Reducing energy costs and enhancing safety with innovative ventilation systems

As one of the most cost and energy-intensive components of a mine, ventilation reliability and efficiency...

By Georgia Williams

Until 1986 canaries were used to warn of danger in underground coal mines. The small birds were kept in cages near miners to warn of gas leaks. If poisonous gases were unearthed, they would kill the canary first, allowing the miners to escape.

Underground ventilation has come a long way from the canary in the coal mine as technology makes mining at deeper depths possible. Ensuring a steady supply of fresh air is only one of the functions a ventilation system must provide the safe and effective removal of air contaminants like diesel fuel, dust, and gas is also an essential function.

The system is also responsible for heating and cooling subcutaneous mines.

Aside from reliability, ventilation systems also need to be efficient and cost-effective.

According to an Engineering Journal report, ventilation is one of the most energy-demanding systems at a mine site accounting for as much as 50% of energy consumption and 15% of a mine’s overall expenses.

Reducing energy costs has become especially important in the last year amid soaring energy costs and the European energy crisis. Miners wanting to bring down those costs are looking to ventilation technologies that are more cost and energy efficient.

“There is a much bigger focus on energy,” said Jan Nyqvist, global product manager at ABB.

He continued: “Ventilation is one of the major energy consumers in an underground operation, so we see that mines are starting to concentrate much more on that to understand how they can reduce energy consumption from different mine systems as well as their overall footprint, allowing them to hit sustainability targets as they strive for net-zero emissions from production.”

ABB’s Ability Ventilation Optimizer is a ventilation on demand (VoD) technology that “intelligently” adjusts airflow to maximise air quality and minimise consumption, eliminating manual fan operation.

“Ventilation systems account for as much as 50% of energy use in subterranean mines, and deploying
VoD can save for large mines up to US$3m per year, depending on the baseline, size of the mine and how they operate,” explained Nyqvist.

INTEGRATING NEW TECHNOLOGY
Aside from the energy savings Nyqvist laid out, miners are looking to VoD as part of the switch to digitisation.

“Underground mine operators are under pressure to produce more and be more competitive, as well as connect more of the mine to the processing plant part of the value chain. (VoD) is pushing operators to convert from manual control to something more digitalised,” said Marcos Hillal, ABB’s global product line manager of automation & digital.

As Nyqvist explained, what sets ABB’s system apart from others on the market due to its ability to integrate multiple aspects into the common distributed control system (DCS) for a higher level of automation.

The VoD system also offers versatility through its three integration levels. The integrated level incorporates the ABB Ability System 800xA, “an open platform that utilises real-time data transmitted from sensors throughout the mine on key parameters such as diesel truck use, the location of personnel, and gas, flow and temperature information, he said.

The ABB Ability Ventilation Optimizer then uses the data to deliver dynamic fan operation according to production schedules, equipment status, and location.

“Different mines are at different stages in their digitalisation journey, so ABB Ability Ventilation Optimizer is designed to be integrated into each operation depending on its specific characteristics and level of automation,” said Hillal.

He continued: “It is also important to note that many older mines are not running in an optimised way considering the technologies at their disposal; however, these solutions must be applied in the correct way.”

Providing scalable ventilation solutions for new mines or brown and greenfield projects was also a factor in building the ventilation system.

“By introducing three distinct implementation stages, ABB Ability Ventilation Optimizer system gives customers time to adapt and grow their culture, processes and people, so that, hopefully, by the time they reach level three – the most optimum and beneficial mode – the system is fully integrated and adopted into the mine operation for maximum results,” he said.

FANS AT THE HEART OF MINER SAFETY
In June 2022, the US Department of Labor’s Mine Safety and Health Administration (MSHA) introduced a new policy regarding silica minute airborne particles that can be 100 times smaller than regular sand. The Silica Enforcement Initiative aims to protect miners from “serious illnesses such as black lung disease, silicosis” stemming from exposure to crystalline silica and other contaminants.

The initiative includes spot inspections and reviews of ventilation systems and roof control plans. Central to a mining ventilation system are the fans that pull fresh air into a mine and push contaminants out.

At Zitron, a company specialising in ventilation systems, fans are integral to system design. As Caleb Warden, sales director, explained, Zitron’s systems adhere to MSHA regulations and client specifications.

“We did a project where we had to have an emergency escape hoist that went down the fan elbow into the shaft; we custom-designed the main mine fan to the client’s needs,” he said.

For auxiliary fans, Warden noted that Zitron has a wide range of booster fans that can be installed in new mines or retrofitted into existing projects.

Zitron uses computational fluid dynamics (CFD) software to generate a simulation for complete mine ventilation systems.

“We can do a CFD simulation and put our fan model in the simulation, and we can add in certain dimensional parameters for the mine itself,” he said.

The simulation can also help the company troubleshoot potential issues long before they occur.

“We can run the simulation and see how the air moves through the mine areas, moves through the fan system, and where there’s pressure loss validation so we can see where the air is getting hung up and where it can be improved and optimised,” said Warden. “That way, we can tailor the design specifically to the mine’s requirements.

NEW DEVELOPMENTS IN THE PIPELINE
On the research side, Canada is investing in the potential of natural heat exchange to reduce costs associated with heating and cooling.

In 2020, the Canadian government awarded the Mining Innovation, Rehabilitation, and Applied Research Corporation (MIRARCO) C$1.5 million to examine the potential of natural heat exchange systems based on the Creighton base metal and PGM mine in Sudbury, Ontario.

The mine, considered among the 10 deepest in the world, utilises rock aggregate and seasonal temperatures to condition ventilation intake.

“Mine sites are a particularly attractive location for a natural heat exchanger due to a locally abundant supply of aggregate material and remoteness from other green energy options,” a 2022 paper in the Applied Thermal Energy journal reads.

The author notes that Vale’s Creighton mine in Canada utilises a natural heat exchange area, which generates 17.5 megawatts (MW) of ventilation coolth that would otherwise be produced using artificial means.

MIRARCO, in conjunction with Vale and Teck Resources, is developing an engineering methodology for the implementation of natural heat exchangers at mine sites across Canada and internationally.

According to MIRARCO, the technology is being tested at NORCAT, an innovation hub in Sudbury with an operating mine designed for testing start-up technologies and innovations.