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Continuous efficiency

In-pit crushing and conveying (IPCC), and variations on the theme, is back in contention as miners look at reducing environmental impact long term, reports Paul Moore

There is more going on in in-pit crushing and conveying in terms of project work than for some years. This reflects some projects planned for some time coming to fruition but also mines planning for the long term with an reduced environmental footprint in mind. In September 2019, Anglo American stated in a release titled Mapping the Mine to Sustainable Development Goals: “One way to reduce fuel consumption is by combining in-pit crushing and conveying (IPCC) with ore sorting. This operation will cut energy consumption in mills by discarding rock.” Anglo has already advanced the bulk sorting side of things in the industry. At the Barro Alto nickel operation in Brazil as an example, a first MMD bulk sorting unit was installed last November, which understands is handling 400 t/h; while another two units are set to be installed there by 2021. IPCC is ultimately going to be an important part of heap leach projects, a notable one being Nordgold’s Gross open pit heap leach gold operation in southwest Yakutia, which uses five overland conveyors, two mobile trippers, an emergency bypass stacker, reclaim hoppers and three mobile stacking/reclaim systems all supplied by Terra Nova Technologies, now part of Cementation.

IPCC in Russian iron ore

To take Russian iron ore as an example of IPCC projects progressing, as previously outlined in IM, Metalloinvest is putting in in-pit crushing and conveying elements at the world class Lebedinsky GOK and Mikhailovsky GOK operations. At LGOK sister mine Mikhailovsky (MGOK) a high angle conveyor similar in design to the one at Navoi Mining & Metallurgy Combinat (NGMK) in Uzbekistan has already been installed. Like the Muruntau gold mine example, the new one at Mikhailovsky was designed by Ukraine’s NKMZ with input from Metalloinvest and installed in a joint project with Metalloinvest construction subsidiary Rudstroy. Metalloinvest told IM that it is currently using it only for iron ore transport but in the future may also look to utilise it for waste as well. The HAC is deployed in Mikhailovsky’s South pit and has an angle of 37 degrees and a lift of 215 m. The commissioning of the crushing and conveyor facility in the southern part of Mikhailovsky GOK open pit is scheduled for this year. It has a capacity of 15 Mt of iron ore per year.

At both LGOK and MGOK, Tenova TAKRAF has also been contracted to deliver IPCC solutions. At LGOK this will include two truck loaded semi-mobile in-pit crushers reducing material to <1,200 mm size followed by a 4.4 km conveyor at a 17 degree angle. At MGOK the TAKRAF project will involve constructing a crushing and conveyor facility in the central part of the pit. The production capacity of this conveyor will be 35 Mt per year. The LGOK IPCC installation is slated for 2021 and will have a 55 Mt/y capacity and the MGOK installation for 2022. Ultimately, IPCC will mean the mine can remove many of its smaller trucks and associated diesel costs, as well as removing the added cost and inefficiency of the railcar system compared to a direct conveyor route.

Elsewhere in Russia, Severstal is readying an investment in a new conveyor system at the Karelsky Okatysh iron ore complex in northwest Russia as part of a major project to reduce haulage costs at the Tsentralniy open-pit mine. In the company’s capital investment 2020 announcement at the end of January, it said one of the major investment projects being run by its Severstal Resources division was the “construction of a conveyor belt for run-of-mine transportation at the Tsentralniy pit”.

This conveyor system will help the complex continue to process 20 Mt/y of iron ore and 45 Mt/y of overburden. Since this announcement, IM received more detail about this planned installation from a Severstal spokesperson. The conveyor complex will consist of three production lines, according to the spokesperson. The ore production line includes a semi-mobile gyratory crusher, with capacity of up to 3,500 t/h, a conveyor that lifts the crushed ore to the pit surface and transports it to a warehouse for storage, a warehouse conveyor and a stacker.

The second production line is for overburden. It has a more powerful semi-mobile gyratory crusher with capacity of up to 7,300 t/h, lifting and transmitting overburden conveyors and a dump conveyor that feeds the overburden to the spreader that forms the tailings heap.

The third production line is intended for “contaminated ore”. It consists of an eccentric crusher, a dry magnetic separation unit and a conveyor system. After separation, refined ore will be fed to the first ore line and the waste rock will be fed to the second overburden line.

The total length of all the conveyors is 6.5 km, with the largest single conveyor being 1.85 km. The spokesperson said the height of the overburden lift by the conveyor system is 320 m. Severstal Resources says the goal of the project, which should launch in 2023, is to reduce haulage costs associated with transporting rock using dump trucks. “Today the Tsentralniy pit is 350 m deep, 4 km long and 2.5 km wide,” the
spokesperson said. “Dump trucks are carrying ore and overburden for about 5 km; by 2023 this will increase to 7 km – hence the decision to build the conveyor complex.” The project has the added benefit of reducing emissions as there will be less exhaust from the equipment in the pit, the spokesperson added.

