



*Koepe type 4-rope hoisting machine with direct AC synchronous drive at KGHM's Rudna mine supplied by MWM Elektro*

## Confidence in conveyance

**The fundamentals of hoisting have not changed since the early days of large-scale underground mining – but the control systems, efficiency, safety and level of automation have advanced beyond recognition – Paul Moore looks at some recent developments**

New solutions for improving operational safety and sustainability within the mine shaft have been developed that are really making a difference in the hoisting industry. **FLSmidth**, whose hoisting division is FLS Mine Shaft Systems based in Orillia, Ontario, has introduced three new solutions in recent years: the patented Cage Guardian™ Safety Brake for steel guides, the skip Crank Type Dump Mechanism (CTDM) and a new onboard conveyance battery charging system.

For decades, many North American mine shafts have operated using wood guides for cages transporting personnel when hoisted via a drum hoist with a single head rope attached to the conveyance. “Safety in transporting personnel in a vertical mine shaft is imperative, and redundancies are set in place to ensure safety requirements are met,” said Matt Goddard, Head of Mine Shaft Systems at FLS. Wood guides, being a natural product, have many disadvantages over the use of engineered steel guides. Not only is their use having an environmental impact on forests and becoming increasingly less cost effective, but their variability in natural properties also make them less desirable and unpredictable for control. FLS has successfully developed, tested and proven to meet the most stringent regulations a new mechanical safety device which functions on steel guides, which would typically not require guide replacement in the case an event should occur. “The advantages on operating with engineered steel guides are numerous. The Cage Guardian uses traditional spring-actuated mechanical activation to effectively clamp onto the guide while an independent braking system mounted to the cage dissipates the kinetic

energy to stop and hold the cage,” Goddard added. “The latest tests verify performance for the Cage Guardian for large four-guide cages with synchronised actuation, a cage load of up to 28,500 kg (70 kN/guide) and a hoist speed of 7 m/s, effectively capturing the largest range of cage size normal for single-rope conveyances.”

The new and innovative Crank Type Dump Mechanism is a unique skip discharging mechanism designed by FLS which can increase hoisting capacity through reduced cycle times vs conventional scroll-type discharge. “Reduced overall cycle time leads to increased production rates of as much as 8-10% (or more),” said Goddard. Furthermore, the CTDM improves simplicity in design and lowered energy consumption over the alternative hydraulically-operated dumping mechanisms to dynamically open and close the skip in a short burst of



*The FLS patented Cage Guardian™ Safety Brake for steel guides*

energy, realising only a single open/close cycle through each complete skip cycle. “Hydraulically controlled systems are continuously energised and operated on ‘standby’ for most of the time while actually providing any useful output less than 10% of the time,” Goddard explained. “By switching to a simple electro-mechanical drive, the system complexity is also reduced and the requirements for fire suppression are eliminated.”

Finally, mine conveyances commonly carry personnel, whether for the regular transport of persons to perform work underground or for conducting inspections and maintenance within the shaft itself. Onboard communications systems are frequently used but require onboard batteries as a power source. It’s quite common for operators to have to remove spent batteries for re-charging at the end of every shift and replacing them with replenished batteries.

Now, FLSmidth has designed a new onboard battery charging system which uses the kinetic energy of the hoisted conveyance during each cycle to continuously charge the batteries while the conveyance is being hoisted. This not only simplifies maintenance requirements but uses inherent energy through hoisting instead of relying on external energy sources to recharge batteries. “The elimination of having to lift heavy batteries from an internal compartment commonly in the roof of the conveyance also eliminates risk of injury,” Goddard said. “The new system is compact and easy to mount using FLSmidth’s own heavy-duty guide rollers and is an efficient and effective way to replenish battery charge.”

In the market itself, FLS has won a major order to supply a 6 m dual-drum, dual-clutch rock lift for a copper mine in South America. It says the incorporation of proven FLS technology will enable the mine to meet its goals of extending its operational life by an additional 30 years. The design uses cages with a capacity of 20 t to achieve a production of 379 t per hour. The scope of the order includes FLS’s complete supply of mechanical, electrical and control systems, complete field installation and commissioning supervision, as well as strategic spare parts. This is another example of FLS’s ability to contribute to customer sustainability.

