OPTIMISING EQUIPMENT PERFORMANCE

Sergei Mishin, Emerson, reviews how modern software solutions are helping organisations to detect emerging equipment health problems earlier, plan downtime effectively, and increase profitability.

Mining companies are under increasing pressure to improve overall equipment effectiveness and squeeze as much productivity as they can from their existing assets. To achieve these aims, it is vital to prevent breakdowns, as mining equipment is the lifeblood of the operation and needs to be kept running as much as possible to maximise profitability. When equipment goes down unexpectedly it can cause a safety issue, and it could take days or even weeks for parts to arrive, especially at remote locations. As well as repairs and replacements being expensive, a long period of unplanned downtime will slow production and take a toll on the bottom line.

Unplanned downtime happens because personnel are unable to see mechanical problems as they develop, which leads to them reacting only when the equipment has already failed. Even during routine maintenance rounds, workers may fail to notice emerging equipment health issues, which causes the cycle of unplanned downtime to continue. Organisations that continue to operate solely with a reactive or run-to-failure maintenance strategy are likely to see their costs shooting up and the profitability of the mine suffering.

For many years, companies have tried to solve this challenge by implementing a preventive or time-based maintenance strategy, with the scheduling of checks and/or part replacements based on a set time interval for each piece of equipment. While preventive maintenance still has a part to play in a maintenance strategy, progressive organisations now realise the importance of also implementing predictive maintenance practices.

Predictive maintenance

Access to good data is essential for improving maintenance practices and mine performance. If a maintenance team cannot see data relating to the health of rotating equipment, this can lead to

unexpected failures and unplanned outages. Predictive maintenance uses data relating to the actual condition of equipment to determine the need for service. Online condition monitoring – i.e. gathering and analysing sensor data from equipment to evaluate its health – helps to identify when the risk of failure due to wear begins to increase, and to predict when that failure is likely to occur. This approach enables maintenance to be scheduled and the problem addressed before the equipment fails, thereby avoiding unexpected downtime, higher costs of repair, and potential lost production.

Figure 1. It is vital to monitor the condition of key electric rope shovel components – the crowd, hoist, and swing drives – all of which are vulnerable to failure.

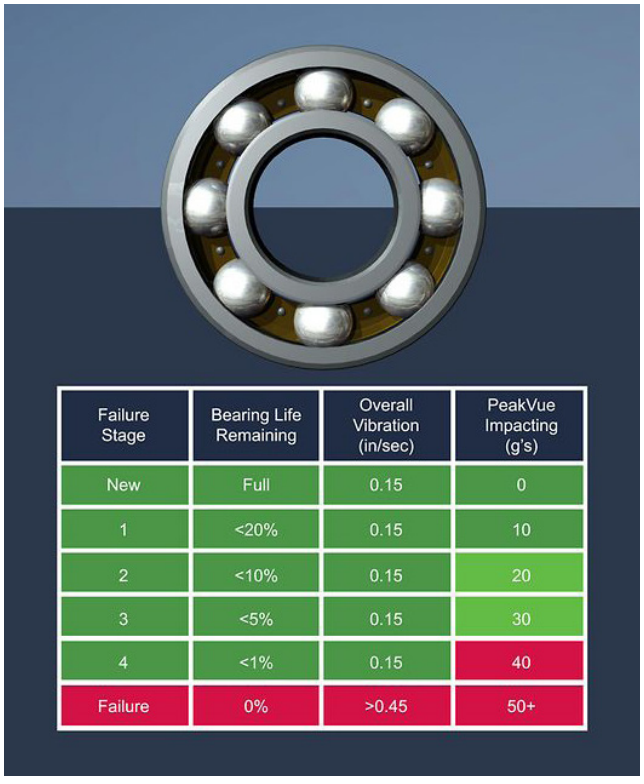

Figure 2. Peak value analysis technology, such as PeakVue from Emerson, can deliver unprecedented insight into the operating condition of critical pit assets, to determine when rotating equipment is healthy, and when an abnormal situation is present.

