

Advances in low voltage motor practices Unearthing electric motor potential in mining



Weak commodity prices and tighter financing is putting the mining and minerals sector under pressure. Embracing technology is seen as the way forward. It is important, however, not to overlook established technology, especially the humble electric motor. Today's motor has much more to offer the industry and may have the answers to many of its challenges.

If you were asked to design the perfect electric motor for today's mining and minerals sector, what would it look like? The motor technology, it could be argued, is well established. The motor must meet global mining standards, yet be flexible for adaptation to local legislation; robust to meet the aggressive nature of the environment; and highly reliable, never being the component in the drive train responsible for unplanned downtime.

Yet that is only half the story. It is essential that the product has comprehensive life cycle services that help define the true cost of ownership of that motor. In short it must provide maximum uptime with minimal maintenance.

What is harder to engineer is ensuring that both these aspects - the products and the services - address the key challenges that the industry faces.

These challenges vary, depending on your role in mining. But whether you are in management, maintenance or an OEM, the top three challenges upon which everyone is agreed is the need to maximise productivity, improve performance and operational efficiency and enhance safety, all of which will help tackle a fourth challenge - profitability.

Although there are no easy solutions, it is becoming increasingly apparent that technology will play a growing role in the mine of the future. In fact, mining is among the least penetrated industrial sectors for automation and yet this is key to improving safety, product quality and cost competitiveness.

Maximising productivity

Everyone has the same goal: maintaining or increasing tonnage mined per worker while sustaining production volumes. As the mines mature, most of the easy-to-reach high grade ores are tapped out. Companies need to either mine low grade ore bodies or move to remote regions which are difficult to access because of climate, altitude or unstable politics. Either way there is now an increased need for reliable equipment to make sure the mines avoid shutdown.

To improve the current tide of poor productivity, mining companies not only need to embrace new technology but need to re-think the way they view existing technology. Today's electric motors can be fitted with intelligent instrumentation that tracks the temperature of bearings and windings and monitors vibrations, thereby vastly improving the reliability and safety of the machine. This accelerates and simplifies access to information, alerts operators to potential problems and reduces maintenance with extended equipment life cycles. All of which keeps the process turning and production moving.

Improving performance and operational efficiency

Traditionally, energy efficiency has never been a major issue in mining. This is changing, as customers become aware of the prospect of saving hundreds of thousands of dollars by reducing motor energy consumption. According to a report by Deloitte, energy use can represent 40 to 60 percent of a mine's operating costs.

Enhancing safety

Safety is always topical and extends from product, production, personnel and application safety through to a motor suppliers' own health and safety policy. It covers mechanical, physical and electrical processes with a safety incident more likely if maintenance is not pre-planned.

That is why, when choosing a motor supplier, it is vital to consider their life cycle services. Predictive maintenance, remote monitoring and diagnostics are essential tools to lower maintenance costs while increasing productivity.

Tackling the challenges

Overcoming these challenges requires an understanding of the underlying issues affecting the way the mining sector works, and there are many to consider.

Changing mind set

One thing all mining companies appear to have in common is their conservatism towards new products and technologies. The industry tends to be risk averse. While this is not a bad trait, it can hide opportunities to improve productivity or efficiencies.

For instance, many sites have a habit of scrapping motors, sometimes on a two-year cycle, or at best sending the motor for rewind. Yet today's motors are designed to the highest levels of reliability, meaning that they can survive in the mining environment for in excess of the warranty periods of three to five years. With planned preventive maintenance the motors can last several decades.

If a company's policy is to change the motors as a matter of course, then purchase price becomes a dominant factor. However, a mining motor should be viewed as a long term investment. "Why scrap a motor that has shock resistance windings and up to 30 years lifetime, just because that's the way it has always been done?" argues ABB's product manager Tom Eklof. "Mining companies need to re-asses their motor management policy."