### Tophat profiles

**British Steel’s** Special Profiles business is based in the north of England, UK, and manufactures high-quality steel profiles for a wide range of demanding industrial sectors. One of those is the mining industry where the company’s tophat

profiles are bringing a wealth of advantages to the sector. David Waine, Special Profiles' Commercial Director, said: "Our tophats bring valuable benefits in mineshaft construction and use, including speed of installation, fatigue life is improved by up to 70% and they offer significant operational efficiencies for mine operators. We continue to see a growing trend for larger mineshaft guides and were delighted to have recently supplied our biggest ever tophats to the Canadian Malartic Partnership's Odyssey Mine."

Measuring in at 175 x 350 mm, these huge mineshaft guides will help Odyssey Mine maximise productivity and service life for its gold mining operations. When up and running, the mine is expected to be one of Canada's largest underground gold mines.

Waine added: "Our tophats are carefully designed to deliver superior dimensional control and straightness. This means they can operate faster lifts and carry heavier load weights. Their thickness results in stiffer, straighter steel sections, which also allows the conveyances to run faster. And hand-in-hand with this, their inherent stiffness means winding speed can be up to 20% faster. Their rigidity can reduce the number of buntons needed, so this cuts both cost and installation time."

Project designers **WSP** provided detailed engineering services for the Canadian scheme, which included the ore handling infrastructure, such as the headframe, hoist room, hoisting infrastructure and shaft to enable safe and efficient operations. Mickael Hardy, Project Manager at WSP, said: "The project team evaluated different alternatives for steel guides meeting our requirements for lateral stiffness while reducing space requirement in the shaft and optimising installation sequence. The tophat proved to be best the best product for our application."

In modern mine hoisting operations, operators are looking for three key attributes: high productivity and minimal downtime; ease and speed of installation and maintenance; and durability and long-service life in a potentially highly-corrosive environment

Waine said: "The two main factors considered in productivity are steelwork stiffness and rebound velocity ratio. In an ideal world, a stiff guide with flexible buntons is considered the optimum for efficient hoisting, while minimising the likelihood of sustained slamming of the conveyance during hoisting is also desirable. Studies show that in the vast majority of cases, the performance of tophat profiles is clearly superior compared to a more traditional square hollow section (SHS). Installation is enhanced too. Because the profile shape is open, there is access to both sides during the installation process. This design also lends itself to easier inspections and detection of any defects during

the mineshaft's operational life – and because this inspection is easier, more time can be dedicated to high-quality inspection right to the bottom of the shaft."

It's widely recognised that shaft steelwork deteriorates over time with depth, a consequence of a number of metallurgical reasons. Waine: "As depth increases, the ambient temperature also increases and there are also larger volumes of oxygenated or acidified water. The thickness of our tophats is 13-20 mm so they offer significantly better corrosion resistance than a comparable 10 mm SHS guide. Although galvanising could be used to increase service life, the thickness of our tophats means this expense can be avoided as their 30-year lifespan matches that of most mines."

The Malartic mine is not the first time British Steel has worked with WSP. In 2020, they collaborated on the expansion of Agnico Eagle's gold mine in Finland, once again using tophats as the optimal mineshaft solution. Waine adds: "As well as being cheaper than the traditional hoisting system for underground mining, our system was easy to install, offering enhanced corrosion resistance, durability and outstanding strength. It was a privilege to work with WSP and Agnico Eagle to provide a solution for the Kittila mine development in Finland. It's very encouraging that after several decades of being the go-to solution in Africa, the product is now so widely deployed to cover the globe, from the Malartic project in Canada through to mining applications in Australia – and new regions are adopting tophats all the time including, for the first time, a project in South America this year."

### WSP weighs up the options

Designing a successful hoist plant takes careful consideration of every element and WSP's Ryan Heppler, a Structural Engineer based in Thunder Bay, Ontario, told **IM** that it is invaluable to weigh the different options, and understand how each can benefit, or deter your hoist plant operations. "At the 2023 *Hoist and Haul* conference, our team is presenting an analysis of two key parts of the design: the headframe and the shaft guides. Each has multiple options that need to be weighed during the design process."

He adds: "With almost 40 years passed since the initial development of the paper *Headframe Design Selection: Steel vs Concrete Headframe* by Butler and Schneyderberg (published in 1981), it is important to re-evaluate the selection principals of the past now that we have seen their performance over a substantial period of time. At the same, it's valuable to introduce new topics that have become important in the design selection process."

