Evaluating best process and equipment for the job

by Josh Swank

Business owners know that a key to running a strong operation is evaluation. A constant evaluation of employees, processes or, in some cases, equipment, is crucial to ensuring the company's profit margins are as large as possible.

When working in hard rock and ore mines, where trucks operate around the clock every day of the year, it's nearly impossible to pull the nose from the grindstone long enough to provide a thorough analysis. Fortunately, some manufacturers have assisted by taking a long hard look at the process and ensuing headaches within this application.

And, while there appears to be little difference in the design of truck bodies, the truth is there are huge differences.

Philippi-Hagenbuch has engineered it High-Performance hard ore specific truck body design that addresses three major challenges inherent in the hard rock and ore industry. First, the design maximizes full truck capacity to increase potential profit. Second, the bodies are constructed to handle highly abrasive material while minimizing carryback and maintenance. Finally, the truck body is engineered for minimal maintenance and a long lifespan, creating the best possible return on investment.

Hauling optimization

With iron being the world's most commonly used metal, ore-grade mining operations keep busy producing around 2 Gt/a (2 billion stpy) of raw ore, and are growing at an estimated rate of two percent per year. Iron-rich rocks are commonly mined worldwide, with iron-ore production dominated by China, Australia and Brazil — all mining more than 300 Mt/a (330 million stpy), with China hitting more than 1 Gt/a (1 billion stpy). With such large production numbers, it only makes sense that equipment constructed for hauling ore is constantly becoming more efficient.

All trucks are designed with a finite capacity. Part of that capacity, of course, is the truck itself. In a perfect design, the amount of ore able to be hauled would consume the rest of the capacity limit.

High Performance ore bodies are engineered with that exact goal – to maximize truck hauling capacity and provide the highest possible payload. Designed with the mine in mind, these bodies are custom constructed after all specifications have been taken into consideration and key factors that impact that design are identified – height and width restriction, loading equipment, shovel type and size, density and cohesive qualities of the material, climate conditions, hauling distance, average time per pass and per load and the average number of haul cycles per day.

With this knowledge at hand, High Performance ore bodies are constructed in a way to achieve optimal capacity. Bodies are wider and match up with the loading equipment shovel, allowing for a larger loading target, which achieves a quicker load rate achieving maximum productivity per day. Additionally, bodies are constructed based around the results of Philippi-Hagenbuch's load profiling process, examining the natural angles of repose, or how the material lays once it is dumped into the body, to maximize its payload capacity and reduce potential for material to fall out of the body.

To further increase capacity limits, engineers focus on a proprietary process for High Performance ore bodies that removes unnecessary steel, supporting the load, but not building unnecessary structure where the load will not be contained. By doing so, additional features, such as greater width and the most substantial floor bolster can be added into the design due to better allocation of the steel resources without having an unnecessarily heavy truck body.

Focusing on the specifics of the mine and removing any unnecessary weight

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significantly increases hauling productivity and contributes to fully utilized gross vehicle weights (GVW). Customizing the body to each individual mine also aids in productivity by ensuring low maintenance and minimal carryback.

Cutting the carryback

In an industry where trucks are running around the clock, 365 days of the year, productivity is the last thing that should be sacrificed. In order to ensure job productivity stays high, trucks that can handle highly abrasive, sticky material while minimizing carryback becomes a huge benefit.

Innovative construction continues within the load-containing portion of the High Performance ore bodies with patent-pending hydrophobic steel liners in the front corners and the front third of the body, along with a high-abrasion liner in the rear third of the floor. The liners provide ultimate durability against abrasive materials while ensuring as much hauled material as possible leaves the body during dumping. Often, the ore and soil mixed payload becomes sticky, and tends to form a bridge across the front of the truck body. Traditionally, that has left valuable and costly material behind while minimizing future loads until the body could be cleaned out. However, as the name suggests hydrophobic material repels moisture and is strategically placed in key parts of the truck bodies, specifically in areas where carryback begins — in turn reducing the likelihood that material will build up.

Reinforced body side top rails are half sections of rounded pipe that tie the inside steel plate to the outside plate at the top and cover the gap between them. They provide added reinforcement to the sides of the truck body and eliminate the potential for material to build up within the sidewalls.