Online condition monitoring solutions

Industrial automation technology suppliers can provide organisations with a broad range of online condition monitoring solutions for the rotating equipment used in mining. When implemented correctly, these types of solutions provide substantial benefits, with production rates increased by as much as 8%.

Continuous condition monitoring technologies, such as AMS Machine Works from Emerson, can tie into a mine's supervisory control and data acquisition (SCADA) system. These technologies provide better diagnostics at the industrial edge, enabling a wide range of common faults to be detected and addressed before they impact availability. By increasing connectivity to external systems, teams can be provided with an asset health score supported by maintenance recommendations to help them quickly see what is wrong and how to fix it. Intuitive information and alerts can be delivered directly to workstations or mobile devices to provide decision support, helping personnel make the best use of their time.

Artificial intelligence and machine learning

With fewer mines now having a deep bench of experienced maintenance personnel, it is vital that the remaining technicians can access the months, years, or perhaps even decades of data that is stored in process historians. This data can include baselines and metrics from when rotating assets were brand new and operating at peak performance. Such data provides an ideal foundation for an analytics programme using asset monitoring software driven by artificial intelligence (AI) and machine learning (ML).

This software uses the data from a process historian to create a functionality baseline and asset performance metrics. It can then take newly collected asset health data and monitor it in real time to identify any deviations from the baseline. Upon detection of a deviation, personnel receive early, accurate, and intuitive alerts, informing them when and how equipment failure is set to occur, and what remedial action they should take. This then enables even inexperienced personnel to create maintenance schedules based on planned outages. Analytics software can also use its AI and ML engines to examine multiple assets with identified problems, and create a repairs schedule that minimises loss of revenue.

Typical applications

This article will now focus on some of the applications within the industry where online condition monitoring solutions are enabling companies to detect emerging problems earlier, plan equipment downtime effectively, and optimise profitability.

Electric rope shovels

Electric rope shovels are typically expected to be in operation for more than 30 years, but the severe duty motors and complex gearboxes required to operate them put them at constant risk of a breakdown that can bring production to a standstill. Keeping spare parts on hand is cost-prohibitive, and if a hoist or swing motor goes out, a crane – and at least one entire shift – will be required to replace the part. The time, effort, and money spent on securing the parts and expertise to

quickly fix the shovel will be far less than the value of lost production time. Personnel will be pressed to move quickly to complete the necessary repairs, which can potentially put them in harm's way. Even if the repairs are completed without incident, rushed efforts to get the shovel operational can raise the likelihood of mistakes and introduce new problems. If a swing drive is improperly installed or a hoist motor aligned inaccurately, it will not be long before another costly unplanned shutdown is required.

Everything on a shovel is vulnerable to failure, so it is vital to monitor the condition of the key shovel components – the crowd, hoist, and swing drives. Traditional periodic data collection methods place personnel in harm's way, as the data must be collected on an operating shovel under special test conditions. Moreover, periodic methods can easily miss problems that can quickly unfold between collection times. An alternative approach is to use the unique vibration characteristics of rotating equipment to enable emerging problems to be detected. Using advanced machinery health technologies, such as the AMS 6500 Machinery Health Monitor from Emerson, vibration sensor data can be analysed to identify changes that indicate an issue developing. Changing vibration levels are not always an indication of deteriorating machinery health, but collecting vibration data in context with machine operating conditions enables the health of a shovel to be accurately diagnosed.

By applying an adaptive monitoring approach, advanced machinery health technologies can adjust the monitoring strategy based on changing machine conditions, such as load or speed. When these conditions occur within a specific range, data is acquired and stored. Trending of the data, analysis, and alert levels are all based on similar conditions. Faults that occur under abnormal operating conditions can also be identified. A key feature of the AMS 6500 is that it uses a unique processing methodology called PeakVue™ technology, which recognises increasing stress waves during the monitoring process. This provides earlier identification of fault development in mechanical equipment compared to standard vibration analysis techniques, and delivers unprecedented insight into the operating condition of critical pit assets.

