move away from a reactive or preventative maintenance management to a proactive strategy. Therefore, accelerating the maintenance management maturity curve."

AMT is one of RPMGlobal's fastest growing software solutions and has been deployed globally. More than half of the world's mining industry's heavy machinery and operations are managed through this solution; as contractors and original equipment manufacturers continue to strive for more sophisticated asset management strategies, this growth will continue.

Within the partnership, RPM's software, deployment and integration services are bolstered with Quartile One's expertise in change management, training and support

to ensure RPMGlobal software rollouts are implemented smoothly. When you combine the power of the data within AMT with the insight of Quartile One's expert team, data becomes information, and the value unlocked is the holy grail in asset management strategy.

Mr Batkin emphasises stating, "The main goal of any major software implementation project is to improve processes and maximise system integration with minimal disruption. RPM has joined efforts with Quartile One – now we can jointly offer best practice asset management knowledge and change management expertise to achieve that goal."

Since RPM and Quartile One began working together in May 2018, they have completed the successful rollout of AMT to a large mining contractor and are now working together in Australia and in the Ukraine.

"RPMGlobal has long recognised the importance of strategic partnerships and the Quartile One partnership is another of our strategic decisions and will further cement RPM as the industry leader in the space of intelligent mining," said Mr Batkin.

SRK has been providing environmental and social management services to the mining and natural resource industries for over 40 years. We specialise in bridging the gap between engineers and scientists to provide meaningful input to projects. Amongst our clients are many of the world's leading mining and exploration companies, finance institutions and government departments.

WHAT IS AN ESIA?

1. An environmental and social impact assessment (ESIA, or in some jurisdictions EIA or ESHIA) analyses the potential risks and opportunities of a project by following a defined process. It results in a report that can be used to inform a number of audiences including: governments, finance institutes, communities and corporate decision makers. It is usually a prerequisite to obtaining an environmental permit and may also be required for a mining licence, water permit or other government approvals.



Maintenance Maturity Model.

experience. This approach facilitates compliance with regulator's requirements and alignment with good international industry practice, which may be required for project financing. By working together from the start, costly reworking of poor quality studies can be avoided.

- 8 Project financing An ESIA can be used for more than just obtaining a permit. SRK is renowned for working with a wide range of private equity and debt finance institutions to provide due diligence studies, loan monitoring and competent person reporting. We understand their requirements when it comes to environmental and social risk management, and how these can best be addressed through the ESIA process. The ESIA brings together the current project design and various specialist studies, such as socio-economic, water and biodiversity to assess the combined effect on receptors. At SRK, the engineers who design the project (and produce JORC reports, PFS and FS studies) share the same office as our environmental and social specialists. That gives our ESIA's 'the edge' when it comes to in-house mining knowledge. Alice Davies PIEMA MSc Senior Consultant (Environmental and Social Management www.srk.co.uk: adavies@srk.co.uk)



Mine Design Engineering provides specialised services to the mining industry.

Areas of expertise include rock engineering for underground and surface applications, geo-mechanics, numerical modelling, landslide mechanics, mine backfill, ground monitoring and rock mass characterisation.

Mining & Quarry World looks at the requirements, needs, qualifications and commitments to become a Mine Design Engineer.

Mine engineers work primarily to provide technical support and directions for their operations. They also provide estimates relevant to mining construction and are involved with capital/expense projects and equipment selection for the company's mining operations.

Mine engineers may be involved in the customizing, troubleshooting, upgrading and even rebuilding of mining equipment and should decide when machinery must be

2. Why are they needed? A good quality ESIA performed by a respected consultancy can:
 - De-risk the project – the ESIA identifies the key risks, both to and from the project.
 - Inform management planning – by identifying design, mitigation or optimization measures for the impacts predicted to result from the mine.
 - Increase company share price, project NPV and potential future investments – through assessment of alternative designs as part of the process to identify the most environmentally and socially beneficial design, with the lowest risk and optimum CAPEX / OPEX.
 - Save money – by optimization of the project design and operational controls.
 - Indicate a responsible mining company – good environmental performance can be linked back to a quality ESIA report. It also shows shareholders the intent to do things the 'right way'.
3. Value add When applied correctly, the ESIA process adds value to the project by helping to optimise engineering designs and avoiding costly mistakes and project delays. Ultimately helping to identify the issues early when they are easier and potentially cheaper to rectify. Our experts also provide www.srk.co.uk | adavies@srk.co.uk | +44 29 2034 8150 © SRK Consulting SRK provide good quality specialist studies that add value. The reports produced were able to answer key questions relating to impacts and new insights into the project were provided. For more information on our services and a complete directory of our offices, visit our website: informed input to project designs, focusing on key risk areas, with the aim of both reducing negative impacts and potentially costly liabilities.
4. Communicating outcomes Usually ESIA's are submitted as bulky reports, which are challenging for most audiences to digest. SRK is developing innovative field data collection methods and seeking to provide a more digital and interactive deliverable that supports decision making by all parties involved in the process.
5. ESMP The environmental and social management plan (ESMP) arising from the ESIA process is a concise summary of the company's management and monitoring commitments. SRK strives to produce clear, concise management actions that the operational teams can successfully implement.
6. Listen to the neighbours The ESIA process requires consultation with key stakeholder groups including local communities, NGOs, local businesses and government bodies. Although a company is obliged to have community interaction from initial exploration through to closure, the formal ESIA consultation exercises are a good way to evaluate how successful the relationships are. SRK can help you develop, maintain, and implement programs to ensure key groups are identified and the most appropriate communication methods are used both during and after the ESIA.
7. Local content SRK routinely partners with local consultants to ensure our clients get the benefit of local knowledge whilst maintaining international mining

replaced. They work directly with both equipment vendors and mining operations managers, and may serve as liaisons between co-workers and vendors in order to clarify what is needed in non-technical terms. Leadership and interpersonal skills are important in this position, and strong verbal and written communication skills are also beneficial.

Engineers must be able to work independently with minimal or no supervision, as well as in a team environment. Computer skills may be required in order to use various programs and software, and a bachelor's degree in a relevant engineering field is generally required by employers.

WHAT ROLE WOULD A DESIGN ENGINEER HOLD IN MINING?

Design Engineers combine their knowledge of design, engineering and manufacturing processes to create functional products.

Design Engineers research and develop ideas for new products and are involved in designing the systems used to make them. Design Engineers are also involved in overseeing and improving the performance and efficiency of products that are already in existence.

THE DAY TO DAY DUTIES OF A DESIGN ENGINEER IN MINING

- The Design Engineer will create the initial blueprints for mining related structures, systems, equipment and machines
- Design Engineers will typically use extremely advanced computer technology and applications
- Communicate and work with other Engineers to coordinate design plans
- With the help of engineering technicians design and fabricate models of structures equipment and machines
- Testing, which would involve collecting and analysing data from tests on prototypes
- Modifying designs and retesting where necessary
- Writing or presenting regular progress reports
- Meeting with members of various other departments to review prototypes and discuss design modifications and whether the product will meet the desired requirements
- When designing a new idea pay attention to safety and usability
- When designing a new idea pay attention to the efficiency and costs involved
- When designing new ideas would need to pay attention to maintenance and lifespan
- Take into consideration the environmental impact that the new product would have
- Also take into consideration how the product could be safely disposed of once its working life is over

WORKING CONDITIONS OF DESIGN ENGINEER

- Design Engineers would spend a lot of time in front of a computer, or working in a design and drawing office
- Design Engineers may also be required to spend some time on site. Depending on the type of mine, Design Engineers may spend some time in the open above ground, or underground where it can be cramped and hot
- Production sites can be remotely located and can be hot and noisy, and Engineers may be required to wear protective glasses and clothing
- Design Engineers may be required from time to time to travel to and stay away from home for extended periods. They may be required to live on site away from home, or to work on a fly in fly out basis. FIFO commonly involves flying in for a certain period of time whilst the Design would be on site, and then flying home for periods when they are off work
- Design Engineers may get to see the world as if working for large international companies, their job will often involve international travel

EDUCATIONAL REQUIREMENTS OF A DESIGN ENGINEER

- Students interested in entering Design Engineering programs should take courses in mathematics, science and computing in high school
- A four to five year Bachelor's Degree in civil, mechanical, electrical engineering or related would be required
- Relevant subjects include engineering product design, industrial design and computer aided design engineering
- Should you be interested in a Research or Academic position, it will require a doctorate or master's degree
- Many of the more senior positions also require an advanced degree
- Design Engineers will generally have to have a strong background in maths and science and computing
- Specialized onsite training is required

According to a MiHR Sector study report, employee work motivation is typically comprised of two elements: intrinsic motivators and extrinsic motivators.

Intrinsic motivators involve internally generated rewards such as challenge, excitement and the opportunity to demonstrate ones skills and abilities. Extrinsic motivators are externally generated, and typically involve factors provided by the organisation, such as compensation, benefits and opportunities for advancement.

According to the results from the MiHR Student and Knowledge Workers Survey, Knowledge Workers in



general, are more highly motivated by the intrinsic aspects of their work. More specifically they need to feel they are making progress and engaging in meaningful work that is free of organisational obstacles and hindrances.

Whilst one extrinsic factor, being compensation, emerged as a prime motivator for the future career decisions of all students surveyed, the remaining factors were mostly intrinsic in nature. They included the opportunity to engage in rewarding work and apply ones skills, opportunities for learning and development, and having a flexible work environment. Viewed as a whole, the primary motivators for students in both mining and non-mining related programs were not reward based, but tied more to issues to personal fulfilment and career advancement.

TOP FACTORS INFLUENCING STUDENTS' FUTURE CAREER DECISIONS

Students in mining-related programs

1. Rewarding work
2. Compensation
3. Exciting work
4. Learning and developing opportunities
5. Ability to apply skills

The findings from the MiHR student survey did differ slightly from the motivations of the Knowledge Workers already working in the sector. When current mining Knowledge Workers were asked what attracted them to the industry in the first place, the overwhelming majority chose compensation as their primary motivator. Whilst the mining and exploration sector was able to count on its lucrative wages as the number one attractor for young workers in the past, the student survey findings illustrate that the industry may not be able to rely on compensation alone, to attract the new generation of Knowledge Workers.

So even though, money may not be the primary attractor for students in the industry, they do have some clear expectations that they will be well compensated for their efforts.

However the bottom line is that companies need to ensure that not only are future Knowledge Workers compensated well, but that the work they are offered is rewarding and challenging, and that their intrinsic needs are being met. It appears from several reports, that in order for mining companies to be able to attract and retain young graduates, they are going to have to offer work that is challenging and rewarding, as it is not all about the money for these young graduates.

Q&A WITH ANJA VAN DEVENTER PETRA'S GROUP REHABILITATION AND CLOSURE SPECIALIST

What are your key responsibilities?

My key responsibility is to ensure that our operations are legally compliant in matters that entail rehabilitation, closure and financial provision for closure. I have also developed a Rehabilitation Strategy to steer the operations towards sustainable closure objectives. We compile annual rehabilitation plans as well as a closure plan for each mine and these plans are evaluated on an annual basis.