A substantial taper of the body from the front to the back also decreases wear and carryback potential on the body sides. Designing the body to be narrower at the front than at the back, enables material to release immediately when dumped and slide straight out of the body without abrading the sides. By constructing the body in a manner that reduces wear to the sides, High Performance bodies cut weight from the sides of the body, virtually eliminating the potential for weighted carryback. This innovative design also cuts weight from the sides of the body, allowing the extra weight capacity to reinforce other areas of the truck body that generally receive the most wear.

Minimal maintenance

Increasing productivity also entails minimizing maintenance-related downtime. Customizing each High Performance ore body to the mine's specifications increases loading safety and greatly reduces the potential for loading damage by ensuring width is correctly paired with the loading tool. This provides for the lowest possible loading height and allows the shovel to get closer to the floor of the body, nearly eliminating the chances that loading equipment will damage the sides. The wider body also allows for even and well-balanced weight distribution across the entire bed of the truck body. Improved weight distribution benefits truck body and tire life by eliminating the potential for greater weight wearing on specific areas. With the weight more equally distributed across all of the tires, the potential for uneven wear is also greatly reduced.

In addition, construction ensures that the tail of the truck body has ample clearance at full dump. Taking berm height requirements into consideration, truck bodies are engineered so they do not fall below the center of the wheels, or the height of the berm, at full dump. This helps eliminate tail damage from dumping into a pile.

A body lifting system also contributes to easy maintenance and installation of the truck bodies. The system builds four removable free-floating lifting eyes made of 450 Brinell steel for temporary integration into the floor of the truck body. This compares to traditional bodies, which place lifting eyes on the body sides and pull in on them when the body is being lifted. During installation or removal of a body, the 25-cm (10-in.) diameter lifting hole covers are removed and operators can attach rigging to the eyes that are inserted from beneath the body. The lifting eyes integrate into the floor support structure, so there is no stress placed on the body's sides, increasing their life.

Lengthy life

With the intense, 24/7 work done in mines around the world, it's important to use quality materials to extend truck life and minimize downtime. To ensure a good foundation, High Performance custom truck bodies run steel bolsters from side-to-side under the body floor. But, unlike traditional bodies, which simply butt-weld the bolsters to the frame rail, High Performance bodies run the bolsters through the frame rails, doubling up the "sweet spot" within the center floor section. By intersecting the bolsters with the frame rails, which run from front to back, these custom bodies create a super-structure that won't buckle under the immense weight of the mined materials, while at the same time keeping payload at a maximum capacity.

This enhanced truck design couples with some of the strongest steel in the world to significantly

extend the life of the truck. Steel with a Brinell of 450, which is manufactured in Sweden, has been found to be the strongest, most durable steel available. Within High Performance ore bodies, the steel is used only where steel is needed (at the greatest load containing areas) — providing body durability and requiring little maintenance. Even in intense environments, and after hundreds of thousands of tons hauled to and from mines, the steel doesn't show signs of wearing thin. In fact, constructing the bodies in such a fashion typically increases the life of the trucks by 25 to 30 percent.

Purpose driven design

Evaluating processes and making changes that have the potential of boosting success rates, improving efficiency and reducing costs should be first on the list of any operation – especially those that run around the clock. In the case of mining operations, a custom design can increase productivity rates and superior construction can decrease maintenance downtime and carryback potential, all the while increasing a truck's life. It's a focus that's boosting profit margins and ROI significantly – and helping to continue to increase the amount of raw ore produced each year.

While it's nearly impossible to initially pull the nose from the grindstone, time spent on taking a strong evaluation of daily operations will be worth it in the long haul. ■

Mining industry turns to
field analyzers to keep equipment running

Sophisticated, yet easy-to-use motor analyzers, are being used to detect and address motor issues before they escalate.

Electric motors are ubiquitous in the mining industry. Both ac- and dc-powered equipment is used for critical operations such as drilling, ventilation, hydraulics, conveying, crushing, excavation, emergency power and other applications in underground, openpit and surface mining operations.

Keeping these operations running continuously and efficiently, therefore, depends on effective motor maintenance which, in turn, creates a need for regular and accurate testing. By being proactive in this regard, mining operations hope to save money by identifying and solving problems without costly production interruptions or time-consuming trips to the motor repair shop.

In the past, however, the testing and analyzing of electric motors required the services of highly trained technicians using complex instruments. Today, thanks to the evolution of more powerful, yet user-friendly, devices, such training and expertise is no longer required to perform highly reliable diagnostics for use in preventive and predictive motor maintenance.

