Safer Mines through Vibration Analysis

Implementing predictive maintenance to protect mines and miners

Predictive maintenance vibration analysis offers many benefits across multiple industries, including mining operations.

Quick and early detection of problems and faults in complex machinery like conveyors is crucial to the smooth operation, reliability, and safety of mining operations and coal distribution. Safety in a coal-mining environment remains a paramount concern for miners and operators: the flammability of coal dust and the dangers of underground mining require stringent care of machines and plant environment to preserve the safety and lives of workers.

Azima DLI analysts conducted a survey and analysis of a longwall mine's machinery as a demonstration of Azima DLI's predictive maintenance techniques. After building a database and conducting a single day of data collection, the analysts discovered serious damage on crucial conveyors.

Left unchecked, this problem would have inflicted severe damage on the conveyor and shut down the plant for at least a week. The damage would also expose the plant and its workers to the risk of fire or explosion. Azima DLI's fault detection averted a potential safety hazard and ensured continued production and distribution of coal. As a result, the mine instituted new measures to ensure smooth and efficient operation of the machinery as well as safety of personnel and property.

The following case study covers the details of Azima DLI's initial analysis and the potential benefits vibration analysis brings to mining operations and coal distribution.

The mine that invited Azima DLI to perform a demonstration analysis is an established longwall mining facility. Longwall mining utilizes an underground section of earth roughly one mile long and a thousand feet wide. Shearing off individual "slices" about a meter thick, this mining facility processes each of these thin "long walls" of earth for coal, and then allows the leftover rock to collapse, eliminating the potential for aboveground cave-ins and erosions. Underground conveyor belts are crucial to the process, removing useful resources as each long wall is processed.

Modern longwall mining boasts a higher resource recovery rate than more traditional room-and-pillar mining methods, and also ensures greater miner safety, since it provides better ventilation and protects miners from cave-ins with hydraulic jacks.

The mining facility wanted to maintain its high standards of safety in its aboveground coal processing facilities as well. Coal processing and production carries an inherent risk, since coal dust can be explosive, and processing facilities handle mountains of coal alongside a system of conveyors that transport the coal to transfer towers. Mechanical failure, whether under- or above-ground, could be catastrophic to production, as well as to human life and safety. To combat their safety concerns,
Azima DLI analysts were brought in to perform vibration analysis on their machinery. Analysts normally shy away from exploring complex machinery such as gearboxes and conveyors during a first-day demo, but the analyst recognized the crucial role of conveyors in this longwall mining facility and decided to tackle them anyway.

Within a single day, Azima DLI analysts caught two severe faults that had not been detected. If these faults had been neglected any longer, they could have resulted in catastrophic fire and explosion, risking lives and harming production.

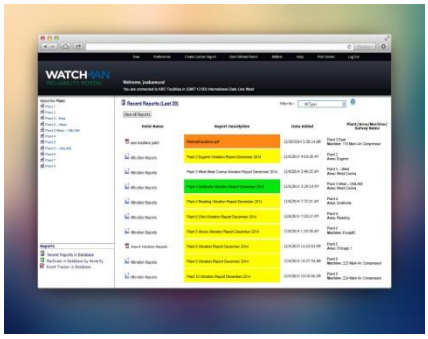
Analysis Techniques

Vibration analysis is an effective tool against machine failure, catching early signs of faults in moving mechanical parts before the signs become clear to the human senses. Pinpointing failures early buys valuable time that enables maintenance personnel to schedule and perform repairs before problems reach a critical level. Early detection is especially crucial in a mining environment where production costs must be kept minimal to keep coal a viable, cheap fuel source.

Predictive maintenance also protects property and human lives. "In an underground coal mine environment, these predictive tools also help protect the health and safety of miners by providing early warning of potentially catastrophic events, involving fire and explosions," states the superintendent of the conveyance system at the facility. "The most important outcome of this project is prevention of mine fires that ultimately protects human life."

Azima DLI builds aggressive vibration analysis programs that target strategic points in machinery systems. Analysts place measuring point fixed pads, junction boxes, and remote sensors on machines, depending on the particulars of the specific machine. This ensures consistent and repeatable vibration test results.

After data is collected with a TRIO™ vibration analyzer, it is transmitted to a cloud database where it is run through Azima DLI's automated diagnostic system and reviewed by a live analyst. A report of the findings, including actionable advice for faults detected, is posted to the WATCHMAN™ Reliability Portal and sent to the mine's staff in PDF format.



Quick and efficient vibration analysis allows on-site mechanics a greater window of time in which to plan repairs, allowing the mine more leeway to plan according to production needs. Azima DLI streamlines the monitoring process by training on-site personnel and mechanics to collect vibration data, improving the skill set of the client's employees and providing one more safeguard against machinery failure. Competent on-site personnel can be crucial to plant safety, especially in a volatile mining environment.