I particularly enjoy conducting LFAs on rehabilitated areas to determine the benchmark for initial rehabilitation, evaluate older rehabilitation and to evaluate the stability of historical sites. The aim is to scientifically validate the rehabilitation status and to remove the given area from the financial provision for closure.

Petra's operations make up a significant part of the South African and Tanzanian diamond industry heritage and therefore keeping these historical gems alive within the boundaries of the closure objectives is a key focus for me.

What do you find most challenging about your position?

Some rehabilitation and closure concepts are "foreign" to those who are not used to environmental jargon. I have therefore had to reinvent my way of communicating with different levels and departments within the Company in order to convey the improvement possibilities of concurrent rehabilitation.

The challenge of finding practical, elegant solutions to complex problems keeps me motivated. There is no "one size fits all" solution for the closure strategy for Petra's operations as the community needs, physical properties of the material and weather conditions will differ in each area. This is something I have to take into account when working on our strategy.

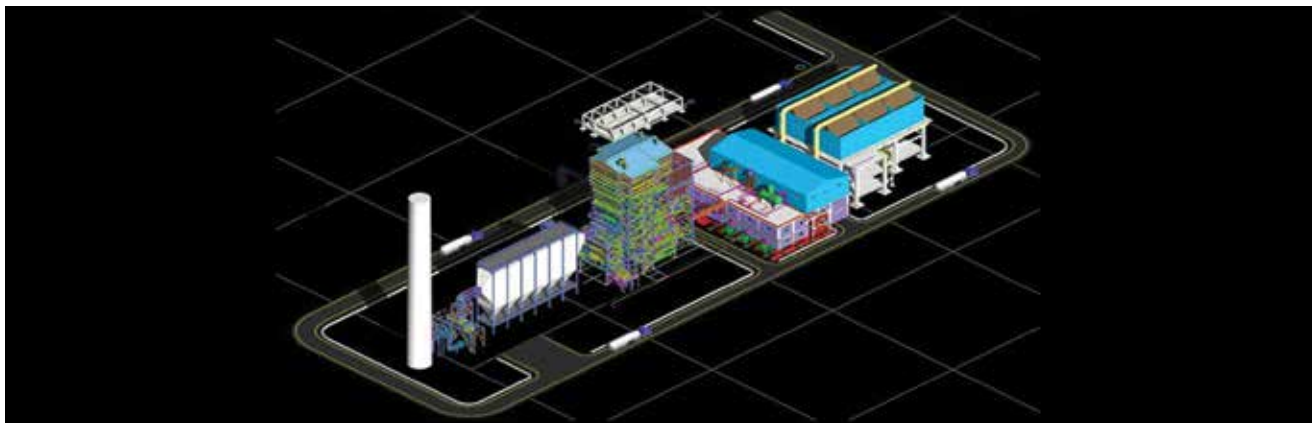
Why do you think there seems to be an increase in interest in mine rehabilitation and closure?

Mining has often been seen in a negative light, due to its impact on resources and ecological functions, however, the current trend to find alternative land-uses in mining impacted areas that will increase the production potential of so called "derelict land" has garnered significant interest. Through mine rehabilitation, areas are now being transformed into positive, contributing resources and some of the most exciting efforts in this area include finding renewable energy options for "problem areas".

Biomimicry is another extremely exiting area of development in the rehabilitation arena, where lessons are taken from nature and implemented in technology with minimum impact on the environment. The overall aim is to find synergies with the natural environment in order to boost the social and economic environment.

What do you think will change about mine rehabilitation and closure over the next five years?

The traditional greening of mine impacted land for the sake of "doing it" will totally disappear, we will plan to restore or alter ecosystem functions. Adaptability for climate change will be a necessity, effluent will be viewed as a resource rather than something that needs to be discarded, the assistance of micro-organisms will have an unfathomable contribution and the reduction (and even positive offsetting) of carbon will influence production as well as future investment.



Reducing groundwater nitrates through improved explosives selection and use

Mines, especially coal mines, in North America are subject to strict water quality discharge metrics, as well as being held to groundwater quality compliance monitoring. This monitoring means limiting the concentrations of several environmental pollutants such as sulphates, selenium, other heavy metals and nitrates in the effluents.

When compared to farming and sewage works, mines have a minor impact on groundwater quality as it relates to nitrates, but it stands to reason that the use of Ammonium Nitrate (AN) based explosives in blasting operations can have some environmental impact at a mine site level. It is incumbent upon mine operations to ensure they choose, and use explosives, in the most environmentally sensitive manner possible, in order to maintain both their social and regulatory Licenses to Operate.

During the blasting process, explosives that undergo a full order, oxygen-balanced, detonation create only three chemicals as a result – water, carbon dioxide and nitrogen – which dissipate into the air after the blast. If the explosives choice and use were to lead to nitrates leaching into the groundwater, the cause can be attributed to fully or partially undetonated bulk explosives product that has been washed (or leached) from the ground by water. A 2006 study by Golder Associates¹ at a surface diamond mine found that up to 8% of the explosives used were either wasted or incompletely detonated, contributing to nitrates leaching into the groundwater.

SOURCES OF FUME AND NITRATE LEACHING WHEN BLASTING

There are a number of potential sources of nitrate leaching when blasting, they include:

1. Design of transfers of Ammonium Nitrate at the site depot to ensure spillages can be cleaned up easily and that storage is not affected by rainfall
2. Unused product left on the bench as a result of poor bench housekeeping; when explosives are spilled around the borehole, or when excess product is discharged on the bench.
3. Using explosives that are insufficiently water resistant in wet ground, particularly ground with flowing, or dynamic, water. The longer such products are left, or “slept” in wet ground conditions, or the more dynamic the water flow is, the more leaching will take place. The overall quantity of explosives that are insufficiently water resistant, in wet ground, will also have a direct impact on the amount of leaching.
4. Poor on bench practices in hole loading, for example top loading a wet hole through water, or poor hose retraction leading to water entrapment in the product and poor detonation through parts of the borehole
5. Product failing to detonate, or detonating incompletely, due to being at or below the critical diameter; **Figure 1** shows that blasting in fractured or seamy ground will

Sources of Nitrates in Mining

MINE OPERATIONS MAIN CONTRIBUTORS

- **Explosives usage.** Water resistance level, sleep time, explosive quality and quantities.
- **Water conditions.** The amount of water getting into contact with explosives is decisive to the transportation of nitrogen into waterways: dynamic vs static water
- **Explosives management.** Losses and spillage of explosives may take place during storage of Ammonium Nitrate raw materials, filling of explosives loading equipment, actual loading of blastholes, spillage on bench and disposal of excess product.
- **Efficiency of the blasting operations** will control the amount of undetonated explosives and the amount nitrogen available in these. Failures may happen e.g. by poor design or execution, fractured ground, poor loading practice, explosive quality, stemming, washout. NOx fume.
- **Other sources:** Nitrogen content from rocks



lead to some of the explosives migrating into cracks and fissures with a diameter (or width) less than the critical diameter and thus remaining in the muckpile after the blast.

6. Product being “dead-pressed” (due to dynamic pre-compression) above the density to detonate completely due to poor blast design such as incorrect pattern size in weak geology or inappropriate initiation system timing between holes and rows.
7. Improper explosives truck operation whereby the product is loaded with the wrong density or incorrectly mixed.

8. Product contaminated by stemming. This can occur when loaded explosives mix with the stemming material, or emulsion blends are loaded from the top of the hole (rather than pumped in from the bottom) and cling to the sides of the blasthole.

Interestingly, these sources of nitrates are the same sources that generally contribute to nitrous oxide (orange) post-blast fumes being generated during blasting, an outcome that can also lead to License to Operate issues for a mine operator.

FUME AND NITRATE LEACHING RISK REDUCTION PROGRAM

Over the years, Orica has developed a comprehensive risk reduction program that helps mining companies reduce both fume and nitrate leaching.

The first step in the program is to engage with the customer when notified of the problem with a bench top self-assessment to identify any specific key issues. As part of our commitment to excellent product stewardship, Orica will dispatch explosives experts to the customer site to begin the second step – a detailed site audit of the blasting operation starting with an assessment of the geology and ground conditions, followed by a review of the drill pattern, explosives product selection and the blast initiation timing employed. In addition, an audit of the site depot and blasting procedures will be undertaken, reviewing the “hygiene” and housekeeping practices of the blast crew as they load the holes and the mobile manufacturing units as they load the equipment.

From the site audit, Orica will work with the customer to define, from the possible sources of nitrates and/or fume, what steps need to be taken to mitigate or resolve the problems.

I feel we have covered the potential sources above, do we need to repeat them again here. Or do we only do a high level in the top section (like in the presentation) and then dive into more detail here in what the outcomes might be from the audit. Working through the list of sources of nitrates outlined above, some or all of the

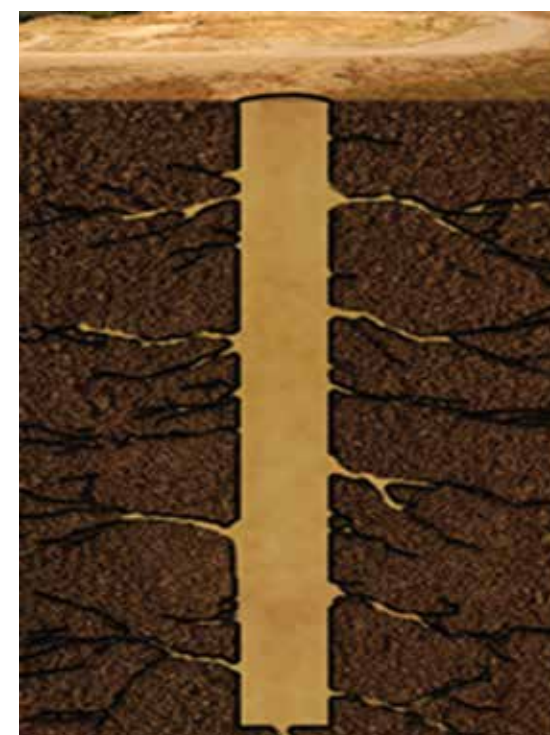


Figure 1: Fractured ground after blasting



Figure 2: Increased clinging of explosives on a blasthole wall as the percentage of emulsion in the blend increases.

following proposals could be offered to reduce both fume and nitrate leaching:

- 1. Improved bench housekeeping.** This is one of the easiest places to start as care when loading explosives should be an expectation of any blast crew. Ensuring that product augered or pumped down a hole is confined to that hole is mostly a matter of allowing the team to work systematically, not speedily – taking time to properly position the loading equipment and making sure that excess product in the hose or auger is used appropriately down a hole rather than dumped on the surface.
- 2. Explosives water resistance.** All manufacturers of explosives can provide data showing the relative water resistance of their products. Mine geologists can provide information about regions within the mine that have wet ground conditions, whether that be static or dynamic. Choosing explosives products that have the appropriate level of water resistance can follow. There is also a procedural element to this solution; ensuring that blast crews do not “dry out” a hole by loading Ammonium Nitrate Fueled Oil (ANFO) into a hole with some water at the bottom. This practice leads to dissolved and a non-explosive product at the bottom of the hole, exactly where the primer is. This can lead to misfires and large amounts of undetonated explosives in the muckpile; a clear source of nitrates available to be leached into the groundwater.
- 3. Critical diameter.** In fractured ground it is important to use an explosives product with high viscosity which slows or limits the possibility that product will flow into cracks or fissures and remain undetonated after the blast. Certain higher viscosity products can also be gassed to a lower density while maintaining a high relative bulk strength. Thus, overall, relatively less product is put into the ground which will reduce the possibility for higher nitrate levels. Another way of accomplishing this is to use a plastic hole liner that encases the explosives inside the hole. However, this technique can lead to changes in how the explosives detonate (due to the additional fuel from the plastic), adding to the time taken to load each hole and, if torn, can lead to water contaminating the explosives products and subsequent misfires.
- 4. Eliminating “dead pressing”.** This is an important step

that needs to be accomplished when designing the blast: understanding the geology of the bench, particularly changes in hardness or lithology across the blast before designing the drill pattern (burdens and spacings) and the explosives load per hole. The key here is to ensure that the dynamic pressures radiating from each hole as it detonates is attenuated sufficiently before encountering upcoming undetonated holes. Failure to do so can lead to the explosives being compressed such that their density increases beyond the point of its ability to detonate. This will lead to misfires and, again, undetonated product being left in the muckpile, not to mention the resulting poor fragmentation and movement of the blast.

