Extracting potential

Gearless drives can help optimise the performance and reduce the environmental impact of mines as **Marcelo Perrucci (Switzerland) and Ulf Richter (Germany), ABB,** explain.

The challenges facing the global mining industry are well-documented. The combination of market volatility, the sustained downturn in global commodity prices and industry-specific factors such as depleted resources, ore variability and increased environmental, regulatory and geopolitical risk have forced mining operators to reduce costs and boost automation and operational efficiency.

A recent report by the World Economic Forum identifies key trends shaping the future of the mining and metals industry. Some of these trends include:

- The transition to the low carbon economy.
- Access to resources in frontier areas where extraction was not previously economically viable.
- The role of big data.

Figure 1. ABB has sold more than 140 units in 23 countries and currently has over 50% market share.

Figure 2. Conveyor flight underground. Source: TAKRAF.

Developing technologies for extraction and processing, such as gearless mill drives (GMDs) and gearless conveyor drives (GCDs), can help operators save energy, achieve greater throughput at large mills with higher grinding capacities and, through the application of big data, help cut costs using preventive and predictive maintenance.

Sustainable operations

Increasing the energy efficiency and productivity of mining operations while minimising the impact on the environment in terms of climate change, energy security, water scarcity, land degradation and declining biodiversity is now at the very top of the agenda for mining companies worldwide.

Operators are examining their investment, capital expenditure (CAPEX) and operational strategies to ensure sustainable and environmentally friendly operations.

In the past, investments in sustainable practices and capital equipment were not thought to provide significant returns on investment.

However, the changing regulatory and economic environment, as well as the benefits of new technology and business practices – particularly direct savings through greater efficiency – mean such investments now make sound business sense in the long term.

Saving energy using gearless mill drives

Using GMDs to power semi-autogenous (SAG), ball and autogenous (AG) mills has been proven to provide improved throughput, reliability and availability at processing plants.

Traditional ring-geared mill drives comprise a ring-shaped gear that encircles the mill and drives it through one or two pinions followed by conventional motors. GMDs mount rotor poles directly to the mill body and surround it with the stator ring, incorporating the mill itself into the motor.

The necessary torque is transmitted between the GMD motor and the mill via the magnetic field in the tiny air gap between the stator and rotor. This type of motor system requires no gearing or direct contact transmission, meaning GMDs improve efficiency by reducing frictional losses. Moreover, fewer mechanical critical components equals less maintenance downtime due to wear and tear.

Less electricity means that every kilowatt hour saved goes straight to the bottom line and increases the payback period of investments in savings programmes and energy-efficient capital equipment.

“Installing GMDs potentially means using less on-site mechanical equipment, thus a reduced footprint in terms of mechanical space,” explained Marcelo Perrucci, Global Product Line Manager (grinding), ABB.

“It is a more efficient technology in terms of energy savings and higher overall system efficiency. Savings of as much as 3% are possible compared with conventional solutions – and that means lower carbon emissions and cost savings.”

Low ore grades, higher-capacity production

Resource depletion and declining ore grades are forcing operators to enter frontier mining locations where they may have to run multiple, large-capacity mines with higher grinding capacities in parallel.

“When a mine is first brought online, the surface ore quality might be good; however, after a few years of operations, the ore grade may deteriorate, meaning mills have to grind very large quantities in order to extract the same amount of ore,” explained Perrucci. “Mining companies have to prepare for that.”

GMDs are now the accepted technology of choice in these remote environments, where the need for higher-power drives to achieve greater throughput must be balanced with optimum availability.

GMDs work by eliminating mechanical components found in a conventional mill drive system, such as the ring-gear, pinion, gearbox, coupling, motor shaft and motor bearings. In ABB GMDs, the rotor poles are mounted directly onto the mill, which effectively becomes the rotor of the gearless motor.

The motor is fed by a fuse-less cyclo-converter connected to the medium-voltage (MV) network through three special cyclo-converter transformers. Additionally, a small excitation converter is required to supply the poles’ excitation via the slip rings to the rotor of the gearless motor.

By eliminating complex mechanical components that may fail, resulting in production downtime, the company claims that energy savings of up to 3% are possible based on the company’s calculations – a not insubstantial economy when you consider that some modern mines may have as many as six 15 - 25 MW drives running in tandem.

"In terms of power, for anything over 18 MW, GMDs are practically the industry standard," stated Perrucci. "However, we have always delivered GMDs at powers as low as 12 MW.

"If you have low availability, the mill will be stopping more, resulting in costly downtimes, and again ABB can help its clients translate the benefits of the GMD solution into dollars so that they can be compared against the costs of the mill standing still due to an inefficient technology. In this context, you can very easily justify an increase in CAPEX."

ABB's gearless mill drive footprint in Russia

The company was an early mover in the Russian market. As a result of this, ABB is benefitting from the recent boom of large projects in Russia and in the '-stan' countries.

The company recently took an order for 12 GMDs in Russia, the largest single order in the history of GMDs in mining, where companies are refraining from the traditional model of multiple, small-capacity mills in favour of larger grinding capacities.

"Running smaller mills simultaneously has been tried in the past, but in addition to energy losses, there are issues related to mechanical components that require maintenance and the need to maintain large spare parts inventories, as well as the physical space required," commented Perrucci.

It is nowadays recognised that operating multiple small mills is impractical, complicated and inefficient, with operators seeking an upgrade in their technology. As a result, operators are instead choosing one or two large lines with big SAG mills and balls mills. This enables companies to not only reduce their overall operational footprint and CO_2 emissions, but grinding large capacities also helps to increase efficiency.

