ABB DISCUSSES THE BENEFITS OF VENTILATION ON DEMAND

VoD can result in energy savings of up to 50%

By Jan Nyqvist and Michel Serres

Operators of underground mines must ensure that the subterranean working environment is properly ventilated. Personnel should not be exposed to excessive levels of CO_2, dust, humidity, temperature, toxic blasting and strata gases, and, chiefly, nitrogen dioxide (NO_2) emissions from diesel vehicles.

In addition to duty of care considerations, the cost of supplying fresh air to underground mines, taking spent or contaminated air out, and monitoring and regulating air temperature in extreme environments means that ventilation systems are currently the largest consumers of power in underground mines, accounting for as much as 50% of energy use.

Diesel engines in vehicles and other equipment, for example, typically waste 60-70% of energy in the form of heat, and additional ventilation is required to clear continuous tail pipe emissions.

To mitigate these costs, ensure workers receive clean air where and when they need it, and manage constraints in hybrid mines that combine diesel and electric machinery, companies are turning to digital technologies that enable the supply of ventilation to be brought in line with actual demand.

ABB installation at state-owned Codelco's Chuquicamata underground copper mine, in Chile.
CREDIT: ABB

Ventilation on demand (VoD)

Ventilation on demand (VoD) systems employ sensors around the mine that transmit real-time data on key parameters such as vehicle use, personnel, and information from gas, flow, and temperature sensors to a central control system, enabling mine-wide control of fans and air regulators.

VoD systems learn and adapt over time with more data available, intelligently adjusting and optimizing air flow to maximize air quality and minimize consumption. In addition, potential problems are identified more quickly and blast gases are evacuated faster, decreasing downtime. By controlling mine ventilation in this way, annual energy savings

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of up to 50% are possible.

ABB Ability Ventilation Optimizer operates equipment according to actual demands dynamically calculated from mine production schedules and events, including event equipment status and location.

At ABB, we use a positional tracking system to identify where people and vehicles are in the mine, and their ventilation demands. Based on that, an algorithm calculates the optimal set points of the fans and these are then communicated to the fans, which are all connected to the central ABB Ability System 800xA. In addition, positional tracking, also known as location tracking, could be used with other technologies through the system.

Flow sensors feed back on the air flow in certain areas of the mine to ensure we have calculated the correct demand. For example, a gallery may have three machines in operation so we know the area requires 50 cubic metres of air per second. If the flow isn't sufficient, the VoD optimizer recalculates and sends back new set points. It does this every 15 seconds, 24/7, monitoring ventilation entirely automatically.

ABB VoD solutions

To ensure a ventilation solution that fits the operational and organizational demands of different clients, ABB Ability Ventilation Optimizer is configured in three implementation levels.

The first involves centralized supervision and control from ABB Ability System 800xA Operator workplaces, meaning equipment can be remotely started and stopped from the control room, and scheduled, negating the need for personnel to venture hundreds of kilometers underground to start a fan.

Level two makes use of more information that is available. For example, tracking on demand functionality allows us to assess the significant differences in ventilation demands from electric and traditional diesel vehicles – control is of major importance in a combined hybrid fleet.

We use that information to ventilate where clean air is needed and in the correct quantities. Subsequently, we can adjust the mine-wide ventilation system based on the current air flow levels.

Level three utilizes sensor feedback and advanced multi-variable control technology to govern and optimize air flows and quality in the entire mine, while minimizing energy consumption in real time.

Level three involves fully automatic, closed loop ventilation. Algorithms calculate the optimal set points of the fans and the regulators depending on demand. The flow sensors then tell us how well we did, and we can update the algorithm depending on that initial measurement.

Boliden employed ABB Ability Ventilation Optimizer at its Garpenberg mine in Sweden; energy consumption by fans fell by approximately 900kW, which equates to a reduction of around 40%.

At Garpenberg, they have VoD level two up and running, and level three. We are also working with LKAB on its SUM project. They are putting a lot of effort into transitioning to an electric fleet, autonomous driving and increasing productivity by 50%. LKAB has 1,000 fans underground, and so VoD is a major part of that transition from an energy point of view.

