Machines That Help Reduce Dilution

The top narrow vein mining solutions on the market offer an increased power-to-weight ratio, lower ownership costs and higher productivity

By Jesse Morton, Technical Writer

The DL2711 is a fully mechanized top-hammer longhole production rig capable of drilling vertical and inclined fans, single or parallel, 64- to 89-mm-diameter longholes, up to 38 m in length, using T38, T45 and T51 MF-rods or 65-mm tube rods. (Photo: Sandvik)

Hecla's San Sebastian silver mine used a handful of techniques to reduce dilution. They used controlled blasting techniques, trench sampling, and relied heavily on geologists in the pit to visually assess the muck and face and pinpoint cutoff grade. "Through the whole project, through to the end, we didn't exceed 10% on dilution," Alberto Ramos, senior project engineer, Hecla Mining, said. "It ranged between 3% and 7%."

When it launched underground operations in 2018, it planned on cut-and-fill stoping, with ore extracted by rubber-tired equipment. It tested longhole mining, which proved successful, and it refined its blasting plan. "We designed everything at 2 m. Then we did some stope optimizations and reduced that to 1.5 m," Ramos said. "We ended up managing to mine at 1.5 m, longhole stopes, at 15-m sublevels."

In its late stages, the mine is now a success story in part because the company prioritized continuous improvement as part of the mining process.

Some of the headlining solutions in the underground narrow vein mining space speak to that discipline. They are dynamic and versatile, safety-centric, and designed for operations looking for ways to mine more ore and less waste.

Compact Long Hole Production Drills

Sandvik released the DL2711 and DL2721 long hole production drills, which complete the 2711 narrow vein drill class. The electro-hydraulic drill rigs were developed through close working relationships with customers, ensuring designs specific to the applications, the company reported. The resulting exemplary performance should speak to the highest priorities of the company, Damien Tang, product manager, underground drilling, Sandvik, said.

"We are focused on real end-user requirements, not only from the development of a new product perspective, but adding value and benefits at the mining process level," he said. "The DL2711 and DL2721 have been developed and fueled by Sandvik's desire to meet or exceed customer needs, producing real benefits to their mining operations."

Customers around the globe provided feedback, data and information that was used in development. The benefits include increased production. "In China, the drill rigs were used to drill a series of 89-mm-diameter by 25-m-long production holes," Tang said. "They were able to do this highly efficiently and effectively, achieving an average production rate of 200 m drilled per shift."

The rigs averaged more than 100,000 drilled meters per year. "Similar results have been reported from Russia, South Africa and Peru," Tang said.

The drills are described as fully mechanized top-hammer rock drills, designed for underground mining in 3.2- x 3.2-m or larger production drifts. They are capable of drilling vertical and inclined fans, single or parallel, 64- to 89-mm-diameter long holes, up to 38 m in length, using T38, T45 and T51 MF-rods or 65-mm tube rods.

The listed features include: a robust design and proven components; a HL710S hydraulic rock drill; 360° drilling module rotation; wide boom swing and tilt angles; and a long hole drilling module with carrousel equipped with a strong anchoring system. The DL2711 is more compact and allows the drill module to be closer to the face. The DL2721 has an FOPS canopy.

Tang said the machines offer high drilling capacity, safely and ergonomically, in a compact machine format with high levels of mobility. "Furthermore, as mining operations are tough on man and machine, they have a robust design and hard wearing components to provide the highest levels of mechanical availability."

Top benefits include lowered operating and maintenance costs, he said. "All key components were designed with commonality across the entire Sandvik underground equipment offering," Tang said.

Most importantly, the drills save money by reducing dilution. "Dilution of mined ore with waste from drilling operations is now considered to be the biggest challenge facing miners in order to deliver efficient and productive drilling and hence mining," Tang said.

"The narrow platform of the new drills enables miners to excavate smaller tunnels and production drifts, and the strong anchoring system of the machine with its precise boom positioning enable excellent hole accuracy," he said, "thus reducing any dilution of waste into the ore, thereby providing a solution to this major problem."