These devices are capable of measuring and analyzing a variety of key motor performance indicators, including winding resistance, insulation resistance, dielectric strength, turn-to-turn and phase-to-phase insulation integrity and strength, impedance, phase angle and other parameters.

Motor stress, failures

The motors used throughout mining are often subjected to harsh conditions, including excessive heat, dust, debris, vibration and even occasional lightning strikes, all of which can damage windings and hinder motor performance.

One of the key points of failure in a motor, after the bearings, is its insulation system.

Motor windings receive any type of voltage from 120 volts ac to 13,800 volts, depending on the size of the motor and the application, up to 15,000 volts in some motors overseas. The copper wires of the windings are insulated from each other and also insulated from the frame of the motor.

As insulation weaknesses develop due to the harsh conditions, the windings in these motors eventually begin to leak current from windings to ground, one winding to another or from a turn in the winding to the next turn. The result is less efficiency, greater heat buildup, more rapid breakdown of the insulation and, ultimately, the failure of the motor.

By performing tests using a portable analyzer and diagnosing any issues early, maintenance personnel aim to minimize repairs and avoid extensive downtime.

Naturally, as with any portable test equipment used in the field, users must be aware of any potentially hazardous conditions (e.g. explosive gas or combustible dust) that would warrant relocating a motor from the field to the service shop for testing or analysis.

Simplified testing

One of the advantages of some of today's most advanced instruments is that they are easy to operate and contain powerful features.

The iTIG II is a winding analyzer and motor tester from Electrom Instruments that comes with varying options and output ranges from 4kV to 12kV. By adding power packs one can go to even higher voltages.

A key advantage of all iTIG models is that they use a 60-Hz surge pulse frequency, the same frequency at which most motors operate. This high pulse rate provides a sufficient frequency to overcome ionization dissipation and can thus isolate insulation weaknesses with more sensitivity, predicting future faults before low frequency testers and also better simulates motor operating conditions.

One of the most significant ease-of-use features is that this powerful device enables users to enter the surge test voltage, push a button, and let the machine run the test independently. Surge waveform ranges are automatically set for all models, which eliminates the need to specify configurations, push multiple buttons, or turn dials.

All tests can be done with one instrument; they are available in manual to fully automatic models. Tests that can be performed on this system include surge comparison, dc hipot, step voltage, insulation resistance (Meg test), dielectric absorption (DAR), polarization index (PI), low resistance (Ohms), impedance (Z), phase angle, inductance (L) and capacitance (C).

Additionally, motor and customer information can be set up on a PC and transferred to the iTIG II before tests are done. This eliminates the need for the operator to enter any information in the analyzer. The motor can just be selected and testing started. Most motor and customer information can be entered before or after a test.

For the mining industry, a winding analyzer is a powerful diagnostic and maintenance tool that can reduce downtime and save on capital and maintenance costs by identifying problems early, ensuring the insulation system is operating properly, and verifying that spare motors are ready to be used when needed. ■

ABB launches electrical control
system for mines of the future

ABB has launched the new System 800xA mining integrated distribution automation system (MIDAS) library, an application that gives the engineers who operate automated mines a more powerful way to rapidly troubleshoot the electrical system through an enhanced substation control and monitoring environment from the control room. This remote substation monitoring allows the plant team to solve problems safely away from the electrical substation, thus reducing the time for electrical fault diagnosis and problem solving.

The MIDAS library works within ABB's System 800xA, which is a platform for monitoring and controlling a range of automated industrial processes. It is based on the International Electrotechnical Commission's 61850 standard, which creates a common language for automated substations and power distribution systems. This means that technologically advanced mines around the world will be able to take advantage of MIDAS's capabilities.

The main capability is to give plant technicians better information about the state of their electrical systems and to allow them to remotely control and correct those systems. An operator who is using the MIDAS Library will be able to monitor the whole mine's electrical infrastructure from a single workstation using a single software package. The analytics are presented in real time using a graphic interface that is both comprehensive and intuitive.

This, in turn, will create other benefits. For example, the capability to diagnose faults without going on site means greater safety for workers. And the capability to rapidly discover the root cause of the problem and, thus, fix it more quickly when it happens, reduces disruption to the working of the mine and lowers the operational costs of running it. Furthermore, the fact that process and power automation can be done by one common system reduces the cost of training and spare parts. The combination of information allows processes to be fine-tuned so they use as little energy as possible.