At the event, WSP is presenting a comparison between steel and concrete headframes,



*WSP argues that there are numerous factors involved with determining the right conveyance guide system for any operation*

describing the advantages and disadvantages of each, and noting the factors important in the evaluation of the optimum selection. Through this evaluation, WSP concluded that, although many of the fundamentals of headframe type selection are as true today as they have ever been, new considerations have emerged since Butler and Schneyderberg explored the topic in their paper.

"Factors such as safety, seismic design, modular construction, sustainability, and headframe replacement/rehabilitation have all come to the forefront as important considerations that need to be evaluated. However, even in doing so, both steel and concrete headframes remain a viable option for a mining operation. Both types have their advantages and disadvantages and need to be thoroughly evaluated at the project onset."

Looking at fixed guides versus roped guides, the conveyance guiding system selection is one of the key influences in shaft layout and hoisting plant design. The two primary guiding system options available are rope guides and fixed guides. "In comparing the two, we evaluated the factors requiring consideration in choosing the correct solution for the mine's operation. Innovative solutions for both system types were considered, including the fixed guide cantilever buntion system and rope tensioning system for the rope guide system. There are several factors to consider when choosing the optimal conveyance guiding system. The shaft diameter, preferred hoisting speed, the number of conveyances, regulatory requirements, the mine air ventilation velocity, and of course, cost all must be carefully evaluated."

The research being presented highlights that a 'one-size-fits-all' solution is not possible, as

## INNOMOTICS insights

*INNOMOTICS was launched in Germany as a separately managed legal entity as of July 1, 2023. The global carveout is also to be largely completed by the beginning of the new fiscal year on October 1, 2023. Under a single roof, the supplier of motors and large drives, which remains a Siemens-owned business, brings together business activities with low- to high-voltage motors, geared motors, medium-voltage converters and motor spindles as well as project and service offerings for this product portfolio. This includes major mining solutions such as mine hoist solutions. IM spoke to Bernd Erdtmann, Senior Sales Manager, INNOMOTICS with responsibility for hoisting and winder technologies*

**Much of Siemens' mining and large drives related businesses and technologies are moving forward into a new standalone company, INNOMOTICS – is hoisting part of that and what will it mean for existing and future customers?**

**BE:** Hoisting is one important business of INNOMOTICS Mineral Solutions for existing and future customers. We will continue to serve the market and our customers with the same enthusiasm as we did in the past.

**Will your collaboration and partnership with SIEMAG TECBERG continue under the new INNOMOTICS?**

**BE:** INNOMOTICS has two different approaches for our mine winder business – the drive system business and the minerals solution business. The drive system business is focused on drive solutions for dedicated customers like SIEMAG TECBERG while the minerals solution business implements comprehensive electrical, drive & control solutions. INNOMOTICS is a well-trusted partner of SIEMAG TECBERG for our drive systems as part of the INNOMOTICS system business. Integrated MV-/LV-drive solutions have been used in new installations as well as modernisation projects worldwide. So SIEMAG TECBERG is one system integrator with INNOMOTICS drive systems. Close cooperation was established with this partner to standardise the interface as well as communications between the drive system and the SIEMAG TECBERG automation system. As mentioned INNOMOTICS Minerals Solutions is a supplier of comprehensive electrical & control solutions which include, besides the drive systems, our proven winder controller, power distribution, communication, sensors & instruments, and others which are required for a full mine winder electrical solution. This solution for example has been implemented together with the German company OLKO Maschinentechnik GmbH for the successful delivery of complete mine winders for customers in Turkmenistan, Russia, Belarus, Great Britain, and Germany.

**Siemens has been well known in the hoisting market for its commitment to safety and regular updates to the Winder Technological Controller (WTC); will this continue under INNOMOTICS and are there any recent**

**developments you would like to highlight?**

**BE:** INNOMOTICS Minerals Solutions will certainly continue to improve and update our Winder Technological Controller as we did under the Siemens umbrella. To respond to the increased SIL requirements in some markets in Europe and North America, we developed our SIL3 certified safety monitor/controller in 2018. Together with our German mechanical partner OLKO Maschinentechnik we are currently developing a SIL3 certified winder brake. Thus, INNOMOTICS together with OLKO Maschinentechnik GmbH will be able to deliver full SIL3 mine winder solutions.