The drills should help dispel the long-held misconception that miners and contractors should primarily focus on drilling and blasting for ore extraction. The drills help prove long hole drilling in many cases is a viable alternative, Tang said. "Sandvik has over the years been tasked to deliver purpose-designed solutions for specific applications, encompassing various mining and excavation methods," he said. "Sandvik has been able to do this successfully due to our extensive and wide offering which has been able to provide customer-focused solutions for virtually all requirements."

While purpose-designed for narrow vein operations, the new drills are "suited to a wide spectrum of applications," Tang said. "This means that whether the drill will be working in the diamond mines of South Africa, the permafrost gold mines in Siberia, or at high altitude (up to 4,600 m above sea level) in the Andean countries or the Himalayan Plateau in China, it will perform to specification, meeting or exceeding customer requirements."

The new drill class was announced in mid-November 2019. The company reported drills in the class would come with its fleet data monitoring systems for optimal performance and management. The first two models in the class, the DD2711 development drill and the DS2711 mechanized bolter, were described as "ideal solutions for underground mines and drilling contractors looking for smarter control of ore dilution and increasing selective process in mining."

Tang said the two new long hole drills, released in July, are "part of an ever-growing story that reinforces the message of Sandvik's experience and expertise in underground drilling, satisfying or exceeding the requirements of the mining industry, and dealing with and overcoming issues and trends, such as narrow vein applications."

The PFL 8 LHD has a 0.8 m^3 bucket, a payload capacity of 1.5 mt, breakout force of up to 40 kN, an operating weight of 6.3 mt, and engine power of 69 kW. (Photo: Paus)

The HVL-38 offers an impact energy of 196 Nm, uses female striker bars, features a shorter feed length for reduced weight and improved mobility, and can be retrofitted on existing carriers. (Photo: J.H. Fletcher & Co.)

Powerful Rockdrills for Compact Carriers

J.H. Fletcher & Co. reported the field-proven HVL-38 and HV-32 hydraulic percussive rockdrills are designed for efficiency and sized to fit low-profile rigs for narrow vein mining.

The (hydraulic valve-less) HVL-38 is a high-performance, low-operating-cost percussive rockdrill that provides an impact frequency of 97 Hz, an impact energy of 196 Nm, and output power of 19 kW, Steve Nye, western district manager, metal and non-metal division, J.H. Fletcher, said.

"All that at around 190 kg," he said. "The rockdrill does not require the maintenance of accumulators, therefore there is no requirement to charge accumulators with nitrogen and replace damaged diaphragms."

The drill uses female striker bars, eliminating one threaded coupler and decreasing overall feed length. "A shorter feed length reduces weight, decreases boom wear, and improves equipment mobility," Nye said.

The supplier has around 115 machines successfully operating in the field with the HVL-38.

The company's automated mechanized rock bolters use the (hydraulic valve) HV-32 rockdrill, which is described as the shortest hydraulic percussive drill in its class.

"A J.H. Fletcher module length of 2.55 m can accommodate a 1.8-m rock bolt," Nye said. "This low-profile rockdrill allows J.H. Fletcher the ability to offer the shortest mechanized remote or automated roof bolt modules in the market."

With a height of 0.5 m, it has an impact frequency of 75 Hz and an output power of 9 kW.

HV-32 mechanized remote modules can accommodate a variety of rock bolt lengths and types.

"These modules are available to be retrofitted on your existing carriers or J.H. Fletcher's dedicated carriers," Nye said. "The carriers can be powered with battery, diesel, electric cable or a combination of power options," he said. "J.H. Fletcher offers rubber tire with steer axles, articulated steering, and rail mounted machines; and FOPS/ROPS enclosed cabs or canopies are available."

Historically, the rockdrills have been used in platinum, nickel, copper, coal, limestone and salt mines.