The MIDAS Library also makes it simple for engineers to deal with intelligent electronic devices (IEDs) for protection and control of the electrical system. A right-click of the mouse brings up a full suite of technical information, including manuals, information on the device's parameters and its role in the wider system. And as the IEDs can be connected to the automation system by ethernet, one team can control substations in many different and distant locations. ■

Cat introduces new wheel dozer
with long-term durability

The new Cat 824K wheel dozer builds on the solid performance of predecessor models with engineering refinements in its power train, operator station and structures, and in features that enhance safety, serviceability and machine management. With a net power rating of 302 kW (405 hp) and a maximum operating weight of 34,004 kg (74,966 lb), the 824K is available with six blade configurations ranging in capacity from 5 to 16.2 m^3 (6.6 to 21.1 cu yd) to customize it for production dozing, stockpile dozing or cleanup work.

The Cat C15 ACERT engine features an electronically controlled fuel delivery system, an engine idle shutdown system to conserve fuel by limiting idling time, and a delayed shutdown feature to ensure that the engine is not stopped until operating temperatures have stabilized. Drive train efficiency, fuel economy and travel speeds are further enhanced with the lock-up clutch in the Cat torque converter, a feature that reduces drive train power losses and system heat. Two engine options are available that meet either U.S. Environmental Protection Agency (EPA) Tier 4 Final/EU Stage IV emission standards or EPA Tier 3/EU Stage IIIA equivalent emission standards.

For further drive train efficiency, the smooth-shifting, electronically controlled 4F/4R Cat power shift transmission can be set by the operator to automatically upshift or downshift based on machine speed. In addition, the single clutch speed shifting controls allow the 824K to carry momentum through range shifts for high productivity and fuel savings.

Both operating efficiency and operator convenience get a boost with the left foot pedal, which serves as an engine decelerator, transmission neutralizer and brake, depending on the degree of application. As a decelerator, the left pedal allows the operator to temporarily reduce engine speed by overriding the throttle lock setting when maneuvering around obstacles. Additionally, a new fuel tank provides a minimum of 12 hours operation, depending on the application. An optional tire pressure monitoring system provides real time information to the operator in the cab, ensuring proper inflation and optimizing tire life.

The steering and transmission integrated control (STIC) system allows single-lever steering and transmission control. Simple side-to-side movements of the STIC lever provide up to 43 degrees of steering articulation in both directions for precise maneuverability, and buttons on the lever provide fingertip control of directional and range shifting.

Operator environment

A primary focus of the 824K design is operator convenience and safety, such as providing lighted, shallow-angle stairways for entering and exiting the cab and designing the STIC armrest to fold away for added room when entering or leaving the seat. Also, the Cat Comfort Series air-suspension seat features extra thick cushions and moves both the attached electro-hydraulic STIC control pod and electro-hydraulic implement control pod when adjusted.

The cab, isolation-mounted to the frame,

New Cat 824K wheel dozer is now available.

is pressurized with filtered air, and the selected temperature is maintained automatically. The control panel uses large, backlit switches with LED indicators, and a simple two-position rocker switch controls the parking brake. An optional rear view camera with in-cab monitor increases operator awareness.

Serviceability and machine management

To promote the safety of personnel servicing the 824K, routine maintenance points are grouped and accessible from ground level or from non-skid walkways that are protected with handrails. Swing-out doors on both sides of the engine compartment provide easy access to daily service checks, and ecology drains simplify service and help prevent spills. In addition, a ground level power service center has electrical disconnect, emergency engine shutdown and stairway light switches.

To further complement serviceability, the Cat Vital Information System, VIMS 3G is integrated into the 824K design and keeps operators informed about machine operating conditions using a graphic display that features a touch-screen interface. To expand machine monitoring capability, the Cat Product Link system provides event and diagnostic codes, as well as data such as operating hours, fuel level and idle time. This information is transmitted to a secure web-based application, VisionLink, which can convey information to machine owners and dealers, including working time versus idle time and mapping functions.

Durable structures

The 824K design integrates massive, purpose-built structures and heavy duty components that can support multiple rebuilds. The new dozer features a full box-section rear frame designed to resist twisting forces and shock loads encountered in heavy dozing. Steering cylinder mounts are designed to effectively dissipate steering loads into the frame, and axle mounts are heavy duty components that contribute to the overall structural integrity. This robust design results in significant cost savings and sustained optimum performance over the life cycle of the 824K. ■