**Similarly does the use of automation in mine hoisting continue and as such are many of your customers opting to use your cloud-based mine hoist monitoring and control solutions?**

**BE:** One optional part of the INNOMOTICS Minerals Solution mine winder portfolio is our Asset Health Analytics which operates completely separately from our mine winder control system. It covers modules for maintenance concepts & maintenance management; management & documentation of mandatory tests to comply with public mining regulations; and condition monitoring of critical components. Our Asset Health Analytics can be implemented as a cloud-based solution or onsite. If required, our service experts can connect to the customer operation via a safe remote access.

**Does the modernisation and retrofit of existing winders and hoist represent an important part of the market and has it increased as customers look to extend the life of existing assets?**

**BE:** A retrofit is one way of extending the life of existing assets. However, in general, the main components of our solutions, such as motors and the power sections of variable speed drives, are designed to have a life span of 20 years or longer. This is borne out by the experience of our customers. In most cases, our customers focus on replacing their existing control & SCADA to obtain the latest control developments together with state-of-the-art electronic components, to be prepared to connect to future digital solutions and to ensure that spare parts are available.

**Hoists are significant power consumers – with mining so much now focused on sustainability, is the efficiency of your solutions a major part of any discussion either for retrofits or for greenfield hoist projects?**

**BE:** The mining industry is currently working hard to reduce its CO<sub>2</sub> emissions in general and for raw material haulage specifically. Electrifying mining processes is a key element in ensuring that these efforts are successful. Using electrical mine winders to haul raw materials has been a zero-emission application since when it was first implemented in the early 20th century. If powered with renewable electricity, it would be a 100% green solution. The provision of electrical equipment with the highest efficiency is certainly a must for suppliers like INNOMOTICS Mineral Solutions.

there are a number of key variables that play into a mining operation's overall decision: shaft diameter/number of conveyances; hoisting speed; hoisting ropes; mine air ventilation; upfront cost; and operating costs.

He concludes: "There are numerous factors involved with determining the right conveyance guide system for any operation. The factors above are a large part of the decision criteria but, most importantly, it is imperative that the operator work with a qualified person to guide

them through the evaluation process to determine the right application to meet their needs."

### Stantec and shaft successes

Derek Naude is a Shafts and Hoisting Consultant for Stantec in Phoenix, Arizona. He is a Mechanical Maintenance and Design Engineer with 25 years of experience in all matters related to mine shafts and hoisting installations. **IM** went through some key issues with him. First off,

the fact that the fundamentals of production hoists - such as the Koepe and Blair winder designs are pretty much unchanged - how has it been possible to continue to optimise new hoists and make them more efficient and how has Stantec been able to assist mining customers in this regard?

Naude stated: "The fundamentals of hoisting are simply raising a conveyance from depth by winding a rope onto a drum, so the basic concept of hoisting has not changed since hoisting was



Derek Naude, Shafts and Hoisting Consultant for Stantec

first envisaged for mining. What does change is the need to go deeper and raise higher payloads, and of course doing this efficiently and safely. Advances have been in the design of the hoist's structural, mechanical, control, and instrumentation components to make them more cost-effective, energy efficient, and safer. Rope technology is another key factor and often a limiting factor of hoisting capability. There are currently studies and trial projects underway testing alternate rope material that could dramatically change hoisting."

Stantec provides functional specifications for the equipment, and then collaborates with

industry technology leaders to design each hoist. Virtually all hoisting applications are unique, and Stantec seldom, if ever, has standard designs that can be used.

He continues: "One of the ways we make new hoists more efficient is to optimise how they are used – here we can reduce operational delays by optimising the hoisting time to reduce downtime. This is done by automating as many of the processes as possible. This includes inspection activities and real-time monitoring. Through this the team can diagnose and solve problems in real-time and warn of impending issues so they can be inspected during routine maintenance. The result is less unplanned downtime. Coupled with these technologies are hoist technicians, located in dedicated monitoring centres, who monitor systems in real-time and report potential issues. There are also technologies now being developed and, in some cases, available for automated shaft examinations, rope intelligent photographic examination, and continuous ultrasonic testing."