- 5. Improved explosives loading truck operation.** Having a well maintained and well calibrated explosives delivery truck is paramount to ensuring that products delivered down the blasthole have the correct oxygen balance, the correct density, and the correct sensitivity in order to perform as designed. A straightforward way to check that this is occurring is to do a Velocity of Detonation (VOD) test and compare the in-situ VODs against the design specifications. Some mines will have this test highlighted as a contractual obligation of their explosives’ provider.
- 6. Stemming contamination.** Another good practice during explosives loading is to insert a barrier or cap (sometimes called a “witch’s hat” or stemming plug) between the explosives and the stemming. When stemming migrates into the explosives, the resultant contamination can lead to undetonated product (and poor fragmentation) in the stemming zone, again leading to nitrates in the muckpile. Another source of nitrates in this zone can occur if pumped product is top loaded. Emulsion blends should always be loaded from the bottom of the hole so that the explosives rise can be measured (so the hole is not overloaded) and to ensure product does not bridge or cause a discontinuity, resulting in misfires, in the explosives column.

Beyond the procedural, or housekeeping, practices noted, choice of explosives is the most effective step a mine can take to mitigate against nitrate leaching into groundwater. Orica has developed a range of emulsion-based products that are specifically designed to provide the appropriate levels of water resistance, density, and viscosity to meet

the range of ground conditions encountered by surface mining operators. When used in concert with data from “smart drills” (that can provide real time rock hardness/lithology metrics) and advanced blast design software through the BlastIQ™ blast optimisation system, Orica can provide the equipment and services that will tailor the explosives specifications to maximize blasting performance while minimizing blasting costs and minimizing the issues caused by nitrates leaching into the mine’s groundwater.

Orica has made great strides in the development of explosives and delivery technologies to minimize undetonated explosives and thus, nitrate residual. In 2019, Orica developed Fortis™ Protect, a thicker emulsion chemistry that can be thickened further through our explosive delivery MMU™ (mobile manufacturing unit) to

the blasthole. While maintaining the capability to blend the emulsion with AN prill, this system provides a robust solution to minimize seepage into cracks and crevices while delivering the right blast outcomes.

With our 140 years understanding and advancements in explosives chemistry and delivery technology, Orica is providing the technical know-how and effective solutions to reduce nitrate leaching so that our customers can operate within environmentally safe guidelines and achieve high levels of operational productivity.

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1. Golder Associates, 2006. Report On Review of Blasting Operations and Explosives Management Diavik Diamond Mines. DCN 103. May 2006.

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Solar energy in the Mining Industry

Certain mining operations have unusual demands when it comes to power supply. So, there are many companies that are now supplementing their mining operations by using solar energy. There is no doubt that this form of energy is a cost cutter and helps to save the other sources of energy from running out.

RELIABILITY

We all know that most mines operate round the clock, so the mining operators would expect constant availability and high reliability from the various power systems without any shortfalls. Solar plants with battery banks can store a lot of solar energy. Other solar technologies can also be used to generate steam which in turn runs a turbine and produces electricity. These power plants can work well in isolation and can provide services without any problems. The best part is that as a mining operator you do not have to depend on natural gas or diesel. If you are carrying out mining operations in remote places it may be logistically difficult and expensive to transport fuel. Natural gas also has significant financial and logistical challenges.

THE IMPORTANCE OF SOLAR ENERGY IN THE MINING INDUSTRY

Certain companies that provide solar energy to the mining industry can integrate fossil fuel, photovoltaic panels, and Concentrated Solar Power (CSP) seamlessly. The CSP technology used in mining operations can offer 90% capacity factor. To achieve 100%, you may consider using diesel generators to supplement the shortfall. This is by far the most cost-effective way to power mining operations. If you run a small mining operation then you could consider using PV solar to bring down the cost of energy and cut down on the emission of CO₂ and you will also reduce dependence on the use of diesel.

SOLAR ENERGY IS INDEED A BOOM TO THE MINING INDUSTRY

There are many companies out there that provide solar energy to power mining operations but not all of them

are reliable. Caution needs to be adhered too about the company you decide to hire. Make sure you carry out a thorough due diligence and research the company you are working with who will design and install the system.

There is no doubt that the sun can generate huge amount of energy and it is used not only to power homes and appliances, but the mining industry is making effective use of it. The mining operators will no longer have to depend on the other sources of energy.

SITUATION

As the largest economy in Latin America and the ninth largest in the world, Brazil is a Southern Hemisphere economic powerhouse that relies heavily on mining. Gold, copper, tin, iron, bauxite, and gemstones top the list of items extracted from Brazil's mines and directly drive its economy.

To ensure its expansion and growth, the Brazilian mining industry is increasingly turning to solar power to support its mining operations. Powering these can be a challenge – a mine has inherently high energy consumption due to the heavy equipment, lighting, and safety and ventilation required. Add to that the fact that mines are usually in very remote locations and pose safety concerns with either no or unreliable grid access. Often mines must rely on noisy, emissions-producing diesel generators with their significant fuel and maintenance costs to supplement their on-site electrical consumption.

Replacing diesel generators and augmenting unreliable grid power with local renewable energy sources has the potential to reduce mining operation greenhouse gas emissions as well as costs, by reducing or eliminating production delays due to load shedding and power outages. Which is why mine operators across Central and Latin America, and especially in Brazil, are increasingly turning to solar electricity to take advantage of the regions'

abundant sunshine and harvest the electricity required locally, cleanly, and more cheaply.

PROJECT

One firm specializing in renewable applications for mining is Trailers RD-Minas, a company based in Belo Horizonte, Brazil. Trailers has 17 years of design, manufacture, and assembly experience in developing solutions for mining companies in the areas of dispatch, data networks, cameras, and lighting. Their engineered solutions are renowned for improving worker safety and performance while also reducing maintenance costs.

To develop energy systems with the long-term dependability and performance demanded by mining operators, Trailers specifies Morningstar solar controllers in their projects, specifically the TriStar MPPT-60, TriStar Meter-2, Pro-Star MPPT-40 and SunSaver-MPPT-15 solar controllers. In fact, Morningstar components are installed in over thirty separate Trailers mining, construction, road, and airport sites throughout North America, South America, and Africa, in projects including mobile radio repeaters, mobile surveillance cameras, and mobile light towers.

SOLUTION

Mobile radio repeater trailers provide customers with real-time view of the status of their solar panels, batteries, operating cycle, and position, at remote locations. This facilitates maintenance and avoids unnecessary shifting and/or allocation. These specially designed and constructed trailers feed into the AC network and are mounted with a generator, air conditioning thermal insulation and battery banks. A typical trailer's chassis might accommodate 8, 14 and up to twenty deep cycle batteries rated at 110Ah to provide sufficient autonomy in remote applications.

For on-site lighting, mining operations use mobile light trailer towers with high efficiency LED spotlights powered by batteries recharged with solar panels and sometimes a wind turbine-powered generator (an option offered for regions with sufficient high wind). These lighting trailers are automatic, and do not require an operator to turn on at night or turn off in the morning. When fully automated, a tower can operate for 28 hours without incident of sunlight, over a day of autonomy. They are ideally suited for use in mining, maintenance stations, workplaces and other locations that require illumination for safer work at night. Unlike conventional diesel lighting trailers, Trailers RD-Minas' designs do not require fuelling, filter replacements, belts, lubrication, and other maintenance items – or even frequent bulb replacements since the LED spotlights can last about 50,000 hours.

It has been said that all the riches in the Earth originated in the Sun – and if so, then there's poetic justice in tapping directly into the sun's power to extract them more efficiently, safely, and cleanly. Minas' engineering combined with Morningstar's technology is rapidly improving one of the world's oldest industries to ensure that Brazil and other developing countries maintain their economic momentum. Morningstar Corporation features examples of products used by customers across a wide variety of environments and systems, to highlight their flexibility, performance, and dependability. Installation best practices and preferences can vary across diverse regions and applications, and the examples shown here are for general interest and not intended as a guide. Always consult local codes and refer to product installation manuals for correct requirements.



Rio Tinto and Sandfire are committing to solar energy, helping drive efficiency and sustainability.

Together, the world's active mining operations consume four hundred terawatt hours of electricity per year. Because mines are often isolated from electric grids, providing this power typically means trucking in fuel at great expense over rough, dangerous roads. Determined to cut expenses and improve reliability, mines around the world – including Australia's Weipa and DeGrussa operations – are looking to the power of the sun for energy solutions.

Reliance on diesel fuel to power on-site electric generators has, for many years, been recognised as a problem. In Australia alone, mines and other remote industrial facilities self-generate around 1.2 gigawatts of power on average by burning diesel fuel. That fuel is subject to all the price uncertainty associated with petroleum, on top of the expense inherent in trucking it to remote destinations. Supply breakdowns are also common, resulting in lost productivity.

"The mining industry has clearly reached a tipping point, with a growing consensus that renewable energy at mine sites, both grid-tied and off-grid, is doable and, in many cases, desirable," Navigant Research observed in a recent report.

Although renewable energy in various forms has been widely used for decades now, it has typically been too expensive to appeal to price-conscious mine managers.

Advances in technology have brought costs down in many cases, though, leaving mine operators in particularly well-suited places eagerly turning to technologies like solar power. In Chile, for instance, the country's complete reliance on imported petroleum and the deep-blue skies of the mine-studded Atacama Desert have meant that solar has made sense for some time already.

At the Codelco copper mine, a high-tech thermo-solar plant provides around 80% of the mine's overall electric power needs, producing electricity right through the night by releasing energy trapped in specialized heat-storing batteries. That saves the mine from needing to transport diesel up a winding road over a rise of more than 2.5 kilometres.

If the clear skies of Chile's Atacama Desert make the country an especially eager adopter of solar power for mining, Australia is not far behind. Two of the country's most significant mines, the Degussa copper mine operated by Sandfire and Rio Tinto's Weipa bauxite mine, are also making the move.