Azima DLI's vibration program also drives root cause analysis. Root analysis takes failure information and probes for the patterns and causes behind the failure, in order to circumvent similar failures in the future. Root analysis, performed by personnel at the facility, takes into account the machine, the environment, the personnel involved and their level of expertise, the tools, parts, and treatments (including grease and lubricant) used, as well as any potential contaminants or maintenance issues that may have contributed to the failure. Root analysis, when performed correctly, minimizes the possibility of reoccurrence.

Fault #1: Drive Motor Gear Pulley

The first fault Azima DLI analysts caught during their demo analysis showed elevated harmonics on a drive motor gear pulley in the coal processing plant. The pulley also showed impacting at the head roll coupled-end bearing. The increased speed of the head roll indicated a serious to extreme bearing fault. The initial report presented by Azima DLI analysts after the first day "allowed us to plan the repair at a convenient time for the plant maintenance department," says the facility's superintendent. The quick catch allowed mine personnel to repair the fault without any risk of fire or safety. If this fault had been allowed to progress, mine personnel would have had to shut down the conveyor for up to a week. This conveyor is crucial to plant production, and plant production would have suffered a considerable loss.

Conveyor in the mine processing plant

The cracked bearing outer race, prior to repair

Fault # 2: Underground Conveyor

The second critical fault Azima DLI analysts uncovered involved the pulley frame on one of the underground conveyors. Pre-shift inspections revealed a slight vibration at the location of the head pulley and snub pulley mountings. At first, it was unclear whether the A-frame foundation had loosened, or if the vibration was due to an issue with another bearing. The analysts collected data from all four bearings mounted on the A-frame. They pinpointed the source of high energy impact and short high frequency events: rolling element bearing wear on the snub pulley. The rolling element bearing suffered water and coal damage,

developing pitting and spalding. The damage was concentrated on one side of the bearing, which proved to be a crucial detail when analyzing the root causes of the problem.

The outer bearing shows impact from spalled bearings

The damage primarily occurred on one side of the bearing

Root Cause Analysis

Catching faults before they cause severe damage and loss of production only marks the beginning of the root analysis process. Vibration analysis finds faults before they become catastrophic, allowing analysts, engineers, and mechanics a comfortable window of time in which to plan a convenient and effective repair strategy, and, more importantly, understand what went wrong and prevent it from happening again. Machine health sustainability depends largely on preventive measures and maintenance strategies, a fundamental part of Azima DLI's work. The damaged bearings had not yet reached their estimated lifespan of 10 years, and a check on the original engineering calculations that provided that estimate was shown to be correct. Mine analysts determined that a maintenance strategy problem must have caused the severe damage. They analyzed the bearings and found coal fines contamination as well as water infiltration at the seals. Since the bearings already benefited from regular purging and auto-lubing, analysts decided that more aggressive maintenance strategy was necessary.

After conducting a thorough investigation, the mine's maintenance team decided to switch from their present grease to heavy-duty aluminum complex grease formulated to handle harsh underground environments. In addition, mine personnel installed

spherical roller bearing solid block housed units to protect machinery from the toughest conditions. The primary and secondary seals featured in these units offer outstanding protection against grease and coal contaminants.

A vibration data collection work order was implemented on a monthly basis, and Azima DLI was authorized to train mine personnel in vibration data collection. These maintenance strategies, built on root cause analysis, minimize the risk of the reoccurrence of similar faults in mine machinery.

Epilogue

This coal facility hired Azima DLI as their primary predictive maintenance provider. Azima DLI analysts returned to the mine to prepare 100 machines for vibration data collection and analysis. Azima DLI analysts also trained personnel to operate TRIO data collectors, ensuring independence and another level of vigilance safeguarding secure and efficient mine production. Azima DLI continues to monitor, analyze, and recommend actions regarding the information mine personnel upload to the Azima DLI cloud database.

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Azima DLI is the leader and premier provider of predictive machine condition monitoring and analysis services that align with customers' high standards for reliability, availability and uptime. Azima DLI's WATCHMAN Reliability Services utilize flexible deployment models, proven diagnostic software and unmatched analytical expertise to deliver sustainable, scalable and cost-effective condition-based maintenance programs. The company's bundled solutions enable customers to choose comprehensive, proven programs that ensure asset availability and maximize productivity. Azima DLI is headquartered in Woburn, Massachusetts with offices across the U.S. and international representation in Asia-Pacific, Central America, Europe and South America.

To find out more about how this type of program can help your organization keep your machines healthy and running, contact us today.

Azima DLI
300 Tradecenter #4610
Woburn MA 08101
+1 781-938-0707
Sales@AzimaDLI.com