**Mae Moh’s long standing use of sizer technology**

MMD is delivering another Semi-Mobile Sizing Station and 500 t Atlas Transporter to the Mae Moh coal mine in Lampang, Thailand. This crucial asset feeds the neighbouring Mae Moh Power Station, owned & operated by EGAT (the Electricity Generating Authority of Thailand).

ITD (Italian-Thai Development Public Company Ltd), the mine operator for phase nine of the project, has also requested MMD to undertake the design of a far-reaching refurbishment of the four Semi-Mobile Sizing Stations supplied back in 2005 for phases five, six and seven. After installation of these new and refurbished machines, it will bring the total to eight MMD Sizer Stations and two MMD Atlas Transports operating at Mae Moh coal mine. MMD has had a long relationship with the mine dating back to 1993, and delivered true turnkey processing solutions to assist the mine’s progress, from initial order through to final commissioning and after-sales service and support.

Each of these latest Semi-Mobile units will be utilised to the full, processing overburden at a rate of 5,500 t/h, whilst reducing material from up to 1.5 m down to 300 mm. With parts supplied from the UK, South Africa, China, India and Thailand, this ambitious refurbishment and new build project brings together MMD companies and expertise from around the world.

“MMD deliver good performance and reliability,” said Payungsak Jaikham, Project Coordinator of ITD. “We received a very competitive price, and we are looking for a long-term relationship with MMD. We know they can support us.”

**FLSmith forging new IPCC futures**

Arguably now having the most comprehensive IPCC offering since its acquisition of Sandvik Mining Systems in 2018 and with a portfolio now covering everything from primary crushers to fixed, semi-mobile and fully mobile crushing stations, overland conveyors, shiftable mine conveyors and spreader systems plus innovations such as the EcoTails (co-mingling of crushed waste rock and dry tails) and the Hybrid Apron Belt (HAB) feeder, FLSmidth now has activities across a number of different project types and activities in different commodities and regions, Branco Lalik, Director Process Line Management Mining Systems, told **IM**.

First off the company is in discussions with a client in Brazil about different scenarios – including trials and testing - on how to utilise the FLSmidth ABON sizer technology in operations for various material types found in iron ore, including harder rock types, which previously have not been suitable for processing by any roll crusher type. “However, with our extensive sizer tests and operational experience from other hard rock applications we see this as a great technical opportunity. We are very confident that our sizers can perform well in these manifold applications at high capacities in the challenging environment.”

Moving to China, FLSmidth is having ongoing business development discussions with JV partner Northern Heavy Industries Group (NHI) about opportunities based on their crusher portfolio on an application case-by-case basis to utilise the JV (NHI-Fuller Mining) in the best possible way. Currently the focus is more on secondary crushing applications with cone crushers but could include the consideration of larger gyratory crushers in fixed or semi-mobile crushing stations. Lalik stated: “This will depend on the expectations of our customers in terms of the required features of the crusher. For instance, applications in not too challenging environments in terms of materials to be crushed such as coal, lignite or in non-abrasive waste materials may certainly be more suitable, where there is no need for a top service crusher and other special maintenance features.”

On agreements with major Tier 1 miners, the recently signed Global Framework Agreement with Rio Tinto is not only based on equipment deals but also on new developments and the whole R&D area in mining. “There has been a regular, active dialogue and bilateral exchange of information between Rio Tinto and ourselves since this agreement has been put in place. We have had a very positive trend and development at FLSmidth in the last two years with key accounts such as Rio Tinto and Goldcorp/Newmont regarding close cooperation in order to realise large mining projects together and we are certainly glad to be part of it.”

The new HAB system is still in the development phase. Lalik states: “The main focus of our work is to look at how we can cover multiple applications with the same concept whilst keeping the technical and economic advantages of the HAB at the same time. With introducing different materials for instance, one needs to look at the material flow capabilities, the durability of the feeder and its scalability to address different feed capacities in particular. At the moment we have a couple of solid enquiries in iron ore for medium capacity levels. We will put a new reference for the HAB feeder into operation soon.”

Finally on actual IPCC references and projects in the offering, in Peru FLSmidth was selected as a preferred supplier by a major copper miner for a high-capacity semi-mobile crushing plant. Further down the line in northern Brazil in iron ore a new project is now in the execution phase with two complete IPCC systems each with 5,000 t/h nominal capacity consisting of two semi-mobile crushing plants and five overland conveyors in total with a length of more than 5,000 m. The longest conveyor is around 1,500 m long. “It has a difficult geometry with an inclined section, where the system requires significant power and a decline section with regenerative operation. This wide range of load conditions makes the conveyor control quite difficult, especially when starting and stopping the system.”