With 1.7 megawatts of solar power having just recently come online at Weipa, Rio Tinto was the first mine operator in the country to enjoy solar on such a large scale. That initial phase will be supplemented by more solar panels in the future, bringing the total generating capacity to just under seven megawatts.

Further work will also include the addition of storage batteries allowing the facility, like that at Chile's Codelco mine, to produce power through the night to support round-the-clock mining. Overall, project directors expect to cut down on the mine's usage of diesel by 600,000 litres annually, with 20% of all daytime power needs being satisfied by photovoltaic solar panels.

When it is completed, the recently begun project at Degussa – nine hundred kilometres from Perth – will be even more significant. It will eventually top out at more than ten megawatts, taking care of over half of daytime electricity

requirements and cutting back on diesel usage by five million litres per year. Lithium-ion battery banks will store up to six megawatt-hours of power, with the whole project being financed under a 6-year power-purchase agreement.

Although attractive for a number of reasons, both projects have been made more appealing by support from the Australian government. The Australian Renewable Energy Agency, or ARENA, has funded the Degussa work to the tune of \$20 million, accounting for over half of overall funding. The Weipa work has already drawn on \$3.5 million in ARENA funding and will up the total to \$8 million before the final phase is finished.

Even with clear skies and the difficulty of transporting diesel seeming to recommend solar, it can take some encouragement of other kinds to tip the balance.

Ultimately, of course, solar power must stand on its own inherent merits, whether in the mining sector or elsewhere. Panel prices are still dropping and efficiency improvement will help, as will the development of better storage solutions to rely on when the sun goes down or becomes obscured. Between these developments and the lessons that will be learned through ambitious projects like those now underway in Australia, it seems that solar power will feature more prominently in mining operations around the world.

Australia's largest hybrid renewable microgrid – the 56MW solar, wind and battery project developed by EDL at the Agnew gold mine in Western Australia – has had its official launch, some six months after its completion during the Covid-19 pandemic.

The ground-breaking microgrid combines five wind turbines (18MW), a 4MW solar farm and a 13MW/4MWh battery energy storage system, to provide an average of between 50-60% of renewables for the mine in WA's northern Goldfields region.

The renewable components of the off-grid system are backed up by a 21MW gas/diesel engine power plant and managed by an advanced microgrid control system that has, in favourable conditions, achieved up to 85% renewables at the mine.



The ARENA-backed microgrid project was developed and is now operated by EDL under a 10-year agreement to supply power to the Agnew gold mine, which is owned by the company Gold Fields.

The project started by adding the solar to the gas and diesel plant in 2019, and then installed the wind turbines in early 2020, making it Australia's first mining sector project to use wind power as part of a large hybrid renewable microgrid.

A similar non-resources project is currently being developed to meet just under half of the energy needs of the Western Australia coastal town of Esperance, using a mix of 4MW of solar, two 4.5MW wind turbines, a 5.5MW/1.9MWh lithium-ion battery system and gas generators.

The WA resources sector has served as an important test-bed for innovative renewable energy and battery based microgrid power solutions, including a hybrid solar and battery system being put together by Juwi Renewables for the Gruyere Gold Mine, which Goldfields also owns alongside Gold Road Resources.

Goldfields vice president Australasia, Stuart Mathews, said on Thursday that the Agnew project was a testament to what could be achieved by taking courageous decisions and demonstrating true leadership.

"This is important to all of our stakeholders, including our employees, who want to see tangible outcomes in relation to our environmental, social and governance priorities and sustainability vision," Mathews said.

"With demonstrated success in construction and now operation, this project has provided a framework to take innovative energy solutions further across Gold Fields' mine sites both in Australia and around the world."

EDL CEO James Harman said the Agnew microgrid had highlighted engineering excellence at every stage – from its inception to its innovative integration of five energy technologies, to its navigation through a bushfire and a global pandemic.

"Credit must go to Gold Fields for its vision and belief that we would successfully deliver this complex project; and

credit must go also to the entire project team, including EDL and all our contractors, who worked tirelessly to safely deliver the Agnew Hybrid Renewable Project on time and on budget.

"Since we completed the microgrid in May 2020, and pulled the switch, it has been powering Gold Fields' Agnew Gold Mine with clean, reliable renewable energy," Harman added.

"EDL's hybrid renewable journey has not stopped with this landmark project. As the energy transition continues at pace, our goal is 100% renewables, and we look forward to continuing our work to make this a reality."

Earlier this year, the CEOs of five major mining companies – including Gold Fields – pledged to shift their operations to renewable energy, and to help accelerate the broader decarbonisation of the industry, as part of an unprecedented collective agreement.

As Renew Economy sister site One Step Off The Grid reported, South32, OZ Minerals, IGO, Gold Fields Australia and Barminto co-signed a statement of intent committing to the electrification of their mine sites, paving the way for the phase-out of costly and heavy-polluting diesel generation.

The pledge was made in conjunction with the establishment of the Electric Mine Consortium, founded by a group of 14 companies in response to climate change and in a bid to harness the economic and social benefits of clean energy, large-scale storage and battery electric vehicles.

WHAT ARE THE CURRENT AND UPCOMING INNOVATIVE MATERIALS?

A typical solar cell consists of semiconducting materials such as p- and n-type silicon with a layered p-n junction connected to an external circuit. Sunlight illumination on the panels causes electron ejection from silicon. The ejected electrons under an internal electric field create a flow through the p-n junction and the external circuit, resulting in a current (electricity). With a swiftly growing market and the development of creative applications, R&D on innovative solar energy materials is at its peak to achieve maximum solar-to-electricity efficiency at low

cost. Three types of highly investigated semiconducting materials of today are crystalline Si, thin films, and the next-generation perovskite solar cells (PSCs).

CRYSTALLINE SILICON

Crystalline silicon (c-Si) is the most used semiconducting material in solar panels, occupying more than 90% of the global PV market, although the efficiency is significantly under the theoretical limit (~30%). Solar cells made of alternative low-cost and high-efficiency materials are emerging.

The National Renewable Energy Laboratory (NREL) is driving the development of high-efficiency crystalline PVs, which includes III-V multijunction materials (with target efficiency of >30%) and hybrid tandem III-V/Si solar cells. Their six-junction III-V solar cells have reached an efficiency of 47.1% under concentrated light. Moreover, Si-based bifacial technology can harvest solar energy from both sides of the panel, with 11% more efficiency compared to standard panels.

Thin Films

Second-generation thin-film solar cells are appearing as one of the most promising PV technologies due their narrow design (350 times smaller light-absorbing layers compared to standard Si-panels), light weight, flexibility, and ease of installation. Typically, four types of materials are used in their construction: cadmium-telluride (CdTe), amorphous silicon, copper-indium-gallium-selenide (CIGS), and gallium-arsenide (GaAs). While CdTe has a toxicity concern due to the cadmium, the CIGS solar cells are turning out to be the more promising high-efficiency and economic options for both residential and commercial installations, with efficiency up to 21%.

Perovskite Solar Cells

Among the next-generation solar cells, hybrid metal halide perovskite solar cells (PSCs) have garnered a great amount of attention due to their low price, thinner design, low-temperature processing, and excellent light absorption properties (good performance under low and diffuse light). PSCs can be flexible, lightweight, and semi-transparent. Notably, perovskite thin films can also be printed, leading to scalable high-throughput manufacturing, and a recent roll-to-roll printed PSC has reached 12.2% efficiency, the highest among printed PSCs.

Notably, combined perovskite and Si-PV materials have shown a record efficiency of up to 28% under laboratory



An Oxford PV solar module.

conditions, as demonstrated by Oxford PV. While stability and durability have remained a major concern, a recent low-cost polymer-glass stack encapsulation system has enabled PSCs to withstand standard operating conditions. Although PSCs are still not commercialized, they hold significant economic and efficiency advantages to drive the future of the solar energy market.

WHAT ARE THE BREAKTHROUGH INTEGRATIVE SOLAR CELLS TECHNOLOGIES?

Apart from innovative materials, creative methods of harvesting maximum solar energy are also emerging. For example, Swiss start-up Insolight is using integrated lenses as optical boosters in the panels' protective glass to concentrate light beams by 200 times while reaching an efficiency of 30%.

Another recent development is the designing of prototypes of thermoradiative PV devices, or reverse solar panels, that can generate electricity at night by utilizing the heat irradiated from the panels to the optically coupled deep space, which serves as a heat sink.

Interestingly, along with innovative materials, integrative applications other than standard rooftop installations are also rising and are currently in their infancy. For instance, solar distillation can harvest solar energy while utilizing the dissipated heat from panels to purify water, if there is an integrated membrane distillation attachment.

Another transformative technology of the future could be solar paints, which include solar paint hydrogen (generates energy from photovoltaic water splitting), quantum dots (photovoltaic paint), and perovskite-based paints.

Furthermore, transparent solar windows are highly innovative applications, and Ubiquitous Energy has achieved a solar-to-electricity conversion efficiency of 10% with their transparent materials. A demonstration from Michigan State University, a pioneer in this technology, can be seen in this video:

With the rapid development of low-cost, high-performance semiconducting materials, space-saving thin films, and easily installable technologies, the solar energy market is expected to boom in the next five years. Despite the setback caused by the pandemic, the anticipated cost reduction of 15% to 35% by 2024 for solar installations is encouraging and could make this renewable energy more affordable.



Liebherr to unveil new Kalgoorlie branch

Liebherr-Australia is set to open a mining branch in Kalgoorlie in January 2022, its third in Western Australia.

The Kalgoorlie branch will support Liebherr's growing fleet of equipment and customer base in the Goldfields region, providing fast access to spare parts and customer service.

The branch will be supported by full-time parts personnel, with customer support and service teams using the branch as a hub when travelling between sites.

"Returning to Kalgoorlie marks the success we've had in recent years in growing our equipment fleet in the region," Liebherr-Australia managing director Trent Wehr said.

"We have always been committed to providing

the best support to our customers and establishing the Kalgoorlie branch will only further enable us to provide these services."

The opening marks a return to the region for Liebherr-Australia, which was there through an agent between 1986 and 1990, before taking over the official original equipment manufacturer (OEM) dealership in the region from 1990 to 2006.

In recent years, Liebherr's footprint of mining equipment has grown, now supporting more than 30 excavators and trucks, over 15 mine sites and nine customers, with more scheduled into 2022.

The branch will be in the



city on a 10,000m2 block, incorporating a 1000m2 warehouse and 180-square-metre office space, with necessary parts and Liebherr tooling held in the facility.

Liebherr-Australia's mining customer support network includes branches at Mackay in Queensland, Mt Thorley in New South Wales, Perth, Newman, and soon-to-be Kalgoorlie

in Western Australia, along with the head office, national distribution centre and production facility in Adelaide, South Australia.

The Kalgoorlie branch will begin operations in January 2022, with Liebherr-Australia to hold an official opening ceremony with key customers and partners in the first quarter of 2022 to celebrate the milestone.

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Dust control and management

To understand dust suppression, it is necessary to have a basic understanding of surface and underground mining processes. Since the 1969 Health and Safety Act, the mining industry has experienced many changes in the production processes used. As an example, more than forty years ago we were mining much cleaner coal seams and production demands in mining were not as great as they are today. During this time- period the first dust standard for underground coal mines was set at 3/mg3.