This is exactly what one global mining company discovered. It had a policy of scrapping motors because of the corrosive nature of the calcium carbonate, within its mine, on the motor's bearings. However, using the latest motor technology the company discovered an energy efficient design that stood up to the hostile environment. Now they no longer scrap their motors and keep them running for a lot longer. "It is more likely that the gearboxes or drive belts will be the cause of most breakdowns," says Eklof.

Reasons why motors fail

Bearing failures

- Excessive motor temperatures
- Contamination due to inferior bearing seals
- Lubrication related issues
- Vibration and shock loading

Winding failures

- Poor or ineffective cooling design
- Excessive number of starts

Corrosion

- Inadequate materials used for the application
- Insufficient sealing system design

External damage

- Fan cover material not suitable
- Fittings and connectors not rugged enough
- Terminal box design not suitable for application

As can be seen, this conservatism manifests itself in a reluctance to embrace change – “it’s just the way we do things!” Two areas demonstrate this. The first is the insistence on rewinding motors when often a rewind can adversely affect a motor’s efficiency and may incur a higher cost than buying and installing a new model. Studies show that the first rewind of a new electric motor can result in as much as a three percent reduction in efficiency. It can also, in some cases, cost more than a new motor.

The second area relates to insulation class. Many specifications call for Class H insulation which covers motors temperatures up to 180°C. However, achieving such a high temperature use comes at a price. The winding tends to be fragile and cannot withstand vibrations.

It can also lead to premature bearing failure if the higher running temperatures offered by Class H insulation are really utilized. The hotter the motor runs the hotter the bearings. Every 15 degree increase in bearing temperature will cut grease lifetime in half. Therefore, hot running bearings will require frequent lubrication, otherwise failure is inevitable.

An alternative is to use Class F insulation and utilize built-in winding temperature protection to safeguard against accidental, long term overloading. Typically mining motors are dimensioned for 120°C, Class B temperature rise.

Class F insulation has safe and ample margin as it can take temperatures up to 155°C. This insulation can accept short-term overload of two to three times nominal torque, for example during starting.

Class F insulation offers higher endurance against vibration and, overall, the motor efficiency is greater in comparison to thicker and more rigid Class H insulation.

“What is important is the resistance to vibration. Class H has become an urban myth; it, quite simply, is not always needed; it is an additional cost and is not really necessary for the application if engineered properly,” says Eklof

Certification

Motors that meet global standards for explosive atmospheres and efficiency provide the minimum requirement within the mining sector. Several countries, like China, Russia and South Africa, have local standards or adaptations that a motor supplier must be able to accommodate. For instance, regarding mechanical specifications, in countries like Australia and South Africa, British Imperial standards still dominate.

While new installations in Australia are based on IEC and Cenelec, the replacement market is still biased towards Imperial standards, especially with certain frame size motors where the shaft diameter is different to that required by Cenelec. In South Africa customers are requiring motors with Imperial dimensions even with new installations.

For example, in South Africa, motors with four-poles or more require a larger shaft diameter than that specified in IEC motors which follow Cenelec dimensioning. In Europe and other countries that follow Cenelec, the frame size for a 2- and 4-pole, 75 kW is 280. In South Africa, the same motor will be frame size 250. Likewise a 110 kW motor in Europe has frame size 315, whereas in South Africa this is 280.

In other instances, ABB goes beyond what the standards specify by providing third party certificates such as IECEx for motors and CU-TR conformity certificates, even though not officially required. The production, quality systems, as well as products themselves, are regularly audited and certified by independent organizations such as Bureau Veritas, CSA, CQST along with the IECEx certification body and the ATEX notified body.

Furthermore, to meet the specific local requirements, a motor supplier needs to be adaptable. ABB’s range of IEC low voltage motors have many variant codes that provide the flexibility of design and build that the localized industry demands.

Meanwhile, for overground mining applications, Ex-motor certification for hazardous areas is reasonably harmonized. IECEx certification is widely recognized although there are some countries where this is not the case and local certification is demanded.