In India, FLSmidth is also executing a lignite handling system on an EPC basis. The plant has two semi-mobile crushing stations (SMC) for receiving lignite from the mine and transporting it to the local power plant at a rated load of 1,000 t/h. The system also incorporates a pipe conveyor and other material handling systems such as smaller conveyors, feeders and hoppers.

Lastly, in the last couple of years, FLSmidth has successfully delivered two copper producing plants for a customer in Kazakhstan together with the associated IPCC systems for copper ore from ROM material downstream through all the comminution stages. “These two references are a good example where we can provide the full value chain as the only OEM in the market being able to deliver the full flowsheet. This brings value to customer processes and allows us to work closely with the customer throughout their operations to find the best possible solutions that are underpinned by a harmonized optimisation from the pit through the plant. Being active in the processing side as well as the mining side combines two very important aspects of the mining value chain. We can add to the productivity gains that our customers are looking for and closing productivity gaps that we currently see on the market.”
Karara opts for mobile stacking conveyor technology

Bis, FLSmidth and Karara Mining have developed a “unique mobile stacking conveyor” solution that has cut water use, costs and the environmental footprint at the iron ore miner’s operation in Western Australia.

If Karara’s iron ore mine had chosen a wet tailings storage facility, the tailings pond would have been roughly 8 km² based on its 30-year mine life, according to FLSmidth.

The operation is also in the Mid-West region of Western Australia, an area with scarce water reserves, so losing so much water to wet tailings would have been costly to both the environment and Karara’s bottom line.

With these factors in mind, Karara looked at implementing a dry-stacked/filtered tailings system to allow for significant water recovery and reuse. As well as reducing costs, dry stack technology would reduce the tailings footprint to around 4 km², according to FLSmidth.

Bis worked with Karara and FLSmidth to develop a solution to build, own, operate and maintain a “unique mobile stacking conveyor”, FLSmidth said. This fixed infrastructure solution was developed by the three companies to integrate a walking conveyor and stacking technology normally used in large-scale copper mining operations.

Aside from the significant reduction of the physical footprint compared with the wet tailings alternative, Karara was looking for cost efficiencies in other areas, FLSmidth said. “For instance, the planning of a wet tailings storage facility needs to factor in an ongoing maintenance strategy. This comes with a perpetual cost that can only be guessed at while the decades pass,” the company said. “With dry-stack tailings, the total cost of ownership over the mine’s lifetime is easier to estimate and Karara were confident the dry stack solution would be cost competitive.”

Water usage was another key consideration for Karara. With environmental and cost factors in mind, Karara wanted to look at ways to have greater control over water assets on site. The ability to reuse and recycle water in the mining process would lead to substantial cost efficiencies by minimising the amount of makeup water.

FLSmidth semi mobile crushing stations, part of an IPCC solution provided to Barmer Lignite Mining Company Limited (BLMCL) in Rajasthan, India needed for the mining operation, FLSmidth said.

The technology implemented into Karara’s tailings storage facility was also an important factor as Karara wanted the flexibility to continually update the equipment with the view of running it more efficiently as new technology became available. It engaged Bis to operate the facility machinery based on its deep industry experience with materials handling and bulk logistics, FLSmidth said.

FLSmidth, meanwhile, was identified by Karara as being able to meet the project’s requirements and mine-specific needs. The mining OEM said: “A primary demand was the ability to supply a cost-effective dry stacking technology ideal for dry climate mining operations that reduced water requirements. With FLSmidth’s advanced stacking capability (machinery working off stacked pile) and ability to stack tailings at 15% moisture content, this meant tangible water savings for Karara.

“At Karara, the dry tailings will be stacked in four lifts to the maximum height approved by the

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**Indurad’s IPCC automation journey**

**Indurad** has been founded on the success of an R&D project starting in 2003 at RWTH-Aachen’s Institute of Advanced Mining Technologies (AMT), evaluating suited sensor technologies for the automation of IPCC and other equipment. The research contained benchmarks of laser, radar, RTLS and ultrasonic technology, and it turned out that radar technologies were most suited for these mining applications due to dust and fog, however, they were only available as 1D level gauge radar. Indurad consequently developed 2D radar under the iPosition system name and was granted the first IPCC related order in 2008 from one of the world’s larger IPCC system mining company operators RWE Power, which runs more than 15 bucket wheel excavators and 15 spreaders, with single BWEs having a daily capacity of up to 240,000 t of coal or overburden. The systems are spread across three large lignite mines in Germany: Garzweiler, Hambach and Inden.