The drills were originally developed with other mechanized solutions for operations using jacklegs for roof and rib bolting, Nye said. The desired end was "improved safety level as well as efficiency, thus improving the bottom line cost," he said. "J.H. Fletcher & Co. operates with a singular vision: to work with a vigilant focus on finding ways to improve mining processes and reducing risk for the people who work there."

Specialized Machines Lower Ownership Costs

PAUS reported its narrow vein mining applications equipment offer an excellent total cost of ownership, which is the focus of product development at the company.

Beyond that focus, the PFL 8 LHD offers ease of use, high load capacity, operator safety, optimal visibility and an "excellent payload-to-weight ratio," Helmut Jaspersen, marketing manager, said.

The loader has a 0.8 m^3 bucket, a payload capacity of 1.5 metric tons (mt), breakout force of up to 40 kN, an operating weight of 6.3 mt, and engine power of 69 kW.

"With our LHD Loaders product range, we offer our customers the right solutions for their individual tasks," Jaspersen said. "Repeat customers prove the viability of the loader."

The Scaler 853 S8 was designed with ergonomics and safety in mind. "The spacious cab with a comfortable driver's seat and functionally arranged instrument cockpit offers one of the best all-round views in this scaler class," the company reported. The cab is ROPS/FOPS certified.

With articulated steering and swivel boom, the scaler offers "unmatched maneuverability," the company reported. With an operating weight of 8.8 mt, and a max speed of 20 km/h, the scaler comes equipped with a NPK hammer with a rated weight of 300 kg.

With a 0.7-m^3 bucket, the battery-powered L140B has a tramming capacity of 1,300 kg, tilt breakout force of 32 kN and lift breakout force of 35 kN. (Photo: Aramine)

The Universa 40 platform vehicle is offered as a workshop or passenger vehicle. With a 7 mt payload and an engine rated at 93 kW, it comes equipped with the PAUS Power Flow variable pumps that regulate oil supply; and features a hydrostatic drive, an ROPS/FOPS-certified cab, and optimized hydraulic lines. "The advantages are fuel savings, lower oil temperatures" and component longevity, the company reported.

The offerings speak to the company's mission to be "the people who care," Jaspersen said. "We are known as a specialist for individual adaptations and we continue building where series manufacturers stop."

Narrow LHD Gets Charging Stations

Aramine reported that its Mobile Charging Stations for the miniLoader L140B are being tested in two underground settings with the hope the solution can be released later this year.

One of the stations is deployed to a wet underground mine with humid and corrosive conditions. Another is deployed to a civil engineering work site "with less difficult conditions," but where it is "moved very frequently," the company reported.

Aramine told *E&MJ* the testing so far has prompted no major design changes but has revealed some potential best practices for users. "Thus far, we noted that in the mine a stationary version of the station would be much more economical," Marc Melkonian, president, Aramine said.

The tests are expected to continue and the solution will advance beyond development once the company is content with the customer feedback, the versatility of the solution and the ease of manufacturing, the company reported.

"Today, battery technology is still in its beginning stages and we need to prove ease of use," Melkonian said. "That is why Aramine created the Mobile Charging Station, which can ease and speed the changing of batteries," he said. "This helps the user in his transition to a battery-powered machine."

Beyond the charging station, the company is developing other technologies key to long-term use of battery-powered machines, Sylvain Reynier, director, research and development, Aramine, said.

"Our R&D department is currently studying our next battery powered machine, the miniLoader L350B, which

The LF-3 has an operating weight of 11 mt, a standard bucket capacity of 1.5 m³, and a payload capacity of 3.5 mt. (Photo: GHH)

will be much bigger than the miniLoader L140B, and plans to use the same Mobile Charging Station," Reynier said. "For this, we are making sure that the weight of the energy modules to be replaced on the L350B is compatible with the Mobile Charging Station."

The station is equipped with a crane, connects to a mine's electrical system, and is piloted by remote control. It will provide charging and changeout scenario optionality beyond the current methods, which include plugging the LHD directly into an outlet or quickly switching the drained battery out with a pre-charged one.

A full recharge from a socket could take from 2 to 5 hours, the company reported.