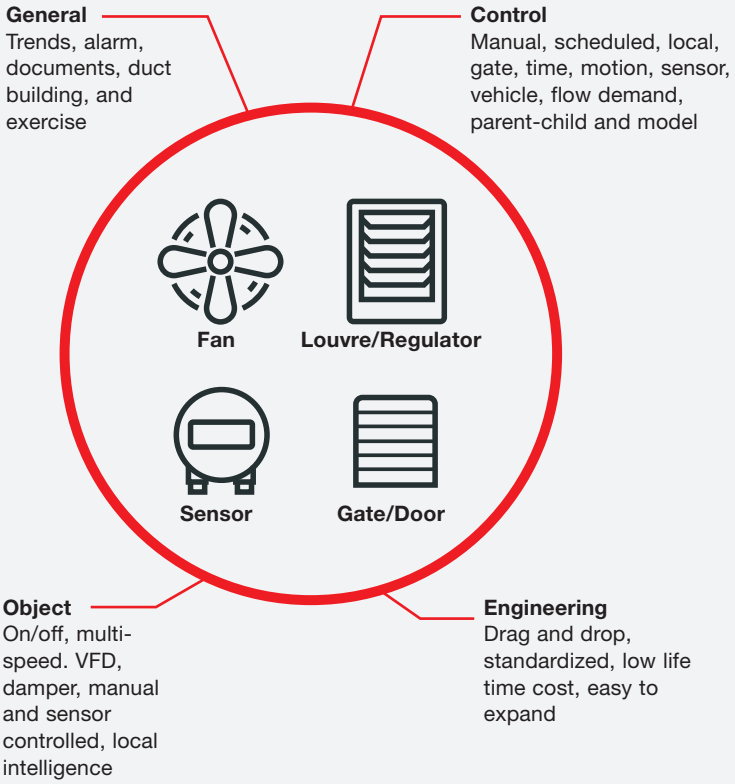
Managing constraints in hybrid mines

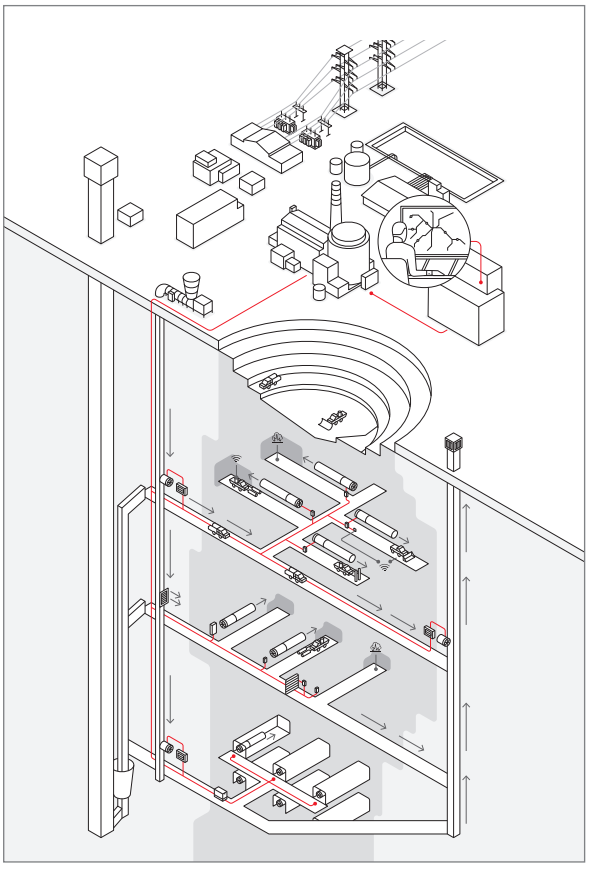
Increased electrification in mines, particularly the transition to electric vehicles (EVs), will inevitably do away with many diesel machines, thus improving air quality and the operational environment.

The next major ventilation challenge in underground mines will be around developing a hybrid solution to manage the existing diesel fleet and the additional electrical fleet, meaning you will not have the same constraints in terms of removing CO_2 and fine particles from diesel.

The air requirement in a mine is driven by the machinery and the personnel

Ventilation objects and functions – Minerals library





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Left: Illustration of a ventilation on demand system.
Below: A schematic of a VoD system.
CREDIT: ABB

deployment, but also by local regulation. ABB works with regulators to ensure that the new requirements for people working underground will also be understood in terms of new digital and electric fleet technologies.