RWE Power’s Senior Manager of electrical and mechanical maintenance section at Inden mine Wilfried Gau comments: “We started with indurad’s 2D radar on the suspended hopper cars and based on the high availability of the manless-automation mode we have been rolling out the concept on the travelling hopper cars and on the spreader side where we replaced existing laser solutions providing now a better machine availability. Finally, we reduced wear on the machinery as of reducing steering commands of about 20%.”

Indurad’s iPosition technology can be now found worldwide, for example in Chile with a focus on leach pad systems including bridge systems from FAM at BHP Spence or a FAM reclamer at Codelco’s Radomiro Tomic. Christian González, indurad’s Managing Director in Chile and PLC expert states: “iPosition together with iBelt and iReclaimer support robust control loops on the machines increasing the tonnage rate by more than 15%, besides protecting the machine with 2D iSDR radar crawler collision avoidance.”

One of the latest projects was the implementation on a brand-new thyssenkrupp Industrial Solutions (tkIS) Bucket Wheel Excavator (BWE) together with a Mobile Belt Wagon (MBW) and Cable Reel Car (CRC) at Huanneng Coal’s YiminHe coal mine in China. The mine is one of China’s pioneers in using modern IPCC technology and first used indurad’s iPosition technology on a tkIS fully mobile crusher fed by a rope shovel back in 2003 and specified this system based on its good experience for the new YiminHe II project. “In China we installed the world’s most advanced iPosition solution using all three technology layers: 2D iSDR Radar, 3D iRTT RTLS relative local positioning and 3D ISMU GNSS global positioning – it is fault-tolerant with ‘hot spares’ allowing a broken cable or sensor to be replaced in the next shutdown without stopping automation of both transfer points and repairs to be carried out at -30°C” says Dr Reik Winkel, founder of Indurad and foremost a Mining Engineer understanding the need for rugged technology.

In Chile, the ore flow at the Chuquicamata Underground project (see dedicated section) on TAKRAF and Metso equipment is also monitored with Indurad’s advanced radar technology, comprising 50 sensors (a mix of 1D ILDR and 2D iSDR types) on the ore passes, feeders and crushers.

Western Australia Government. The solution proposed by FLSmidth also created a smaller tailings storage footprint, which also meant improved site rehabilitation potential.

Karara worked closely with Bis and FLSmidth to get the project off the ground and make Karara the first mine in Australia to take full advantage of this dry-stack technology, FLSmidth said. The tailings storage facility is fast approaching the completion of Lift 1 and, together with Karara, Bis and FLSmidth are already in the planning stage to lift the equipment to the second level.

**thyssenkrupp on IPCC optimisation**

Whenever major miners face mine extension projects, they frequently discuss pros and cons about the implementation of in-pit crushing and conveying into their operations. IM spoke to Stefan Ebert, Head of Sales Revamps Mining at thyssenkrupp Industrial Solutions, who says as part of these, discussions, the perceived inflexibility IPCC systems carry with them by nature always comes up. He says: “Without a doubt mine planning and operational procedures need to be considered and adjusted to a wide extent compared to conventional truck and shovel operation models. However, it is very fair to also argue the large opportunities these assets have in upgrades, which allow adjustments during the lifecycle of an IPCC system as well as reactions on changing environmental conditions within a mine’s operation lifetime.”

Compared with the initial investment of an IPCC system there are many potential opportunities to optimise these continuous mining operations with quite limited resources. “Potential for revamps range from classic capacity upgrades or de-bottlenecking for increased availability, but also optimisation of operational expenditures by analytics of the installed components or simplification of maintenance efforts.”

Important for optimisation of IPCC systems is the analysis of the complete system from crushing plant via conveyor to the stacking or spreading unit to achieve an answer on the bottleneck of the said system. “The detailed analytics of those systems usually start with root cause analyses. These collect PLC data and monitor developments over time as well as behaviour of the machines in certain conditions. These services are performed...
either as single service to assess the asset condition and develop optimisation measures or as frequent and pro-active monitoring of the assets as part of a recurring monthly status assessment reporting. Based on the collected data digital twinning takes place, which confirms considered design data with the data set of the actual equipment and operation in reality. Based on the digital twin for both, crushing plant or conveyor lines, recommendations and statements can be made."