The Quick Replacement System takes about 10 minutes and mandates a designated space in the mine for charging and stowing standby batteries. The system is ideal for a miner seeking to operate only one machine, and is available for adoption as an aftermarket kit.

A fully charged battery allows for up to 4 hours of mucking, Melkonian said.

Released in 2016, the L140B comes standard with a lithium battery, a Can-bus-type electrical system for diagnostics and programming, and "intuitive and ergonomic controls," the company reported.

Benefits beyond negligible emissions include a lower heat and noise signature. The unit has as much or more breakout force than the diesel competition, Reynier said.

The L140B has a tramming capacity of 1,300 kg, tilt breakout force of 32 kN and lift breakout force of 35 kN. It has a 0.7-m³ bucket and can move fully loaded at up to 7 km/h.

Aramine describes the unit as "extremely narrow," and ideal for narrow vein mines. It is 5.3 m long, 2 m high, and 1 m wide.

It was developed for miners that want to "limit the size of their galleries, increase production, and limit dilution," Melkonian said.

The Mobile Charging Station is calendared for commercial release prior to the end of 2020. The battery-powered L350B is scheduled to debut at MINExpo 2021.

Narrow Loader Lowers Costs

GHH reported customers say the compact LF-3 loader "produces well" with "low downtime."

Released in Q2 2018, the loader is the culmination of years of research and development on narrow vein mining solutions, Ingo Rath, product line manager, loaders, GHH said. "The team took all the learning of developing previous low-profile machines and translated this into designing a robust, durable and reliable machine that is extremely maneuverable," he said. "The LF-3 is only 1.5 m wide with excellent power-to-weight ratio."

Units have been deployed to Australia, Brazil, Turkey, and Peru; and soon to Zimbabwe.

Feedback from Ölmez Maden kurşun çinko işletmesi, a cut-and-fill lead and zinc mine in Turkey, states the loader is "working extremely well," Rath said.

"The customer is extremely satisfied with the loader and says it's the best loader in their fleet," he said. "They say its breakout force and speed is far better than others."

Because of its dimensions, it "can be operated almost anywhere in the mine," Rath said.

"Additionally, they mention that while operating the LF-3, there is less exhaust and smoke, which they love," he said. "It is safer and more environmentally friendly."

In Peru, the company partnered with Overprime to sell the LF-3 and other loaders that complement it to make a total narrow vein solution, GHH reported.

The loader is roughly 7.1 m long, 1.5 m wide, and 1.9 m high, with a 3.1 m max inner turning radius and a 5.3 m max outer turning radius.

It has an operating weight of 11 mt, a standard bucket capacity of 1.5 m³, and a payload capacity of 3.5 mt. Customized buckets are offered.

The loader comes with either an EPA Tier 2, EU Stage II, air-cooled, Deutz 72-kW diesel engine, or a Tier 3, Stage IIIA, water-cooled, Cummins 67-kW diesel engine.

"The engine packages allow for deep-level gold and nickel mining, as well as high-altitude mining above 4,000 m, like in Peru," Rath said.

It has a max tramming speed of 17 km/h.

Drive train options are a Dana Series C 270 single-stage torque converter, or a three-gear Dana Series RT 20,000 power-shift transmission.

The canopy is ROPS/FOPS certified.

Options include a collision avoidance system, a diesel particulate filter, and a corrosion protection kit.

Top tier benefits include low operating costs and "great operator comfort with excellent cab ergonomics and all-around visibility," Rath said.

"The LF-3 is extremely cost-effective to run and easy to maintain," he said. "It also has a very large and comfortable operator's compartment, considering the size of the machine."

The loader is purpose-designed for narrow vein applications, Rath said. "It provides a solution to miners in a way that they can keep their haulage sizes as small as possible according to the vein and make sure to minimize dilution and maximize productivity and ultimately profitability."

The unit is part of a line that will include the LF-7 at the end of 2020. The LF-7 will be the largest narrow vein loader the company offers, Rath said. "We now have a complete narrow vein offering from small to large loaders."