Then onto the topic of hoisting and sustainability. Energy efficiency and the goal of an energy-neutral design is a constant consideration for any hoist design. But Naude argues that with hoists being such large energy consumers, getting an energy neutral design is unlikely at this stage. "However, there are technologies available that will reduce power

consumption. For example, on a sizeable hoisting project that employs a number of large Blair Multi Rope (BMR) Hoists, Stantec will employ a hoist control strategy to sequence the acceleration cycle of one hoist with the deceleration (regenerative) cycle of another. This approach allows for absorbing the regenerated energy of another hoist. Stantec is currently working with hoisting technology leaders on other energy storage means, such as mechanical flywheel and battery storage. Since these solutions need to be large enough to supply these powerful machines, the economics remains a factor to be considered, but we continue to pursue these advances." Finally, Stantec is also studying the plausibility of a ropeless hoisting concept. Steel wire hoisting ropes contribute to a significant portion of the hoist power demand, and if these can be removed from the equations, the systems would be more energy efficient.

What about the significant market for retrofitting newer electrics, automation systems and other upgrades to existing hoists? "The most noticeable change in the industry is the application of Functional Safety to hoist electronic control systems, resulting in the application of Safety Integrity Level (SIL) rated equipment. This has been prominent in Europe and Australia for some time but is fast becoming the gold standard for mining operations around the world. The specification and testing of these systems is so



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**Hoist and winder brakes – Altra joins Regal Rexnord**

On March 27, Regal Rexnord Corporation completed the acquisition of Altra Industrial Motion Corp, closing a deal that was signed on October 26, 2022. **Altra Industrial Motion** brands Twiflex and Svendborg Brakes manufacture a vast range of industrial disc brake calipers for industrial and mining applications, with hoists and winders being a core market. Twiflex as an example caters for all combinations of brake actuation. Direct acting brakes may be specified with pneumatic, hydraulic or mechanical application. Additionally, spring applied (sometimes referred to as fail-safe) calipers are available, released by pneumatic, hydraulic, mechanical or electric operation.



*Regal Rexnord Corporation recently completed the acquisition of Altra Industrial Motion*

Commenting on the announcement, CEO Louis Pinkham said, "Altra's Power Transmission Technologies business significantly enhances our legacy power transmission portfolio, in particular our industrial powertrain offering, by adding complementary products in brakes, gears, and clutches. The combined power transmission, automation and powertrain capabilities of the new Regal Rexnord offer customers a significantly enhanced value proposition across a wider range of end markets – many with highly attractive secular growth tailwinds."

stringent that it most often will result in a complete electrical and control system retrofit if it were to be supplied as an existing hoist upgrade."

He adds that while there will always be a market for low-time used machines, it can almost certainly be assumed that these will require a new electrical and control system and possibly a full brake and hydraulic upgrade. "Employing a used hoist does require the luxury of time as the machine must often be uplifted from its current location, fully inspected and inventoried, and then refurbished. The refurbishment should be carried out by the OEM or at least under their supervision to ensure original standards to be certain tolerances are maintained."

Stantec generally recommends that new machines are used to remove the risk of

unwanted failures on a newly installed hoist, but if required it assists in finding suitable used equipment. "From my personal experience I have found the time it takes to locate and refurbish these, along with the cost to upgrade and replace items, often means it is more effective and quicker to go with new equipment. That said, there are several reputable suppliers who do supply good used machines and there are applications where these are used very effectively."

Looking at safety, functional safety is the highest safety standard for hoisting, and Stantec says it supports the application of the highest possible safety standards. Naude: "That does not mean that existing operating hoists are not safe. It should be noted that Functional Safety is not specifically legislated in the US. Stantec will still

support customers who do not require the application of Functional Safety, and we will always strive for the safest possible engineered solution for any application. As Functional Safety can be very expensive to implement, we find that many of our smaller operating customers do not require the application thereof. Because our designs are risk-based, we will always deliver designs to meet or exceed tolerable risk levels."

As Functional Safety matures among the hoisting suppliers, Stantec is finding that some hoist suppliers are starting to offer SIL packages as standard equipment, and believes with time, these will become standard offerings for new equipment. "It should be noted however, that just purchasing a specific SIL-rated component does not mean you have a SIL system. Each system must be assessed on its unique basis, evaluated for the associated risks, and these must be mitigated in accordance with IEC 61508 process for it to be fully compliant. Stantec specialises in these services and we have partnered with industry Functional Safety experts to support our clients through the rigorous process of SIL accreditation."