For example, it can be worked out if there are reserves for higher capacities or if there are issues at certain conditions (eg during start-up). Based on these recommendations and statements upgrades and revamps can be developed to increase value of the asset by increasing performance (eg capacity upgrade) or by reducing operational expenditures (eg optimised component selection based on actual conditions). Implementing a digital twin and ongoing collection of relevant data also allows the implementation of predictive maintenance measures which would increase the overall system availability and reliability of operations.

"Introducing solution providers like thyssenkrupp Industrial Solutions benefits the assessment of the complete IPCC system by an analysis without prejudice in relation to any specific component or equipment. This allows an open-minded approach to develop the optimum upgrade recommendation, whether it concerns the crushing plant, conveyor, idler or structural steelwork."

Another key argument from miners on the inflexibility of IPCC systems is the challenge of relocation procedures and preparation. However, Ebert says it must be taken into consideration that there are service providers like thyssenkrupp Industrial Solutions who can take over the shutdown planning and scenario engineering to support the mine operator with knowhow to properly deal with this temporary challenge. This would both include the relocation process support itself (eg advisory services on the transport crawler operation), but also analytics of the structural integrity and modifications of the equipment to allow its relocation. “The main lever of thyssenkrupp's involvement nevertheless would be the scenario engineering to ensure a maximum limitation of the operational shutdown plus an implementation of improvements onto the equipment en-route.”

Ebert concludes: “Especially when looking into capacity changes in a mine operation, semi-fixed or semi-mobile equipment like those found in IPCC systems have a definite potential to apply flexibility to a mine's operation. There are also measures worth looking at in detail which have the potential to optimise operational expenditures to create increased shareholder value in the long term.

Komatsu launches new IPCC product
Komatsu launched a new reclaim feeder model, the Stamler RF-5, at the 2020 CONEXPO-CON/AGG show in Las Vegas earlier this year. Reclaim feeders are a type of chain feeder that transfers material from a stockpile and meters it on to a belt conveyor. The stockpile can be created by a belt conveyor, wheel loader or with a truck dump. Reclaim feeders can also work in a dozer trap configuration.

With minimal civil work required for set up, reclaim feeders offer a low installation cost, typically sitting on the ground. They can be easily relocated to be used where most needed, not requiring any special equipment to relocate. They provide an operational flexibility by being able to be dragged into position with dozers.

Coal or cement operations, which sell multiple grade products, often use multiple reclaim feeders to blend the products on the belt. They are a low-cost option to back-up bucket wheel reclaimers in a heap-leach application. They can also be utilised in ports for barge and ship loading. More than 500 reclaim feeders have been supplied by Komatsu to date with capacities ranging from 500 to 4,000 tons per hour.

To maximise productivity, the fully enclosed, sandwich belt High-Angle Conveyor (HAC) from Komatsu is capable of elevating high tonnages of material at steep angles, up to 90°. Komatsu told IM that it recently commissioned its 164th HAC system.
Dos Santos high angle conveyors for Colombia gold miner

Des Santos International recently commissioned two Sandwich belt high angle conveyors for Continental Gold’s Buritica project in Antioquia, Colombia. The DSI Sandwich high angle conveyors will serve as transfer conveyors elevating crushed pebble ore, each at a rate of 235 t/h, and operating at an incline angle of 45°. While not IPCC per se, the same technology is highly applicable within the pit as well, and DSI has also supplied IPCC solutions.

These two systems were rationalised to be the same belt width, and to use the same mechanical equipment (idlers, drives, pulleys, belt, etc). However, the first unit achieves a higher lift and length than the other. Unit 1, adjacent to the grinding SAG mill has a lift of 14,250 mm and a length of 34,100 mm. It feeds a crusher, when then feeds the second Sandwich conveyor. That unit has a shorter lift and length at 6,750 mm and 17,500 mm, respectively. Unit 2 elevates the pebble ore outside of the building and discharges onto a conveyor which also delivers stockpiled material into the building.

Early in the commissioning process, Continental Gold determined that a conventional conveyor on the site (not supplied by DSI) would need to be modified from a simply supported structure to a cantilevered head end. Continental reached out to DSI for their structural engineering expertise, and the additional task was completed quickly and economically. Though the new steel was procured by the site personnel, DSI ensured that the modifications could be made with minimal additional cost. The result was an elegant strut design that maintained the support at the head end, while also incorporating modifications to allow for access to important equipment.

This is the second gold project on which DSI has cooperated with M3 Engineering. DSI also executed a contract through M3 for an overland conveyor system at Goldcorp’s Los Filos Project in the Nukay mining district of central Guerrero State in Southern Mexico.