Underground and surface mining equipment has been modified to be much heavier and faster than ever before to meet production demands, giving rise to a rigorous scrutiny when being submitted for the approval process. These are but a few of the many challenges that the mining industry is confronted with now and in the future.

However, it is important to note that while legislation is adhered to, all companies adopt their own practices and methods to tackle this problem, some companies form their own hierarchy of controls, these can take varying forms dependant on the environment you are working in, a typical hierarchy could look something like the one below:- (although this is not an exhaustive list)

HIERARCHY OF CONTROLS

Hazard controls should be applied in this order:

1. **Elimination** – remove the hazard, or the need to perform the hazardous activity.
2. **Substitution** – substitute a safer alternative.
3. **Separation/isolation** – isolate or separate people from the hazard by use of barriers, distance, or time.
4. **Engineering controls** – redesign or modify tools or equipment.
5. **Administrative controls** – use training, rules, procedures to reduce the risk of the hazard.
6. **Personal protective equipment** – provide fit-for-purpose protective equipment.

More than one control may need to be used to control the hazard. Controls used must be maintained to ensure they continue to remain effective.

Mining and Quarry World takes a detailed look at a variety of approaches being adopted by the mining industry.

DEFINING DUST

Dust is a term that refers to particles that are smaller than ten micrometres (PM10) and are susceptible to airborne transport. The background to the problem of dust in haul mine roads revolves around the use of mining haul trucks in all surface mine operations. Transit of mining materials within or from mining premises results in haul trucks generating most of the dust emissions which is 78% to 97% of total dust emissions. The short-term challenge posed by dust is as a safety hazard through impairing visibility of

haul truck and road grader operators thus increasing the chances of accidents. Consequently, the long-term hazard to prolonged and over-exposure to respirable and inhalable dust is penetration into the respiratory system and settling in the alveolar region of the lungs. Pulmonary inflammation is triggered leading to toxic responses and eventually, the condition of clinical silicosis develops. The type of dust, its concentration and duration of exposure determine whether it is acute, accelerated, or chronic silicosis.

Non-silica dust is harmful, but not as bad as silica dust, so different government guidelines apply to activities where non-silica dust is created. Non-silica dust is present in construction supply materials such as cement, dolomite, gypsum, limestone, plasterboard, and marble. Non-silica dust is created from cutting, blasting, or grinding the materials. In comparison respirable dust is fine dust which can be inhaled and reach the lungs. It is measured as smaller than ten microns in diameter. There are respirable dust types that include silica, and ones without. Both types of dusts, if respirable, need to be treated as very harmful to workers and those in the local communities. Special caution needs to be applied to suppress respirable dust.

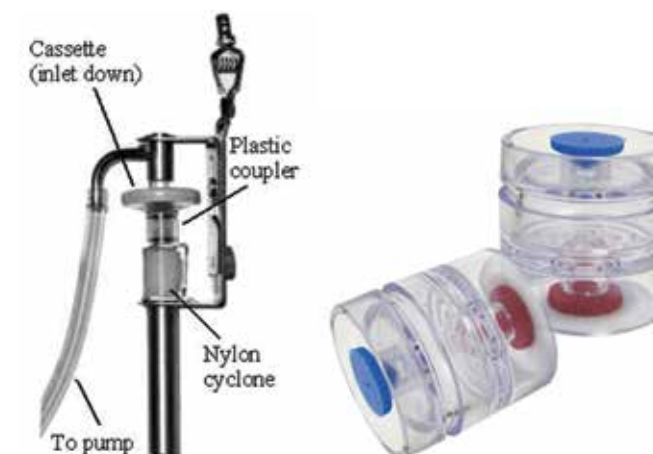
Classification of dust particles

| Fraction | Size Range |
|------------------------------|------------------------------------|
| PM10 (thoracic fraction) | $\leq 10 \mu\text{m}$ |
| PM2.5 (respirable fraction) | $\leq 2.5 \mu\text{m}$ |
| PM1 | $\leq 1 \mu\text{m}$ |
| Ultrafine (UFP or UP) | $\leq 0.1 \mu\text{m}$ |
| PM10-PM2.5 (Coarse fraction) | $2.5 \mu\text{m} - 10 \mu\text{m}$ |

Particles larger than $10 \mu\text{m}$ are filtered out in the upper air passages before they reach the lungs.

Particles with a diameter of $<10 \mu\text{m}$ are respirable (i.e., able to be inhaled into the lungs). Particles which have reached the lungs are deposited there and are removed very slowly over time (respiratory illnesses).

The most common type of sampler used in the mining industry is the gravimetric sampler. This device is designated for use in compliance dust sampling by the Federal Coal Mine Health and Safety Act of 1969. It consists of a constant-flow sampling pump, a size selective cyclone, and a filter cartridge. For coal mining operations, the sampling pump should be calibrated to operate at 2 lpm.



In metal/nonmetal mining operations, the pump should be operated at 1.7 lpm. The 10-mm Dorr-Oliver cyclone separates the oversize dust from the respirable fraction (usually considered to have an aerodynamic diameter of ten μm or less). The oversize dust is deposited into the grit pot at the bottom of the cyclone, while the respirable fraction is deposited onto a 37-mm-diam polyvinyl chloride (PVC) filter. The filter collects the respirable dust and should be weighed by a qualified lab to determine the mass of dust that has been collected during sampling. The mass of dust and the volume of air sampled are used to calculate the concentration of respirable dust in milligrams per cubic metre.

The most obvious hazards in coalmines are the presence of gas and the threat of explosion, as well as floods in wet mines and structural collapse in particularly unstable ones. But two other killers, pose significant risks to mine workers. They are pollutants in the form of coal dust and diesel particulates from engine fumes. Dust is a recognised hazard for workers in the coal industry; particularly for those working in underground coal mines.

The formation of dust and the associated impact on employees, animals and technology plays a significant role in many areas of manufacturing. Dust can occur everywhere where materials are loaded, unloaded, or processed. Controlling coal dust is vital to worker safety because of the risk of coal dust explosions. In addition to creating safety and environmental hazards, coal dust increases the cost of maintaining material handling equipment.



COAL MINE OPERATORS: THE GENERAL REQUIREMENT

As an example, in Australia all coal mine operators are legally required to monitor and manage worker exposure to respirable airborne coal dust.

Mine operators must have a documented Dust Management System to ensure respirable dust is kept to an acceptable level and statutory exposure standards are met. They must ensure workers do not breathe an atmosphere containing respirable dust exceeding concentrations of three milligrams per cubic metre of air during an 8-hour shift.

Dust control measures must be in use such as suppression sprays, ventilation, scrubbers, positioning of operators and the use of personal protective equipment by workers.

Mines must monitor respirable dust levels and make the records of that monitoring available to workers. In most countries legislation requires Mines Inspectors to monitor industry compliance, including the review of dust monitoring data and visual inspection of the work areas at the mine. All coal mine workers are also required to undergo a mandatory Coal Mine Workers Health Scheme medical assessment prior to the start of their employment and then at least once every five years.

NONCOMPLIANCE

Where mines are found to be non-compliant, Mines Inspectors can issue a legal Directive to operators to achieve compliance. Prolonged non-compliance can result in penalties including suspension of production. Directives issued require a mine to develop dust reduction action plans and demonstrate a process where they will reduce their dust exposure to an acceptable level in a timely manner. Plans must focus on implementing engineering controls as the priority to ensure that any improvements are sustainable; and those mines implement these action plans and monitor worker exposure to demonstrate the effectiveness of the control measures.

The need to increase the productivity of any Coal mining operation requires mining equipment and practices to be improved. Unfortunately, increased production also results in the potential for increased respirable dust generation and worker exposure. In response, US operations are applying basic controls at elevated levels and looking to emerging technologies to better control respirable dust levels.

Ventilating air and water sprays remain the basis of dust control strategies for both longwall and the continuous



mining operations, and the level of application for these controls continues to increase. In addition, modern technologies are emerging that have the potential to further reduce dust levels. The National Institute for Occupational Safety and Health (NIOSH) has been conducting research into methods to optimize existing control technologies and evaluate emerging control technologies.

In general, spraying dust with liquid adds weight to the particulate matter and prevents it from becoming airborne or settles it quickly, if already airborne. A wet particle can become accumulated to another particle, or it can adhere to a surrounding object (e.g., a wall or other obstruction).

Depending on the application, several different spray procedures are available for dust suppression:

- For small, localized dust emission points (e.g., for conveyor belt operation), "static" systems are used, meaning water is sprayed from nozzles which are mounted on fixed pipes within the dust area.
- For broader defined areas (e.g., halls, dumpsites, varying loading stations, etc.), "dynamic" systems are used. In these cases, a spray mist is delivered to the location via a ventilated air flow.

There are measures that mines can take such as ensuring workers wear masks and introducing engineering controls including ventilation dilution, water infusion, wet-cutting, water sprays, wetting agents and foam, and dust collectors such as dust scrubbers.

HAUL MINING ROADS

For as long as there is mining as an economic activity dust suppression is and always will be a priority in the design and maintenance considerations of haul mining roads.

The transitional drive from abatement to complete elimination of inhalable and respirable dust in haul mine road applications has evolved over time. In this period, a lot of changes have occurred for the better which has been evident in more research and factually based approaches to the problem. As a result, this has led to more targeted and improved product development of dust suppressants with a shift from traditional to more non-traditional dust suppressants factoring in sustainability and eco-friendliness. The article will focus on the generation and occupational health concerns of dust in haul mine roads, the developmental history of dust suppressants over time and the pros and cons of the preferred dust suppressants used in haul mining roads.



Haul trucks, in general, can work at a reduced speed, watering of the haul road and treatment of haul roads with dust suppressants are some of the methods used to suppress dust. Minimizing wearing course disturbance of the haul road at low operating speeds can reduce dust but is not always ideal given targets that have to be met from a business perspective. Instead, it is imperative to focus on methods that are long-lasting and do not compromise on production. Whilst still focusing on longevity alternatives, a balance should be achieved between incentive for less repetition and considerations for durability through stabilization in attaining good dust control efficiencies. The tendency is to deviate from just one centred approach but a multi-purpose and cost-saving approach from the operation of the mine whilst fulfilling given operational and business targets. The oldest and most used form of dust control in haul mine roads has been watering. Comparisons between un-watered and watered dust emission rates have been assessed before. It has been shown that on a haul mine road a water truck operating once an hour achieves 40% reduction in total suspended particles. Increase in frequency of watering to every 30 minutes, improves the control efficiency of total suspended particles to 55%. Dust control efficiency of water varies on its application rate. The more L/m2 the longer dust suppression duration even at a slightly lower percentage of total suspended particles. The opposite is true at a lesser L/m2 application rate.