As might be expected the main focus has been on permanent installations, and temporary and construction installations have less onerous requirements but still very high regard for safety systems. "For new permanent applications, the technology is being applied across the board for production and service hoisting, with a focus on optimising production hoisting, of course, but equal consideration to safety. Reducing delays in the production cycle for loading and unloading skips remains the goal of Stantec hoist designers for all our customers. We have recently noticed that some of our larger customers are calling for much higher standards during sinking and construction, specifically for safety systems where we note the requirement for SIL systems."

**ABB and Smart Hoisting**

The world of mining is going through a deep technological revolution. The need for miners to digitise their operations and the many new tools on the market are changing the way of mining operations. This applies to hoist systems as well. **ABB** says it is continuously helping its customers to move toward autonomous and digitised operations. The use of data analytics tools can predict potential safety risks and enhance overall safety. For instance, automated alerts can be sent to operators in real time if the system identifies any signs of abnormal activity. These predictive analytics can pre-emptively identify and mitigate risks, thereby preventing accidents and ensuring a safer mining environment.

With its solution suite ABB Ability™ Smart Hoisting, ABB says it is helping mining companies to improve uptime, availability, performance and productivity of their mine hoists by getting access to actionable information on Key Performance Indicators (KPIs). Data is automatically collected, monitored and analysed to generate actionable insights that can increase production performance, identify safety hazards, and provide optimised maintenance scheduling. During 2023, ABB will launch an update to the existing Smart Hoisting solution which will enable even



higher mine hoist reliability than before.

"The new and improved Smart Hoisting solution offers a step change in the operational performance and reliability of mine hoists," says Charles Bennett, Global BL Service Manager, Hoisting at ABB. "From improved uptime, reduced environmental footprint, and strengthened cyber protections, this solution brings enormous benefits to the industry at an important time."

Does sustainability also have a role to play in hoist system selection? Naude: “Sustainability can contribute to reducing the impacts of hoisting, but due to the large power consumption of hoisting systems, it is unlikely to be fully sustainable without significant capital outlay in the immediate future and with current technology. In my opinion it will be some time before these systems can be called sustainable. However, it remains an important focus of our design teams to seek solutions in this area.”

Finally, looking at actual projects, Stantec is currently the hoisting design engineer for what is set to be one of the largest copper-producing mines in the US. This mine will employ the largest ever BMR hoists to be manufactured, with a drum diameter of 25 ft, hoisting high payloads of ore from 6,800 ft depth. The team consists of numerous shaft and hoisting specialists with experience from around the globe. When constructed, this installation will break a number of hoisting records. In addition, Stantec has a very experienced team of auditors who travel the globe inspecting shaft and hoisting installations and providing clients with reports and corrective actions for the installations.

### Hoisting systems for KGHM's record GG-1 shaft

Shaft GG-1 at 1,348 m will be the deepest shaft in Poland's Copper Basin, and is one of the most

significant investments ever made by mining major KGHM Polska Miedz SA. It has a 7.5 m casing and is an intake-air shaft that will be used to transport people and materials. All works related to sinking shaft GG-1 are performed by Przedsiębiorstwo Budowy Kopalni PeBeKa SA – owned by KGHM and a leader in shaft sinking and accessing of underground mineral deposits.

The mining company told **IM** that sinking the GG-1 shaft was carried out using a 45.5-metre-high steel-framed headframe, designed as a free-standing, single-space structure with internal service platforms. The tower was designed to accommodate two hoisting machines, located in separate buildings on either side of the shaft in the north-south axis, as well as low-speed winches located between the tower and the hoisting machine buildings.

During the sinking the GG-1 shaft was equipped with two mining shaft hoisting compartments, designed for hauling excavated material, vertical transport of equipment and materials, transporting people and inspection of

the shaft. The excavation vessels of each compartment are guided by a sliding mechanism and two cable guides. In both compartments, mining shaft hoists have been installed with drum, haulage, single-end hoisting machines from Poland's **MWM Elektro** with a maximum permissible static force in the cable of 240 kN, a rope winding diameter in the first layer on the drum of 4,300 mm and a maximum travelling speed of 8 m/s. Due to the depth of the shaft, low-speed drum hoists were used to suspend drilling aids that are moved as the shaft progresses, and these include those that allow a



*At 1,348 m, the GG-1 shaft is KGHM's deepest and one of the most important investments in the copper giant's history*

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## Weir Minerals' alternative vertical transport system

*IM* recently caught up with Ralph van Rijswijk, Chief Engineer Venlo Technology Group at **Weir Minerals**. While most of this article is about traditional winder-based mine hoisting, Weir argues that hydraulic ore hoisting has the potential to revolutionise vertical transport systems in the mining industry. Weir Minerals has designed a system that harnesses its GEHO® positive displacement (PD) pumps – a proven technology with the high pressure and flow assurance and stability requirements needed for this application. Its GEHO® hydraulic ore hoisting system is an innovative solution that has the benefit of being a continuous process that's basically scalable to any required capacity.