The long-hole open stoping mining method will be employed to extract high-grade ore from the underground deposit. Cut-and-fill method and shrinkage stoping methods will be applied to extract lower quality ore. The Buritica underground ore body will be accessed via three ramps namely South ramp, Yaraguá ramp, and the Higabra valley tunnel. The mining rate will initially be 2,100 t/d and will be ramped up to 3,000 t/d by the third year.

DSI Sandwich belt high angle conveyors take on many forms the company says they offer many advantages. “Each DSI Sandwich Conveyor uses two standard, smooth-surfaced conveyor belts, face-to-face, to gently but firmly contain the product being carried. This not only makes steep angles possible; it also offers a spillage free, environmentally sound operation because the material remains secured between the belts. A DSI sandwich conveyor is capable of higher conveying speeds and greater capacities than other high angle conveying methods. With the availability of wider belts and accompanying hardware, capacities greater than 10,000 t/h can be easily achieved with a DSI Sandwich conveyor. High angles of 90° are typical, and lifts of 300 m are easily accomplished. The use of all conventional conveyor parts ensures high availability and low maintenance costs, as well as interchangeability of components and fast delivery of replacement parts.”

The second DSI Sandwich belt conveyor at Continental Gold’s Buritica project is fed by the first conveyor belt.
system moving crushed copper ore from underground storage bins to the surface processing site. Mario Dilefeld, Head of Belt Conveyor Systems at TAKRAF outlined the project in some detail to IM.

The system called for no redundancies, which meant that high system availability, minimal system wear and easy maintenance of components were critically important. The project scope called for removal of crushed ore from 60 m high underground storage bins with a conveying capacity of 15,000 t/h, transportation to the surface with a minimum number of material transfer points, and conveying of the ore from the underground tunnel exit to the existing processing plant, taking into account existing infrastructure.

In designing the system, numerous innovations resulted in six patents being implemented for the first time, resulting in a modern, powerful and environmentally friendly conveyor system. Highly efficient electric drive motors replaced diesel truck engines and as a result, CO2 emissions produced by transporting the material have been reduced by more than two thirds for the same copper production volume.

TAKRAF employed a feeder conveyor in place of conventional belt conveyors for controlled material discharge. The conveyor belt has a 45 degree trough angle along the entire conveyor route, with only chutes being in the storage bin discharge area. The contour of the material being conveyed is specified by a shear gate and the flow of discharged material is defined by varying the conveying speed. The elimination of the vertical sidewalls associated with belt conveyors means less wear and thus reduced maintenance costs, combined with energy savings of around 25%.

Two conventional trough conveyors connect the material discharge of the feeder conveyors with the loading point of the inclined conveyor, around 900 m away. The tunnel extends some 6,400 m to the surface and the inclined conveyors overcome a difference in elevation of 950 m.

As each underground transfer point along the tunnel requires an underground chamber with considerable infrastructure, the number of transfer points was minimised by using an inclined conveyor section with just two conveyors. This was made possible by newly developed components that redefine the performance limits of belt conveyor technology.

St 10,000 quality conveyor belts from ContiTech were used for the first time. Operating belt safety ratings of S = 5.0 required belt connections with a reference fatigue strength of over 50%. Once again, new dimensions were achieved - this time in terms of installed drive power - with 10,000 kW of installed drive power per drive pulley and 20,000 kW per conveyor.

In cooperation with the drive motor manufacturer, ABB, Tenova TAKRAF engineers developed a drivetrain consisting of a 5,000 kW synchronous motor, membrane coupling to connect the pulley shaft and rotor shaft and drive pulley.

Maintenance of the air gap between the rotor and stator is a crucial requirement for the operation of the motors, with the 14 mm air gap...
TNT helping mines go SUPERPORTABLE®

Terra Nova Technologies (TNT) told IM it has been busy with a number of interesting projects in the last two years and is actively adapting and re-introducing their highly flexible heap leach SUPERPORTABLE® Mobile Stacking Technologies for use in waste rock disposal for IPCC and dry tails stacking.

Along with their JV construction partner Vial y Vives DSD, TNT recently completed a crushing and conveying brownfields expansion at the BHP Spence mine in Chile. The scope included a fully modular primary gyratory station, the first of its kind in South America, complete with 27 m high mechanically stabilised earth crusher wall, 33 modular structures installed in 10 phases, a 60” X 113” – 750 kW gyratory crusher, associated pollution control and a hydraulically driven 3 m wide sacrificial conveyor complete with all electrical rooms, sub-stations and automation. The station feeds 6,250 t/h of ore along a 54” wide and 3 km long overland conveyor, equipped with belt condition monitoring and two 1,865 kW WRIM drives, to the 200,000 t coarse ore stockpile. The modularised station and stacking structure ensured fast schedule and lower construction costs with record construction times.