To support the mine operator, the analytical data can be made available on board the shovel or integrated with other systems for remote analysis. This enables organisations to easily identify and monitor developing faults and schedule repairs during planned maintenance.

Conveyor monitoring

As an arterial system that is essential to continuous operations, bulk transfer conveyors must be properly monitored and maintained to avoid costly repairs, time-consuming and unsafe manual inspections, and unplanned downtime that could bring the entire process to a halt. Downtime can be minimised by implementing condition-based monitoring systems to continuously monitor critical components and provide safe and cost-effective data collection for consistent conveyor operation.

The length of conveyors makes wireless sensor technology ideally suited to these applications, which helps organisations in simplifying installation and reducing costs. In addition, some components, such as the take-up pulley, are difficult to monitor because they can travel as much as 100 ft. Due to the variable speed of operation, online systems with tachometer inputs may be required to monitor other parts of the conveyor.

Figure 3. The Rosemount 848T High Density Wireless Transmitter accepts up to four independently configurable inputs, dramatically reducing installation and operational costs per point through the use of a smart, reliable, and secure wireless network.

Figure 4. Vibration can damage critical conveyors and lead to costly unplanned downtime.

A good example of how wireless vibration monitoring has been used to prevent unscheduled shutdowns of critical conveyors is provided by a mining company in North America. The company was experiencing vibration in some of its conveyors that was damaging the equipment and forcing the process to be stopped.

Wireless field sensors were installed on the conveyers and these send data to an AMS Machine Works software solution from Emerson, which performs peak value analysis of the data to determine equipment health. Analysed data from AMS Machine Works is made available to maintenance personnel via the cloud, with secure access using any browser to tailored dashboards that show information from all of

the conveyors. Alerts are sent out when necessary and direct the maintenance team to investigate. Users at the local site and throughout the company can review the alerts and work together towards a solution.

Not long after the solution was up and running, the maintenance team received an alarm indicating that a bearing was operating above the threshold of 40°C. Rather than rush out to address the issue immediately, the PeakVue software enabled them to monitor the situation over the next two weeks to make sure the temperature rise was not a transient event. After another temperature spike, the bearing was lubricated during a daily inspection, which resolved the issue and helped to prevent a potential unplanned conveyor shutdown. Should that have occurred, it was estimated that the downtime would have resulted in a production loss of 6000 – 8000 t of clean coal, with an estimated value of US$2.4 million.

SAG mill monitoring

A range of asset management and machinery health technologies can be applied to the crushing, screening, and grinding stages to avoid unexpected shutdown and confirm that equipment is operating as it should to maximise production and accuracy. For semi-autogenous grinding (SAG) mill assets, the overheating of constantly rotating motors is a problem that can result in costly unscheduled stoppages and labour-intensive restarts. Implementing a continuous real-time temperature monitoring solution is therefore vital in preventing overheating and helping to achieve higher availability.

At the Minera Yanacocha complex in Peru, Newmont operates the second largest gold mine in the world. The company was looking for a cost-effective and reliable way to monitor the temperature of its SAG mill motor. Unexpected plant shutdowns were estimated to cost up to US$1.4 million per day in lost production and should a pole need replacing on the motor, this would normally require a two-day shutdown. Continuous temperature monitoring was therefore necessary, but because the measurement point is always rotating, this made a wired solution virtually impossible.

Newmont opted to implement a smart wireless solution from Emerson to measure the temperature of the motor at four different points. Data is transmitted to the distributed control system (DCS) that operates the facility. The solution enables Newmont to continually monitor temperature in the rotating motor to prevent overheating, with an alarm notifying operators if the temperature exceeds normal operations. Temperature trending in the DCS helps to identify issues earlier and also allows Newmont to provide the manufacturer of the motor with information it can use for improvements.

Conclusion

By implementing online, continuous monitoring solutions and remote diagnostics, mining organisations can gather essential information about the health of critical rotating assets without jeopardising the safety of their workers by sending them into the pit to measure vibration or temperature. Peak production levels can be sustained by keeping vital equipment running longer, while the high cost of unplanned shutdowns can be avoided. GMR