Weir Minerals recently built and validated its GEHO® hydraulic ore hoisting system using an industrial scale prototype at its Venlo Technology Hub in the Netherlands. The success of this project means that the technology is now considered ready for the next step of scale up and field qualification in actual mining operations.

Rijswijk: "The most obvious opportunities to implement this technology are in greenfield projects because the capital investment associated with creating a new, large diameter shaft with the required hoisting infrastructure would be significantly higher than a hydraulic ore hoisting system. Moreover, factoring in hydraulic ore hoisting as the preferred vertical transportation method at the early stages of the mine plan will ensure its integrated with up and downstream processing requirements. For instance, as more continuous mining methods are being developed and implemented in hard rock mining applications, the material comes off the face at a smaller size and, as a result, requires less processing in order to be pumped."

If, on the other hand, drill and blast is used, the ROM PSD ranges from very fine sand size (63-125 µm) to cobble (63-250 mm) or even boulder size (>250 mm) material. Therefore, sub-surface size reduction would likely be required to make the ROM suitable for hydraulic ore hoisting.

Rijswijk adds: "Moreover, as technologies like ore sorting improved and are more widely embraced, the efficiency of the hydraulic ore hoisting system will also be improved further enhanced because it won't be required to transport as much non-valuable ore. In other words, there are quite a few synergies between hydraulic ore hoisting and new and emerging technologies that are likely to make mining more efficient, sustainable and cost effective."

There are more variables when it comes to brownfield projects, which means that determining whether hydraulic ore hoisting is the ideal solution will need to be done on a case-by-case basis. "For instance, if an open pit mine is transitioning to an underground operation, there is obviously going to be significant mine development and sinking new shafts is likely to be significantly more CAPEX intensive than implementing a hydraulic ore hoisting system. On the other hand, if an underground operation is expanding to mine a nearby reef and the existing infrastructure is suitable, then hydraulic ore hoisting might not be the ideal solution."

Unlike traditional vertical transportation methods, hydraulic ore hoisting isn't an intermittent process, nor is it limited both in terms of



*Weir hydraulic ore hoisting loop*

depth (<100 m) and tonnages (<200 t/h) like trucking. With traditional vertical transportation methods, as an operation goes deeper underground, the distance the material needs to be transported increases and, as a result, capacity is reduced.

"While truck haulage offers a relatively low CAPEX solution, fuel and labour costs are a significant OPEX burden and, in a 24/7 production environment, it's difficult to scale up. And, in terms of sustainability, it's an extremely carbon intensive solution. Moreover, from a safety perspective, manned haul trucks pose a significant considerable risk, accounting for roughly 50 percent of all mining fatalities."

Rijswijk says that skip hoisting systems run up against limitations related to the size of the shaft and skip, as well as the hoisting systems' cable diameter and the capacity of its winding motors. This means that – like truck haulage and unlike hydraulic ore hoisting – it also can't be easily scaled up. "In contrast, scaling up hydraulic ore hoisting systems can be achieved by increasing the size of the pressure exchange chambers for the required flow rate and operating multiple PD pumps in parallel to provide the required flow rate of driving fluid."

GEHO® PD pumps are capable of producing high enough discharge pressures to achieve the lift capacity required for this application; this, in concert with the market's acknowledgement of their unrivalled reliability and stability, means they are the integral piece of equipment in the hydraulic ore hoisting system.

However, Weir Minerals says its all-of-mine capabilities and Integrated Solutions approach – whereby it looks at the process holistically rather than focusing too narrowly on each individual piece of equipment in the flowsheet – means it has the upstream and downstream capabilities to ensure the overall process operates optimally. "Our Trio® comminution equipment could be utilised in the underground primary and secondary crushing applications to achieve the required PSD, while the slurry can be dewatered with Cavex® hydrocyclones and/or Enduron® dewatering screens when it reaches the surface. Weir Minerals portfolio of products, global service and support network and trained personnel ensure it is ideally placed to deliver and provide on-going support for miners interested in exploring hydraulic ore hoisting as an alternative vertical transportation system."

force of up to 450 kN in the cable running directly onto the drum jacket in the first winding layer.