The need for more comprehensive, robust, and sustainable dust control regimes led to the development of non-traditional dust suppressants as better options to traditional dust suppressants. Traditional dust suppressants/stabilising agents include fly ash, lime, cement, and bitumen emulsions whereas non-traditional suppressants include salts, lignosulfonates, natural and synthetic polymers, acids, enzymes, and tree resins. Some of the dust suppressants that have been developed for mine haul roads factor in a combination of dust suppression and stabilization. Introduction of traditional dust palliatives as an effective option to water was met with a lot of industry acceptance at the beginning with dust suppression results far superior. Consistency in their use without thought of the environment became one of the biggest elusive challenges which have taken years to resolve as the greater need was dust suppression which unfortunately overshadowed the burden of post dust control environmental assessment. Haul mine roads are assets and the principles of asset management stipulate the role maintenance plays through rehabilitation of the existing infrastructure with the functionality of the

haul mine road to be kept at its operational best. In recent decades, the need for better application performance, lower resource and energy consumption and drive for environmentally friendly products has seen the popularity of non-traditional dust suppressants.

Going beyond water usage to create effective dust suppression solutions

Increasingly stringent environmental legislation has resulted in onsite dust suppression systems playing a role of continued importance in the African mining industry, and I-CAT Environmental Solutions has been a leader in this field for quite some time.

Pretoria-based I-CAT is a leading environmental solutions company that specialises in the development of products and services that ensure environmental compliance for its industrial clients. Non-executive director professor Jan du Plessis notes that dust suppression has evolved from an optional minimal compliance system into fundamental necessity in the local mining sector.

"Dust is a pervasive problem that undermines the health of workers, impacts negatively on the surrounding environment and substantially reduces the lifespan of machinery. It can damage even the most sophisticated equipment and technology. It is, therefore, imperative to effectively control dust on a continuous basis with objectives that reach far beyond legislative compliance," he explains.

Numerous variables can be associated to excessive dust generation in the mining sector; however, the main contributor is widely recognised as haulage roads with large volumes of traffic. Other operational processes such as blasting, drilling, dumping, and loading are also major contributors.

Although water is the most used dust suppressant, it is severely limited in its effectiveness, states du Plessis. "Using only water to control dust is a perpetually costly task that offers limited dust suppression. The futility of wasting time, money, and precious water resources is increased as the water quickly evaporates, and dust is again released into the environment."

Through its commitment to continuous research and development, I-CAT can ensure efficient dust control and full environmental compliance for its clients, through innovative and cost-effective products that assist with surface stabilisation, while ensuring a significant reduction in water usage.



DUST SUPPRESSANT PRODUCTS

RDC 20 is a water-soluble anionic polyelectrolyte polymer that is exclusively developed by I-CAT. It is an innovative formulation of blended emulsified co-polymers and ionic modifiers. When sprayed onto the road surface, RDC 20 forms a durable cross-linked matrix. The matrix binds fine soil particles into larger heavier particles, which are less prone to become airborne. RDC 20 is used on temporary roads, as it is a cost-efficient means to improve road and dust conditions exponentially.

Du Plessis reveals that I-CAT has received overwhelmingly positive feedback from mines where the product is applied, and especially where I-CAT is contracted to manage the dust control on mine roads. "The overall ambient dust at our largest operation in the Northern Cape has improved by more than 40 percent, when compared the readings prior to I-CAT managing the secondary roads at the mine. This is an extraordinary achievement that would not be possible without RDC 20."

MISTING SYSTEMS

The 'DustMonster' range of machinery minimises the effects of dust by creating an ultra-fine mist that attracts dust and encapsulates the airborne particles, before driving them to the ground. The units are fully automatic, easily adaptable, and portable. "With its rugged 44 Kw motor and user-definable 359-degree oscillation, the DustMonster boasts a throw of more than 100 m, thereby ensuring that its dust trapping atomised mist has a coverage area of 2,6 hA," adds du Plessis.

I-CAT is also the exclusive local distributor of the Scrub Mist System – a technologically advanced mist nozzle system developed and manufactured in the USA. Du Plessis reveals that the most notable advantage of the Scrub Mist System is the fact that it boasts ecologically neutral technology. "This technology breaks down water drops between 50 to 200 microns, thereby neutralising and controlling dust at the source of emission via the grouping of dust elements into larger agglomerations."

GREEN SOLUTIONS

GreenGrip is a natural polymer-based gravel road sealant. It is an environmentally safe alternative to chemically based products for semi-permanent gravel roads on mines and residential areas. The solution produces a durable, smooth and dust free surface with fewer maintenance intervals. GreenGrip is water soluble and is also easily incorporated into routine dust suppression procedures with no requirement for special equipment or handling precautions. For permanent dust roads, I-CAT supplies a bitumen-based dust suppression solution called GreenBit.

CAMERA-BASED TECHNOLOGY

Water and fuel are precious commodities on open pit mines, and spillage and overfilling are a major challenge in the industry. To overcome this costly and wasteful trend, du Plessis points out that I-CAT developed the E-CAM system with integrated RFID, a camera-based technology that assists water bowser operators in lining up 85 000 l water bowsers at the filling points located across the mine.

"In the past, this tedious task involved the driver regularly climbing out of the vehicle before aligning it with the filling point. The element of human error often resulted in misalignment and spillage. I-CAT's E-CAM camera

technology ensures pinpoint alignment without the driver having to set foot outside of the bowser. This substantially reduces the risk of spillage, and leads to significant time and cost savings," he continues.

I-CAT was established from humble beginnings in 2007, and today the company boasts a complement of internationally recognised clients from across Africa. In addition to its dust suppression solutions, I-CAT also offers clients environmentally sustainable services in the fields of; water solutions, environmental management solutions, carbon solutions, agro-forestry, and fire solutions.

Looking to the future, du Plessis is optimistic of continued growth. "Environmental compliance is more important than ever before and, given the rapid acceleration of growth across all major industries in Africa, demand for suitable products and services is set to increase. I-CAT has established itself as a proven market leader over the years. As a result, the company is recognised as a preferred supplier to the industry and has placed itself in a strong position to achieve future growth," he concludes.

CASE STUDY

A few years ago, a case study was conducted on Linwood Mining and Minerals Corporation in Davenport, Iowa (US), where (just like most companies) every hour of downtime means thousands in production dollars lost.

At the Linwood site an electronic monitor constantly assesses the air quality in the mining operation and forwards the readings to Linwood and to the Iowa Department of Natural Resources.

To maintain compliance with government air quality standards, dust emissions from Linwood's plant and other production facilities in the surrounding area must stay within a specified range of values over a 24-hour period. If the readings exceed the specified range due to excessive dust, the facilities must shut down.

In operation since 1944, the company is one of the largest underground mines in Iowa and ranks among the largest limestone mining operations in the U.S. Linwood operates 5-1/2 days a week, year-round, to produce more than one million tons of limestone a year.

Once brought to the surface, the limestone is run through the primary crusher and reduced to 5" or less material. The crushed material is then put on the surge pile where it is taken to the secondary crushing plants on the site to be reduced to a variety of sizes.

In the past, Linwood has used water hoses and spray bars to help control dust both at the crusher and at transfer points. On average, due to excessive dust emissions, the plant experienced a substantial amount of downtime each month.

Not only were the hose and spray bar methods ineffective, but they also oversaturated the material, making it sticky, muddy, and difficult to manage during the finishing process. More importantly, quality is an issue because use of dirty material inherently contributes to the failure of the product, creating air pockets in asphalt and causing cracking or pop-outs on the surface of finished concrete.



The DustBoss DB-60 is an oscillating, twenty-five horse-power fan that can cover 21,000 square feet with a blanket of fine mist. Photo courtesy of Dust Control Technology.

After seeing a dust suppression unit at an exhibition, Linwood Mining decided to rent a DB-60 DustBoss on a trial basis. The unit was set up to run over the primary impact crusher used on the site.

Immediately, management at Linwood observed an improvement in dust control – in addition to a considerable increase in the quality of the crushed limestone – and decided to purchase the unit.

The dust suppression unit paid for itself within one month of use due to the marked decrease in downtime, according to Jim Gilliam, Mine Manager. Before purchasing the unit, the plant experienced several periods of downtime a week, resulting in lost production time. Since implementing the DustBoss at their site, Linwood has not experienced any downtime due to their plant's dust emissions.

"The portability of the unit and our ability to direct the mist as needed makes it more flexible than other options when dealing with the wind," said Gilliam. "The unit's performance and low maintenance have definitely met and even exceeded our needs."

Production Manager Jim Petersen adds, "Some material is dustier than others, depending on the mine horizon. We've run the unit over the dustiest materials we process...it's done exactly what we've needed it to."

The DustBoss DB-60 is an oscillating, twenty-five horse-power fan that can cover 21,000 square feet with a blanket of fine mist - atomized water droplets designed specifically for capturing and containing coal dust.

The DB-60 is developed by Illinois-based Dust Control Technology. "We atomize the water to 50-200 microns, which gives us the maximum attraction and avoids a slipstream effect," said DCT President Edwin Peterson. The DB-60 features thirty brass nozzles designed specifically to atomize droplets to the optimum size for dust capture.



NEW TECHNIQUES FOR DUST SUPPRESSION AND CONTROL

Although water sprays have been the preferred treatment to suppress dust for many years, too much water can cause operational problems, while too little water means ineffective dust control. The fine particles in dust also contribute to holding unpaved road surfaces together. Good dust-suppression techniques, therefore, may result in lower maintenance as well as preventing complaints about off-site air-quality problems caused by operations.

One way to optimize the performance of a dust-control and suppression system is to operate it in conjunction with a continuous dust monitor. In its simplest form, this could report back to operators when high dust concentrations occur so that manual remedial action can be taken. However, it is possible to automate such a system so that the water sprays operate when the dust concentration rises above a pre-determined threshold. This will minimize the use of water and chemicals, thereby reducing costs and keeping the site drier than if water sprays are running continuously.



In the past, one problem has been in distinguishing locally generated dust, which needs to be suppressed, from dust blowing on to the site from elsewhere. Several continuous dust monitors located around the site periphery can determine the quantity of dust entering and leaving the site. This information can be combined with wind speed and direction to determine the dust source. While such a network of monitors is useful for assessing the overall dust generated at the site and confirmation of overall compliance, it may not be much help in controlling dust blow-off from individual stockpiles or roadways.

Fugitive dust particles are larger than $PM_{2.5}$ (i.e., greater than $2.5\mu m$ in diameter), whereas dust particles from distant off-site sources are smaller than $PM_{2.5}$. The reason is that the large particles settle out increasingly quickly with increasing particle size – the reason agglomeration with water droplets suppresses dust. Indeed, the settling rate increases with the square of the diameter. Thus, a long way from a dust source the particles are $PM_{2.5}$, near to the source they will be characterized by the PM_{10} ($10\mu m$ diameter) or bigger fractions.

Until recently it has not been possible to determine the PM_{10} and $PM_{2.5}$ mass fractions in real time using a single low-cost instrument. Turnkey Instruments, however, have developed a range of continuous dust monitors that do so and can provide outputs to control dust-suppression equipment. These instruments are easy to install and maintain. They have a low demand on the receptor site, can be fastened to almost any structure and require a low power supply.

Osiris and Topas instruments operate on the principle of light diffraction and have a constant response irrespective of the colour of the dust particles. They give a continuous and simultaneous indication of the PM_{10} , $PM_{2.5}$, PM_{10} and TSP mass fractions. Due to its low flow rate, the sampling efficiency of the TSP mass fraction will be affected by wind speed – at high wind speed it becomes increasingly difficult to get the largest particles into the instrument's inlet. However, PM_{10} and smaller fractions are sampled efficiently and the relative PM_{10} and $PM_{2.5}$ fractions taken together give a good measure of the local dust concentration and the proximity of the dust source.