TNT has also had a large 100,000 t/h SUPERPORTABLE® multi-lift mobile heap leach stacking system operating in excess of 95% availability for more than 10 years at a South American copper mine. It also recently commissioned for the same mining company another significant 6,500 t/h SUPERPORTABLE® multi-lift stacking system at a copper mine in the US. This was the third system supplied by TNT to this mine, and the fifth successful stacking system supplied to this customer. This most recent system represented the latest advancements and technology that is the culmination of years of advancements made working with this long-time customer’s operational staff. In the first month of operations, they set several daily records exceeding 130,000 t/d.

Underground crushing and conveying is another area where TNT has expanded its offerings, having recently completed the delivery of underground crushing and conveying, and surface conveying packages at Lundin’s Neves Corvo mine in Portugal, as well as an underground conveying system at Pumpkin Hollow in Nevada. TNT is also working on the engineering for a complete crushing and underground to surface conveying project in Canada, that will eventually convey both ore and waste rock to surface, with waste rock being disposed of via a stacking system into an old open pit.

Newmont Goldcorp recently awarded TNT the replacement of an underground conveying system that was damaged in a fire at the Musselwhite Mine in Canada. This venture into the underground arena has led to an almost immediate integration into the Cementation Group in their first year of their ownership of TNT, with the parent company being responsible for varying degrees of underground mine construction and installation on the Musselwhite Project. TNT also now has several conveying and stacking solutions operating in extreme Arctic conditions, including the Nordgold Gross project that operates at temperatures down to -50 °C in Siberia.

According to TNT’s Director of Project Development, Paul Emerson, TNT is receiving a lot of interest from clients regarding the adaptation of their SUPERPORTABLE® technology into both dry stack tailings and waste rock and overburden disposal due to the mobility, flexibility, as well as proven high utilisation and availability when compared with alternate stacking solutions. TNT has over the last year worked on numerous paid studies and projects with multi-lift stacking plan development for a variety of new projects and brownfield sites that often consider a variety of adaptations of both tailings and waste material disposal. One project considers the SUPERPORTABLE® technology to stack rock abutments around an existing wet tailings impoundment to increase the safety and volume. The system also provides a more economical haulage of waste than traditional truck/dump scenarios. Another project considered dry tails with complex gradients and topography with stacking lift restrictions due to seepage and geotechnical stability that essentially could not be contemplated otherwise.

Yet another project considers the crushing, conveying and advance stacking of PAG waste within a wet tailings empowerment so that the tailings can flood the acid generating material to prevent ARD. And a further project considers conveying filtered tails and waste rock, with the SUPERPORTABLE® system essentially “mixing” the material through the multiple transfer points at 76 m centres until disposed on the stacking system and preventing liquefaction or segregation right before the disposal onto the stacked area, thereby ensuring the best possible encapsulation of acid generating waste rock and geotechnical stability.

“A big misconception related to the SUPERPORTABLE® system is that that multiple transfer points reduce the availability and utilisation. In reality, TNT’s clients are advising that they are operating these systems at high 95% plus availabilities.” According to Emerson, in the past the arguments against the IPCC or dry tails solutions was that when one conveyor shuts down, the system is down, whereas if one truck goes down you are still operating. That is where the SUPERPORTABLE® system is similar to trucks since if any one of the string of mobile SUPERPORTABLE® conveyors has an unscheduled breakdown, it is simply removed and replaced in a similar fashion to trucks. “In normal operation this happens periodically and a SUPERPORTABLE® is added in for advance stacking or removed in retreat stack mode. Where high availability is

TNT’s mobile conveyor systems for heap leach and tailings disposal are both super portable as well as super flexible in operations
necessary such as in a tails deposition application, we usually have a spare stacker and stacker feed conveyors which effectively provides a redundant system, particularly if there are an extra couple of spare SUPERPORTABLE® as well. Since you are adding and removing SUPERPORTABLE® in and out of the string TNT states that they can usually arrange the stacking solutions in a manner that has the spare stacker ‘share’ SUPERPORTABLE® and provide a redundant system with very little extra equipment making these systems extremely cost effective and versatile.