The shaft is fitted with auxiliary equipment to ensure the hoisting of buckets in the shaft and to fulfil the functions deriving from the sinking technology and the construction of the shaft, ie a three-floor working platform that at the same time serves as a tensioning frame for the guide and hoisting cables, and a two-floor platform for

the cementing of the shaft suspended on two suspension ropes. In the shaft hoists, excavation buckets with a capacity of 4 m<sup>3</sup> and 5 m<sup>3</sup> and a lifting capacity of 6.4 t or 10 t respectively were used as the primary excavation vessels. Open-bottomed buckets with a capacity of 2.3 m<sup>3</sup> and 2.5 m<sup>3</sup> have been used as material buckets (designed to lower concrete and loose materials).

The GG-1 shaft is currently in a transition

period, following completion of the shaft sinking and prior to its outfitting with target equipment and final facilities of the shaft yard. The GG-1 shaft is of significant importance for the development of KGHM. It provides key support for the process of opening new areas of the copper deposit and extending the operation of the Polkowice-Sieroszowice and Rudna mines - at Rudna, MWM Elektro also upgraded a Koepe type

4-rope hoisting machine with direct AC synchronous drive. The investment is of key importance for improving the ventilation and climate conditions for miners and shortening the access routes for crews to the working faces.

## OLKO presses ahead in Olfen

Since 2012 **OLKO-Maschinentechnik GmbH** has been part of the Thyssen-Schachtbau GmbH family and successfully realised numerous underground mining projects all over the world. OLKO concentrates its activities on the development, engineering, manufacturing, commissioning and service of shaft hoisting technology for vertical hoisting of raw materials. From its brand new headquarters in Olfen, Germany, OLKO is supplying individual machines and equipment for vertical shaft hoisting as well as material transportation systems. Benefitting from a global Thyssen network, customers attest OLKO a global competence and experience in shaft hoisting technology and material transportation.

OLKO's company philosophy is based on design and manufacturing 'Made in Germany' and it told **IM** it is proud that practically all of the products are exclusively manufactured by OLKO itself or with its longstanding partners in Germany.

OLKO recently has been awarded a contract to engineer, produce, supply and commission two double-drum winders and rope sheaves by one of

the largest steelmaking and mining companies worldwide for their operation in Kazakhstan. For OLKO, this is the first project to be realised in Kazakhstan and OLKO is glad that its winders are part of one of the Kazakhstan's largest mining projects. Both winders will be used at two different underground coal mines. The mines produce primarily metallurgical coal, used for steelmaking and therefore shipped to a nearby steel production facility.

In the first stage of the project, OLKO is to supply a double-drum winder for the service shaft. At a later stage, the second double-drum winder will be supplied for the ventilation shaft of. Shaft depths are approximately 813 m and 564 m. The winders are designed for one rope layer, thus effects that the service shaft double-drum winder has a coiling width of 3.15 m and a diameter of 7.07 m. Additionally, to ensure the availability of the winder, the customer insisted

on a special drive design using a gearbox with two inputs and one output. In the unlikely event that one of the two motors has a malfunction, the winder can still be operated with approximately two thirds of its performance using the second motor.

Both winders are equipped with the well-known and most modern multi-channel braking system, type COBRA-01. In case of an emergency the COBRA-01 enables deceleration of the winder with a constant retardation that can be adjusted to the corresponding local mining regulations. The design of the COBRA-01 braking system is such that each channel is hydraulically and electrically 100% redundant and replaceable. In the event of safety braking and failure of one brake circuit, the remaining brake circuits take over the full functionality of the brake without falling below the country-specific limit values. 



## Shaft Hoisting Technology Made in Germany



**OLKO-Maschinentechnik GmbH**  
 Schlosserstrasse 55  
 59399 Olfen / Germany  
 Phone: +49 2595 / 38599-0  
 Mail: [info-olko@ts-gruppe.com](mailto:info-olko@ts-gruppe.com)

Website: [www.ts-olko.com](http://www.ts-olko.com)