It has been found that a $PM_{10}/PM_{2.5}$ ratio close to unity indicates a distant dust source, whereas a ratio much greater than unity indicates an increasingly local dust source.

Since the settling out of the PM_{10} particles depends on time, the $PM_{10}/PM_{2.5}$ ratio depends to an extent on wind speed, which determines how quickly the particles travel from their source. Since the instruments also have a built-in interface for wind-speed and direction sensors, these parameters can be factored into the calculations. The instruments also have a heated inlet system to ensure that the water droplets originating from the suppression equipment evaporate before being sensed and do not, therefore, add to the apparent dust concentration!

Turnkey's dust-monitoring equipment can be operated in several different modes depending on the site and application:

- As independent monitors programmed with a hierarchy of SMS text messages to be sent out to chosen people when the dust concentration has been sustained above one or more pre-set concentrations for a given period.

Site protocols can then determine what action should be taken and by whom.

- As part of a network of monitors controlled by a PC or site computer. These could include site boundary monitors as well as those located near critical stockpiles, crushers, and roadways. The PC can be programmed to send out SMS text messages (as above) and, with appropriate interfacing, directly control the dust-suppression equipment. The PC-based systems allow more complex alarm criteria to be used with various conditional statements, including a consideration of wind speed and direction and other parameters such as time of day etc.
- As a web-enabled monitor so that anyone with the correct password (or none if open gain access is permitted) can access via the Internet to determine the current dust concentration, wind speed and direction etc. Turnkey instruments also have optional inputs for sound-level meters so that mean and peak noise Leg's can be made available.
- As a simple on-off controller, whereby the monitor is directly connected to the dust-suppression equipment and automatically turns it on when the dust concentration rises above a pre-set level and off again once it falls. The control point could be stabilized using a PID control algorithm if required.

The use of Osiris and Topas instruments for dust control and suppression is not limited to mineral extraction sites and applies equally well to storage and handling facilities. For example, fugitive dust emissions from coal and iron ore storage and handling sites in the Port of Rotterdam in the Netherlands cause nuisance in residential areas, due to dust deposition, and add to the PM_{10} dust concentration. After extensive research, a new dust-control system, based on Turnkey Osiris, has been installed that monitors conditions at three receptor sites¹.

This system provides plant operators with the necessary information to intervene when dust emissions are rising, and nuisance is likely to occur in neighbouring villages. The system is expected to reduce peak emissions and thereby reduce the terminal's contribution to ambient dust concentrations. It is also thought that off-line analysis of the data might yield additional information to improve the existing environmental management guidelines in use at the bulk terminal.

The BHP Billiton iron ore handling facility at Port Hedland, Western Australia, operates a large network of Osiris monitors for dust control purposes. Here a recent development has been the use of mobile Turnkey dust monitors fitted into vehicles together with GPS locators. The vehicles are driven over the site roads and monitor the concentration of dust generated against exact location. For this application, the instruments are set to operate at their fastest response time of just one second, all four mass fractions being updated at one-second intervals. Suppression sprays are then applied automatically as required, thus minimizing the use of water and chemicals while keeping the roadways in good condition.

Integrating continuous and instantaneous dust monitors increases the performance and flexibility of dust-suppression equipment and should lead to overall cost-savings and better site conditions.



EFFECTIVE DUST AND NOISE MONITORING ESSENTIAL TO WORKER SAFETY

Thermo Fisher Scientific Australian product manager for gas and industrial hygiene instrumentation, Nick Taylor, says an efficient way to monitor air quality and noise levels in mining sites is with wearable instrumentation.

"There have been remarkable developments with technology in recent years which allow for hands-free dust and noise assessment," Taylor says, who has worked with customers in the Australian mining segment for over 15 years.

"These portable devices can be worn with ease and because they have wireless Bluetooth connectivity, the reporting data can be accessed remotely by the site safety manager. In conjunction with the built-in motion sensor, this also enables the manager to remotely check that the device is being used and is working properly on any given individual."

As a leading supplier of instrumentation for the Australian mining industry, Taylor says the products that Thermo Fisher Scientific have available for monitoring are second to none.

"For example, the wearable Casella devices are best in class solutions for occupational hygiene," Taylor expands. "They are intrinsically safe with wireless connectivity for easy data access."

Taylor makes mention of the Casella Apex² personal air sampling pump, which is designed to monitor worker exposure to dusts, fumes, gases, and vapours.

It has an ergonomic, slim design, long battery life and has high back pressure capability, along with a motion detector to indicate if the pump has been used.

"The pump is worn on a belt, with a tube connected to a sample collection head which sits easily and comfortably over the worker's shoulder, collecting samples during their working shift," says Taylor.

"It's ingress resistant to IP65 as well, meaning it can work in harsher environments, which is a must in Australian mining conditions."

Additionally, Thermo Fisher Scientific also supply the Casella sample pump calibration system called Flow Detective.

"It's an onsite, rugged, portable air sample pump calibration system with a wide flow range so that you can calibrate for high flow dust sampling and low flow vapour sampling" Taylor says.

"When used with Casella's Bluetooth enabled sample pumps, it will wirelessly perform automatic calibration of your devices, so it's a fantastic time saver and will also ensure accuracy. Ultimately, this makes it simpler for employers to service their devices."

For noise measurement, Taylor recommends the Casella noise dosimeter, the dBadge2.

"These are also worn with ease on the shoulder and will simultaneously record and compute all noise data for every measurement run, reporting these back to ensure the workplace is within the regulated parameters," Taylor says.

"These are also wireless Bluetooth devices so remote access is an added advantage."

To conclude, Taylor reiterates the importance of having effective dust and noise monitoring solutions in place.

"It's peace of mind for employees and regulatory compliance for employers, and technology such as the Casella range of wearable devices and calibration system simplifies the process of collection, assessment and servicing of equipment on site."

MODERN DUST MANAGEMENT APPROACHES

Product development of non-traditional dust suppressants in the modern era factors in the source, whether it is environmentally benign, water-solubility, benefits, and drawbacks. Sources come in different forms with options for synthetic, by-products of production processes such as paper and timber and natural-based feedstocks. Depending on breakdown and degradation chemistry of the dust suppressant by-products some can be toxic to the environment depending on the effect of UV radiation and enzymatic action of biota in the soil. Some of the benefits to consider are ease of application with good efficiency, adaptability to



wet conditions, fast action with no interruption to the mining activities, non-hygroscopic to create long-lasting protection, suitability to arid regions owing to water solubility and good water retention capacity. However, they are drawbacks which include susceptibility to thermo-oxidative aging and photo-oxidation, high costs, poor adaptability to wet conditions for some products and failure to render mechanical properties which leads to haul road poor performance.

KNOWLEDGE IS POWER

In the last two decades selecting the right palliative has improved remarkably with methodologies based on average daily traffic, climate, fines content and geometry. Ranking the sums of the different palliatives in addition to life cycle costs completes the process of selection. The decision to be made is based on knowledge of what the non-traditional dust suppressants offer and the key is to determine the dosage rate which is soil type dependent. Dust suppression for haul mine roads is still progressing and implementation of strict legislative and non-compromising dust control laws will complement the calls for greater health and safety rather than a temporary substitute for dust prevention.



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MinRes hauls in autonomous road trains

Mineral Resources (MinRes) has announced a partnership with automation specialist Hexagon to develop an autonomous road train solution for its haulage fleet in Western Australia's Pilbara region.

The solution integrates drive-by-wire technology with an autonomous management system to orchestrate vehicle movement in road-train haulage, as part of the Mineral Resources mining services infrastructure supply chain solution.

"In recent years, we have implemented a number of new technologies which have enhanced the safety and operational efficiency of our long-distance road train haulage fleet, reducing the risks of driver fatigue and increasing fleet availability," Mineral Resources' Mining Services chief executive officer Mike Grey said.

"The autonomous road

trains will take us to the next level again. They provide a safe, cost-efficient solution for hauling ore, which is key to unlocking stranded tonnes in the Pilbara."

An autonomous road train configuration of this scale is a world-first and reflects MinRes' approach to continuous improvement and innovation.

MinRes will initially adopt the technology for its own operations, with a view to offering the solution to its large tier-one customer base, further growing its mining services business.

MinRes is renowned for providing innovative and low-cost solutions across the mining infrastructure supply chain, and the autonomous road trains will form an essential part of the Ashburton Hub iron ore project.

Mineral Resources is planning to run a fleet of



425-tonne gross combination mass triple-trailer road trains operating across multiple convoys, with each road train convoy consisting of up to five prime-mover trucks, with three trailers each, hauling the ore from the mine site to the Port of Ashburton.

"Autonomous vehicles are revolutionising the way we work today and into the future, and Hexagon is very proud to be part of this revolution," Hexagon president and chief executive officer Ola Rollén said.

"Our agreement with MRL further solidifies Hexagon's commitment to autonomous

mobility and fulfilling our customer's safety and productivity requirements."

The announcement follows a successful proof-of-concept completed with the specific economic constraints of iron ore and other bulk commodities, where MinRes provided its deep expertise and knowledge in road-train haulage while Hexagon drew upon its proven experience in autonomy.

The automated road-train solution focuses on safety, productivity and sustainability for Mineral Resources operations and will be phased in over the next two years.

Partnership to focus on underground pedestrian safety

Perenti Global's Barmenco has partnered with Sandvik subsidiary Newtrax to improve the safety of pedestrians working near heavy vehicles (HVs) underground.

Newtrax has developed a collision avoidance system that links "intelligent" cap lamps to the warning system inside the cab of an underground HV.

The system provides the vehicle operator with virtual visibility of any pedestrians in the immediate area of their vehicle, along with an escalated warning system

to both the pedestrian and operator as the distance between them reduces.

This escalation transitions from warning to vehicle intervention, where the HV automatically reduces speed and comes to a controlled stop, when the system senses any pedestrian wearing an intelligent cap lamp in the high-risk zone.

Under the partnership, Newtrax will deploy its next-generation Level 9 Collision Avoidance System across Barmenco's Sandvik fleet, including the supply of intelligent cap lamps with

advanced electronic safety features to Barmenco's underground mines.

The technology is due to undergo initial testing at one of Barmenco's underground sites in January 2022.

Perenti Mining chief executive officer Paul Muller said there were two major focusses for the partnership – the safety of its people and the sustainable adoption of the technology industry-wide.

"The exposure of pedestrians to heavy vehicles underground is a significant risk not just for us, but for everyone involved in the underground mining industry," Muller said.

"The combination of Newtrax's technology, our underground operating experience and Sandvik's role in supplying heavy mining vehicles can put us in a position to offer the entire industry a smart solution to a complex problem."

Newtrax regional vice president Simon Waghorn said the collaboration with Barmenco would provide the partners with real-world experience that would help optimise the system as it develops.

"Although the Newtrax Collision Avoidance System is the best available system on the market, many more enhancements are required to accelerate adoption," Waghorn said.

"This partnership with Barmenco, a world-class underground hard rock mining contractor, will enable collaborative product development which will result in an even better product for the industry."