However, the opposite is true for underground mining applications, where harmonization with Ex-standards is generally poor. Here, IECEx and ATEX certification, outside of Europe, does not really open any doors or markets however they can be used to obtain local certification. China, Russia, South Africa, Brazil and others, all have their own local certifications.

In Queensland, Australia - the country’s biggest mining state - IECEx certification for Group I underground mining equipment issued in other countries is not recognized by the state; the certificate must be issued by an Australian notified body.



Technical competence

For those mines building new lines or refurbishing existing ones, it is important to involve the motor supplier at the start of any project; during the front-end engineering design (FEED) stage. The suppliers have a wealth of know-how about all applications where motors are used, from pumps, ventilation and conveyors to crushers, hoists and drills. They understand, for instance, that a conveyor drive system failure is extremely costly, which makes motors and mechanical power transmission equipment a top priority.

The manufacturer can advise on temperature rise, IP-classification, insulation type and compatibility with other products, such as couplings, gearboxes and variable-speed drives. They can spot pitfalls in technical specifications that can lead to over-dimensioning, unnecessary energy use and higher maintenance costs.

“Never underestimate the manufacturer’s understanding of the industry’s operations and production processes,” says ABB’s mining segment’s market manager Jari Korkiakangas. “Apart from an in-depth understanding of legislations, regulations, directives and standards a supplier will often know the latest implications of energy efficiency rules, overall equipment effectiveness (OEE), harmonics and drive train integration.

“The message is simple. Give us your motor specifications and let us analyse and advise on what is right for your needs.”

Packages

Today products should never be viewed as standalone items. They are designed to work together. Typical of this is an AC motor and variable-speed drive. In addition to better control, AC motors are also easier to maintain than DC motors. Many of the OEMs for underground coal mining equipment are converting DC systems to AC systems with variable-speed drives. DC motors require a lot of maintenance, especially with brushes and commutators. Many of those issues will disappear when an AC motor is placed in the same application.

Overall system efficiency is a driving force in the mining business. A materials handling system, for example, will perform only as well as its component parts. Often changing one component can have an impact on other devices in the drive train. Engaging a motor supplier with good application know-how can lead to advice on mounted bearings, couplings, gearboxes, controlled start transmissions, electric motors and variable-speed drives. In many cases the supplier can provide a complete integrated package. The benefits are a drive train that is matched perfectly and an application that works first time at its optimum efficiency point.

It is not just the drive train that can be integrated. The mine of the future will feature wireless underground communication, cyber security, automated substations, underground electrification and all controlled from a central control room. The Boliden mine in Sweden is already implementing the mine of the future with the help of ABB. An integrated power and automation control system across the value chain from mine to mill included IT/ OT integration, remote monitoring capabilities and high-, medium- and low-voltage electrification, including mining specific drive-motor packages.

Product history

ABB has been developing motors for the mining sector for the past 125 years. “Providing high end electric motors for the mining sector is not a new initiative for ABB,” says Korkiakangas. “We have been providing electric motors to the mining sector for decades. Our references extend from iron ore mines in northern Sweden to the coal mines in Australia to copper mines in Chile. But we recognise the changing needs of the sector and unless we adapt our offering to meet today’s challenges, then we would be failing our customers.”

Its underground explosive area motors, for instance, are based around the company’s proven and mature above ground explosive area motors, which have been successfully used for chemical, oil and gas applications for decades. However, to meet the challenges of the mining sector, more robust component parts are used such as a higher ingress protection classes, for example IP66; heavy duty bearings on the drive end; a steel, rather than plastic, fan; and higher quality paint finish. All of which go a long way to building inherent reliability.

“We invest massively in R&D and have some great new technologies that can be used in mining, such as the synchronous reluctance motors package, SynRM. We are also refining and perfecting our standard induction motor range, including pushing efficiency levels towards IE4 and beyond.