Case study: Chile

ABB is partnering with TAKRAF Tenova in Chile to supply GCDs for the extension of a copper mine which incorporates a conveyor system (13 km) with the world's highest installed power drive, connecting the subterranean operation directly to the concentrator.

Located at an altitude of 2850 m, the mine has a design capacity of 11 000 tph. 11 5MW gearless drives with synchronous motors running at low speeds (50 - 60 rpm) drive three conveyors; two with four motors each and one with three.

Two 20 MW conveyors transport the ore from the underground operation to the surface, overcoming an elevation change of around 1300 m, while the second conveyor feeds into a slightly smaller 15 MW overland conveyor.

"Each conveyer is around 3 km long, and at this length it overcomes around 600 m of altitude," commented Ulf Richter, Conveyor Systems Global Product Manager, ABB. "To transport 11 000 tph of ore requires a high drive power and the strongest available belt."

Once the mine reaches full production, the change from opencast with truck/shovel operations to underground operations with the TAKRAF system using the company's gearless conveyor drives will eradicate the need for 120 large-haul trucks, each consuming approximately 3100 l/d of diesel. Based on ABB/TAKRAF calculations, this equates to approximately 130 million l of gasoline consumption saved and carbon emission savings of around 66%, or 240 000 tpy.

Figure 3. Gearless mill drive (GMD) in Sierra Gorda, Chile.

Noise emissions reduction using gearless conveyor drives

In Europe, the company is working with a mine in the Czech Republic to replace shaft mounted geared drives on an existing conveyor system with its GCDs powered by synchronous permanent magnet motors.

In addition to preventing frequent motor bearing failing due to vibration issues, the company's silent GCD technology also helps operators to meet stringent EU noise emission limits, as Richter explained: "Noise emissions in the EU must be lower than 85 dBA (A-weighted decibels) […] When you have a gearbox with a lot of parts turning at 1000 rpm or higher, it can be very loud and these conveyers in the Czech Republic are close to villages, meaning there are noise limits in place.

"By using GCDs at around 50 rpm, we were able to reduce the noise emission of the drive unit to less than 75 dBA. In this way, the end user can install the gearless drive without the need for additional noise reduction measures such as installing noise encapsulation (housing around the whole geared drive unit) or noise protection walls along the conveyor."

Big data

Using the ABB Ability™ cloud platform, GMD operators can gather and collate real-time data from sensors in the system,

Figure 4. GMDs offer ore producers unrivalled availability, efficiency and durability while reducing OPEX.

Figure 5. Two gearless mill drives at Esperanza copper mine in Chile.

including insulation monitoring and the temperature of the stator windings. This enables them to carry out preventive and predictive maintenance from remote locations using machine learning, artificial intelligence (AI) and other techniques.

The company realised many years ago the importance of information to become truly digital and understanding what is going to happen with equipment in the future. As a result, it added instrumentation to the GMDs, meaning sensors embedded in the system can now detail the machines' behaviour.

Perucci explained: “Armed with this information, and based on the previous operational records, we can actually start to predict how the machine is going to behave in the future. Using our secure web platform remotely from anywhere in the world, customers can see, for example, the status of the air gap, the centricity of the mill, and the pole alignment – and we can proactively alert them if we predict an issue.”

The company is working on using benchmarking to improve the current platform. If a client has six machines, even at different sizes, the company is able to assess how they are performing in relation to each other. Using this comparison, the company can then try to improve the mills’ process, possibly leading to further cost improvements.

ABB Ability Remote Insights

Introduced in October 2019 at the Industrial Transformation Asia Pacific EXPO in Singapore, ABB Ability Remote Insights is a new augmented reality platform designed to improve response times, extend asset lifecycles, improve production performance and ensure operational excellence.

Using augmented reality to overlay computer-generated information, data, images, video or other content onto the real-world environment through Microsoft HoloLens mixed reality devices, the solution enables a field service technician to share their view of a situation using the device’s camera and communicate directly with an expert via on-screen annotations, chat and document sharing.

Developed for use in multiple industry sectors including metals and mining, the platform not only improves asset and production availability by ensuring that maintenance actions are completed faster, but it also reduces training costs and improves safety for the company and its customers.

“We are increasingly moving towards mixed reality, and ABB has been working to implement it into operations,” Perrucci said. “For example, we have created a mixed reality environment for the GMD, which we are working on implementing in actual mining operations for training, maintenance and troubleshooting.

“This means someone can sit in an office using a Microsoft HoloLens mixed reality device and the member of personnel who is in front of the actual GMD can use it as well to be the eyes of the person in the remote location, working together to share documentation, drawing and expertise from thousands of miles apart.”

Optimised conveying performance, based on data analytics

According to Richter, digital services for material handling performance and optimisation are now available. In global supply chains of raw materials, storage locations with belt conveyors and conveying equipment have a significant impact on the efficiency of the entire transport process, yet only a fraction of the operating data is currently used for optimisation.

In response, ABB has worked with experienced operators to develop a specific KPI system that identifies optimisation potential. This system takes the form of a customised toolbox based on the ABB Ability framework with data collection, pre-processing, calculation engine and dashboards.

The KPIs are established with the help of key indicator methods such as machine and deep learning algorithms to allow new services such as: overall equipment effectiveness (OEE), energy and load performance; energy efficiency analysis; automated alarm and event analysis including prediction of critical asset conditions and lifetime estimation and predictive maintenance.

Conclusion

ABB envisages the mines of the future as CO_2-free, digitalised and autonomous. Sustainability is increasingly connected to mining productivity, which is in turn linked to economics and profitability.

As mining companies strive to improve their environmental credentials, while at the same time boosting efficiency and providing value to shareholders, the company is playing a big role in supporting them with solutions such as GMDs and GCDs and the application of technologies such as machine learning and AI. GMR