Barmenco is a subsidiary of Perenti for hard-rock underground mining.

Sandvik acquired Newtrax in April, 2019, to combine with Sandvik's OptiMine technology.



New V-Plow Design Delivers Lighter Weight, Safer Handling



The global leader in bulk handling conveyor accessories has redesigned one of its most popular tail protection devices to be a lighter weight, modular unit delivered in a compact package for improved safety and convenience. The re-engineered Martin® V-Plow HD achieves the gains with no compromise in performance. “The heaviest section of the previous design was about 21 pounds (9.5 kg), while the new modular unit’s heaviest component is just 13 pounds (5.9 kg), a reduction of about 48%,” explained Conveyor Products Manager Dave Mueller. While the previous welded design’s largest dimensions were 17.5 wide x 38 inches long (445 x 965 mm), the new modular design’s widest component is less than 8 inches (203 mm) and the longest is approximately 31 inches (788 mm).

“The result is a package that fits most local delivery trucks and can be easily carried by workers to sites that may have accessibility issues, with the components assembled as they are installed to reduce the risk of injury,” Mueller said.

“Tail pulley protection is essential to efficient conveyor operation, but because of their size, the components can be cumbersome to ship and install,” Mueller

continued. “In most designs, the wide V-shaped unit is typically delivered with mounting equipment in a large box that can pose a logistical problem to both air and ground transport, due to the weight and size. This can lead to frustrating delays during tight installation schedules.”

Mueller further pointed out that, once the previous design was delivered, getting it to the installation point could be a challenge with potential safety issues. Often workers needed to carry the oddly-shaped box by hand up several flights of stairs, through corridors, or to areas with limited accessibility. According to OSHA (U.S. Occupational Safety and Health Administration), workplace injuries caused by lifting, carrying and falling/dropped debris are among the most prevalent.

The Martin V-Plow HD prevents tail pulleys from becoming fouled and damaged by spillage and by traveling on the return side of the conveyor belt. Fugitive material commonly migrates from the cargo side to the return side during normal operation. If this spillage reaches the tail pulley, two things can happen. One is lumps getting caught between the pulley and the belt, gouging and damaging both the belt and pulley face. The other is spillage being crushed by the pressure between the pulley and the belt, adhering to the pulley face and the return side of the belt, causing pulley slippage and fouling of idlers along the system.

Engineered for belts as wide as 120 in. (3048 mm) with speeds up to 900 fpm (4.6 m/sec), the Martin V-Plow HD redesign has made the equipment modular, segmented into a few pieces that are arranged in a box that fits almost any form of delivery transport. This also makes the equipment easier and safer to carry to the installation area.

With easy-to-understand instructions for the tongue and groove assembly, the rugged painted steel parts can be snapped and securely bolted together in minutes, creating a strong

structure. The time saved on delivery to the facility and the work area more than makes up for the few minutes of assembly time.

Mounted to hanger bars by clamps or welding, the unit glides on the return side of the conveyor belt using hinge system, deflecting any fugitive debris off of the belt. The assembly holds an easily replaceable 4 in. (100 mm) wide, 1 in. (25 mm) thick blade, which provides 2 in. (50 mm) of wear life. Blades are available in 60 Shore A durometer nitrile rubber or long-wearing 90 Shore A durometer urethane and can be ordered with specialized blades that are chemical resistant or designed for high temperature applications.

The Martin V-Plow HD mounting system and security cable assembly is safer, longer-lasting and less damaging to the belt than competing units. The return side of conveyor belts is generally more prone to damage and wear than the cargo side. Most plows on the market are attached to the stringer by a chain and ride the return side of the belt using the weight of the unit to apply pressure. Beyond severe bounce and instability issues, which can allow debris to pass, the chain acts as both the mounting and the safety system. If the chain breaks, the unit

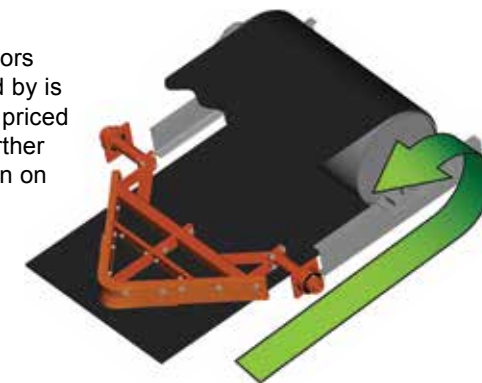


will detach and rattle indiscriminately, damaging the belt and potentially injuring workers. If the Martin V-Plow HD detaches from one mount, the other mount and safety cables keep it in place, protecting the belt and workers until the system

can be stopped and the unit can be repaired.

“What makes the Martin VPlow H-D a popular choice is the safety and performance, but the ease of installation and maintenance are an added benefit,” Mueller concluded. “I think one

of the traits operators are most surprised by is how competitively priced they are, which further improves the return on investment.”



Coal could become carbon neutral with new tech

The Allam-Fetvedt Cycle technology could provide a net-zero avenue for coal by producing saleable hydrogen as a by-product, while capturing the emitted CO₂.

A feasibility study, commissioned by Low Emission Technology Australia (LETA), found that Australia’s annual energy export revenues could increase by 71% to \$35 billion using the Allam Cycle.

LETA explained that the Allam Cycle is a zero emissions technology that uses CO₂ instead of steam to drive a turbine, while eliminating air pollution and capturing the CO₂.

LETA chief executive officer Mark McCallum said the benefits of the Allam Cycle benefitted the environmental and Australian economy.

“This feasibility study makes a compelling case for continuing to develop low emission technologies which are critical to a net-zero carbon emissions future, energy reliability and Australia’s prosperity,” McCallum said.

“This technology’s use at scale would introduce on demand and near-zero emission hydrocarbon and biomass power for Australia — complementing renewables’ increasing role in the energy mix — and can also produce clean hydrogen and ammonia.”

The technology does, however, depend on the development of carbon capture use and storage (CCUS) technology which remains a debated method of reducing carbon emissions.

The Allam Cycle has been identified by the



Federal Government’s Low Emissions Technology Statement as a potential key to improving the country’s emissions reductions credentials.

Hydrogen can be produced using the Allam Cycle at or less than \$2 per kilogram, with a potential export value of \$35 billion, according to the study.

McCallum added that the use of this technology could bolster foreign relations.

“What our feasibility study shows, is that aside from the domestic application,

the Allam Cycle can unlock lucrative new, clean industries and assist our regional trading partners — for example, Korea, Japan and Singapore — meet their own emissions reduction aspirations and energy needs,” McCallum said.

“Now that we know there is a strong business case for the Allam Cycle as a producer of hydrogen, hydrogen as ammonia, or electricity on its own, potentially there could be a baseline plant-scaled facility operational this decade.”

Vulcan inks another offtake in Europe

ASX-listed Vulcan Energy Resources has signed a binding lithium hydroxide offtake agreement with NYSE-listed Stellantis.

Starting in 2026, Vulcan will supply between 81 000 t and 99 000 t of battery grade lithium hydroxide over the duration of the initial five-year agreement.

Consistent with Vulcan’s strategy to decarbonise the battery metals supply chain, the Stellantis electrification strategy

includes ensuring a sustainable supply of lithium, which it has identified as a critical battery raw material with regard to availability.

By 2030, more than 70% of Stellantis’ European sales and more than 40% of its US sales will be low emission vehicles (LEVs). Stellantis’ plans call for a total of five battery cell manufacturing plants in Europe, including Germany, and the US, with a total

capacity of 260 GWh.

The battery grade lithium hydroxide will be used by the three Stellantis battery production facilities in Europe, which combined will produce at least 120 GWh hours of cell capacity by 2030.

“The definitive offtake agreement with Stellantis aligns with our mission to decarbonise the lithium-ion battery and electric vehicle supply chain. The Vulcan Zero Carbon lithium project

also intends to reduce the transport distance of lithium chemicals into Europe, and our location in Germany, proximal to Stellantis’ European gigafactories, is consistent with this strategy,” said Vulcan MD Dr Francis Wedin.

“We look forward to a long and productive relationship between Vulcan and Stellantis, as we work to achieve our shared sustainability and decarbonisation ambitions.”

Caterpillar launches hydrogen backup power for data centres

Caterpillar has announced a three-year project collaborating with Microsoft and Ballard Power Systems to demonstrate a large-format hydrogen fuel cell power system to produce reliable and sustainable backup power for data centres.

The original equipment manufacturer's experts in advanced power technologies, controls and system integration are working alongside Microsoft experts in data centre design and Ballard experts in fuel cell design to demonstrate a 1.5-megawatt (MW) backup power delivery and control system that would meet or exceed the high expectations set by current diesel engine systems.

"This hydrogen fuel cell demonstration project enables us to collaborate with industry leaders to take a large step toward commercially viable power solutions that also support our customers in making their operations more sustainable," Caterpillar Electric Power vice president Jason Kaiser said.

Caterpillar is the project's prime contractor and is providing the overall system integration, power electronics, and controls that form the central structure of the power

solution, fuelled by low-carbon-intensity hydrogen.

Microsoft is hosting the demonstration project at a company data centre in Washington State, while Ballard is supplying an advanced hydrogen fuel cell module.

"We continue to invest in research and advanced development in hydrogen fuel cells as one of the various pathways toward our commitment to be carbon negative by 2030," Microsoft Datacentre Advanced Development distinguished engineer and vice president Christian Belady said.

"This latest project with Caterpillar will provide valuable insights into how to leverage hydrogen fuel cells for backup power in our data centres at scale."

The demonstration will provide key insights into the capability of fuel cell systems to serve multi-megawatt data centres by providing uninterruptible power that supports 99.999% uptime requirements.

This project is the latest example of Caterpillar's contribution to a safer future, with the MineStar Solutions suite allowing businesses to assess their operations, big and small, remotely and from a distance, introducing aspects of safety and productivity.



Bukit Asam sets 2021 coal production target at thirty million tons

State-owned coal mining firm PT Bukit Asam said it has set the target of coal production for 2021 at thirty million tons compared to 25.1 million tons the previous year.

The company will gradually increase production until 2025 when the coal transport capacity of 72.5 million tons is fulfilled, PT Bukit Asam corporate secretary, Apollonius Andwie C, said recently.

The production hike aligns with the increasing capacity of land transport means, including trains and Tarahan port in neighbouring Lampung province, as well as other transport means, he informed.

The company believes the production hike still corresponds to its coal deposits in one of its mining sites in Tanjungenim, South Sumatra Selatan, which are pegged at three billion tons.

However, the company is still awaiting the Energy and

Mineral Resources Ministry's approval of its production plan for 2022, Andwie said.

To develop coal production, the company is looking at the current market demand, including demand from projects which will be conducted next year, the official added.

The projects include Unit 8 of the steam-fuelled power plant in South Sumatra, which will need 5.2 million tons of coal, Andwie said. The construction of the mine mouth power plant is scheduled for completion in March 2022, he added.

The other project is coal gasification, built in cooperation with state-owned energy company Pertamina and Air Product, for producing dimethyl ether (DME) as a substitute for liquefied petroleum gas (LPG), he informed. The project is expected to require six million tons of coal, he added.

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