“Looking to the future we may see the introduction of advanced materials that improve motor strength, conductivity, functionality and self-healing. This will extend the life and performance of mining equipment while reducing the downtime and costs associated with ongoing maintenance,” adds Korkiakangas.

Life cycle services

Because of the locations of the mines, a manufacturer must be able to support its products locally in all countries. This covers the needs of end-users and OEMs and extends from delivery expectations to location of stock – whether placed by the manufacturer in central stock warehouses, in a bonded store or held within the customers site and field service support.

Correct installation and proper maintenance play an important role in maximising reliability. A good motor manufacturer should be able to take these factors into account from initial design onwards.

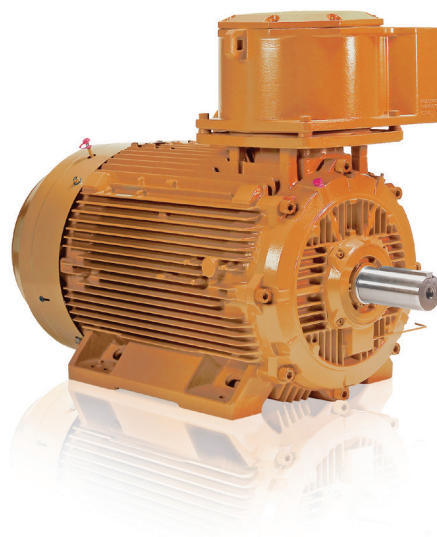
Mines must have a process in place for equipment in explosive atmospheres and above all, the work has to be carried out by competent personnel. Certified Ex workshops are critical to make sure maintenance is done to strict requirements to comply with IEC/EN standards in line with IECEx and ATEX systems. Workshops help with installation and commissioning and provide support whenever needed leading to fast response times that help maximize reliability, availability and safety.

Once installed, often in explosive atmospheres, the motors have to be serviced correctly in order to maintain their high levels of safety. Condition monitoring for example can keep tabs on rotor winding, bearings and power supply quality. Other services such as diagnostics, remote monitoring and predictive maintenance are differentiators in this segment.

ABB, for instance, has developed a service that continuously monitors key parameters related to the condition of the cage rotor, bearings of motors and generators, and it can also address temperature issues. Called MACHsense-R, customers can access operating data and trend graphs via the internet. An alarm is triggered if a measured parameter exceeds set limits, giving the plant operator an early warning that maintenance is needed.

Summary

The key to integrating good motor design with life cycle services is to update or devise a motor management policy. While this document gives a complete overview of the motor installed base, its main purpose is to give detailed information about specification, installation and repair scenarios. A motor management policy helps reduce costs, simplify the repair/ replace decision, reduces down time, make decisions before a motor fails, selects the right motor when replacement is the decision and outlines a procedure for auditing repair shops.



Note to editors:

The ABB low voltage IEC mining motor range covers:

Safe area mining motors

Safe area mining motors are based on proven process motor platform. These motors are used above ground and underground in non-hazardous mines and open pit quarries that typically mine iron ore, platinum, gold and rare earth metals. Applications include conveyors, pumps, fans, smaller winches, crushers, smaller mills, floatation tank agitator motors.

Hazardous area mining motors for above ground application

Are based on proven explosive atmosphere motor range. Available with different protections levels, commonly known as Ex nA (non-sparking), Ex t (dust ignition proof) and Ex d (flameproof). Typically these motors are used by open pit coal mines in conveyors, pumps and fans. Most typical motor type would be Ex t or dust ignition protection.

For more information please contact:

**ABB Oy
Motors & Generators**

Eila Nyman
Marketing Communications manager
IEC low voltage motors
E-Mail: eila.nyman@fi.abb.com

Tom Eklöf
Product Manager, Ex motors
E-Mail: tom.eklof@fi.abb.com

Jari Korkiakangas
Market manager, Mining
E-Mail: jari.korkiakangas@fi.abb.com

www.abb.com/motors&generators

© Copyright 2015 ABB. All rights reserved.
Specifications subject to change without notice.