An example of redundant stacking systems depositing tails on a multi-lift retreat stack is the redundant system operating at Ma’aden Phosphate Company in Saudi Arabia. This system has dry stacked 35,000 t/d of tailings since 2010 on a pad that has five lifts, each 10 m high, with an eventual footprint of 1,200 m x 3,200 m. TNT is currently supplying the third expansion for the dry stack tailings system. “This is an example of a completely stable and safe tailings pad that has saved tremendous amounts of water, and what we see as the new standard for tailings systems.”

between the rotor and stator only being allowed to deviate from the setpoint within small tolerances. This is because deviations in the air gap reduce the efficiency of the motor and, if the rotor and stator were to make contact, it would damage the motor. The air gap is continuously monitored during operation. If deformations and/or subsidence in the steel structure or motor foundations lead to a deviation in the air gap setpoint, the stator has to be realigned. To simplify this process, the spacing between the rotor and stator at the non-driven end of the motor was fixed by a support bearing. A membrane coupling compensates for deformation of the pulley shaft caused by belt tension. The adjustable motor frame facilitates alignment of the motor during installation and ensures simple realignment if necessary. Eccentrics and spindles allow the stator to be adjusted in all directions. Should a motor fail, it can be quickly moved into a disabled position by opening the membrane coupling and adjusting the spindles. The system can then operate with reduced power.

The landscape has been shaped by over 100 years of mining, with, in addition to processing plants, waste heaps, train tracks, roads, pipelines and buildings. The challenge was to design an overland conveyor system that took into consideration this landscape for its entire length from the end of the underground tunnel to the processing plant more than 5 km away. A continuous single flight conveyor was developed as follows:

- **Distance of 5,330 m between the material loading point and discharge with a difference in height of 287 m**
- **Horizontal curves with tight radii (1,600 m to 2,300 m) on more than 60% of the conveyor length**
- **Approximately 50% of the conveyor length on elevated structure with variable lengths adapted to local conditions for foundations positioning and with support intervals of up to 96 m.**

All loading points were optimised to reduce conveyor belt wear. Newly designed transfer chutes allow wear plates to be replaced quickly and easily. A specially designed TAKRAF maintenance vehicle travels along the conveyor path, enabling the conveyor belt to be lifted and worn idlers to be safely and efficiently replaced.

At the material discharge point, a bunker building provides limited material storage. Two feeder conveyors remove the material and feed it to the processing plants. Three 5,000 kW direct drive motors drive this conveyor, using a St 6,800 conveyor belt with a belt safety of $S = 5$.

**McLanahan feeder breakers set for Indonesian coal mine expansion**

US-based McLanahan Corporation says it continues its long-standing support of Indonesian coal projects after being awarded an A$4.5 million contract to supply custom-engineered Feeder-Breakers to PT Bukit Asam. PT Bukit Asam’s main sites are the Air Laya, Muara Tiga Besar North and West & Central Banko mines with a combined production of over 25 Mt/y.

The contract includes the manufacture, assembly, supply and commissioning on site for two McLanahan FB48-50-46 Dump Hopper Feeder-Breakers and one RFB48-50-49 Reclaim Feeder-Breaker. The ROM Dump Feeder Breakers will be handling raw coal. Each machine will be positioned underneath a 150 t, 12 m long hopper allowing two 50 t rear dump trucks unloading from each side of the hopper. All machines are being designed, manufactured, assembled and shipped from McLanahan’s Australian factory in Cameron Park, NSW, where factory acceptance testing will also be witnessed by the client’s representative.

“It’s a real thrill to be able to showcase our technology to one of Asia’s most trusted coal mining companies,” said Chris Knowles, Director of Sales and Marketing at McLanahan. “As an Australian OEM, we feel that our experience in developing equipment focused on safety and ease of maintenance, along with automation, was a big factor in our selection. Of course, it helps to have a partnership with the industry’s best service provider, PT Suprabakti Mandiri. PT Supra offers highly trained local personnel who are able to respond immediately and meet the needs of the customer.

“Coming off the back of the most successful year in our history, we see this new project as a great start to the new year, and confirmation that our continued investment in the region is well supported,” Knowles said. According to Emerson, it is encouraging to see clients starting to engage TNT directly much earlier in dry tails stacking and IPCC waste stacking projects, which is key. “It is logical and easy to understand the advantages of conveyor haulage versus trucks when considering the environment, safety, water usage, carbon footprints, dust and OPEX. Making the paradigm shift is more difficult because trucks are ‘easy’ and a known quantity. However, by involving the OEM equipment suppliers early in the design, the optimum use and application of their systems is better applied. In reality, the CAPEX is generally similar, the OPEX is half or less and the resulting cash flow/IRR are much improved when conveyors are maximised in the mining process. Again, it is logical and common sense. With conveyors as flexible and mobile as TNT’s SUPERPORTABLE® systems, many of the advantages of the trucks disappear. Water, CO₂, dust and labour will force us to all look at the best haulage systems for waste, ore and tailings that are better for the environment and the bottom line. This is where TNT sees the future of mining projects, and where we believe the SUPERPORTABLE® technology will excel due to the mobility, flexibility and versatility of the design.”