With fully electric mines yet to become a reality, in the interim operators will still need to deal with the efficient removal of blast and strata gases. In addition, as mines go ever deeper, cooling and refrigeration become more of an issue, with some mines operating at temperatures of 35° Celsius.

There will potentially be a lot fewer people working in underground mines in the next couple of years, but operators will still need people there to perform

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Combine any layout and control strategy

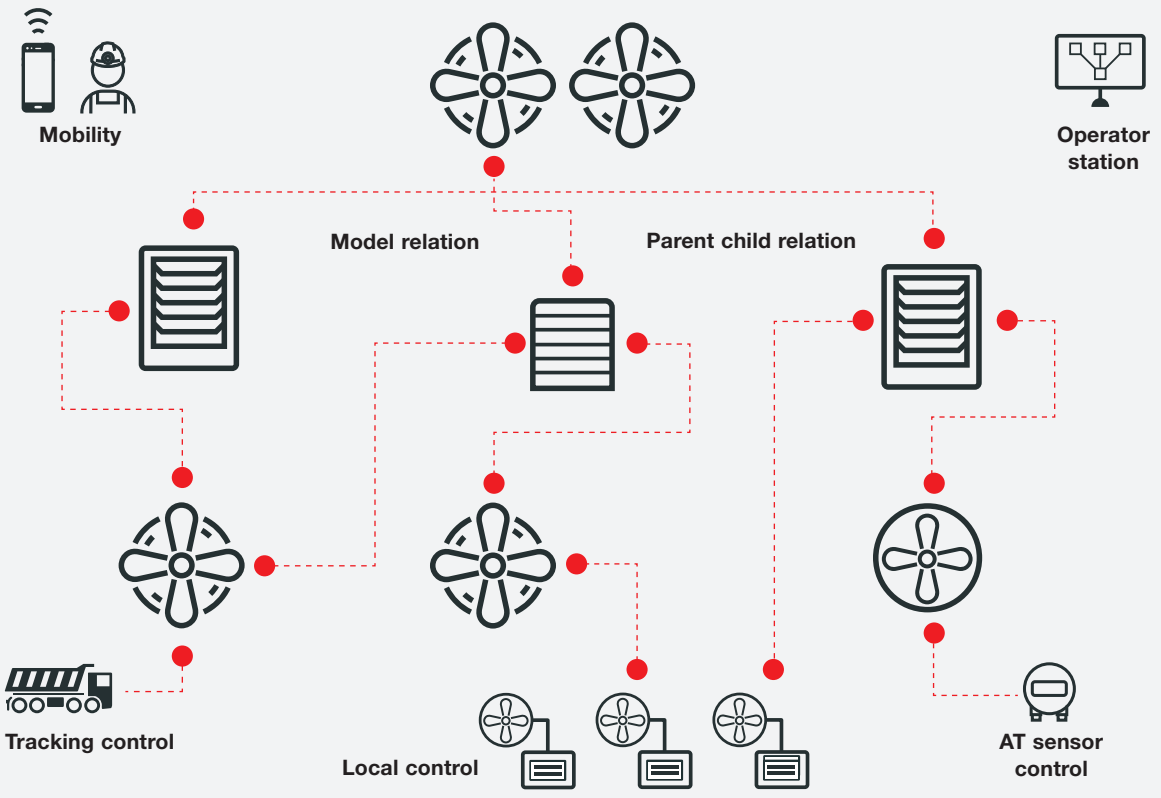

ABB installation at Codelco's Chuquicamata underground copper mine, in Chile. CREDIT: ABB

maintenance – and to be able to do that, we will still need to deal with the ventilation requirements of both fixed and mobile assets in accordance with specifics local regulation.

We install temperature sensors on the ground and supply either more air or we cool it, depending on the mine area and the machines and personnel. Even if we transition to EVs or autonomous vehicles in the future, you still need to ventilate the mine efficiently and manage costs.

In this scenario, the control system for the fans becomes even more important because you will need to adjust the ventilation to supply more air to those areas of the mine with diesel machinery to ensure healthy working conditions for the operators.

Reducing capex

Going electric can mean a premium of roughly 25-30% on mining equipment. Reducing ventilation costs therefore makes sound business sense as a way of offsetting these additional capex costs.

Using non-diesel equipment means less capex on ventilation, thanks to the relatively low-level requirements of EV equipment and less cooling requirements for fresh air in the mine.

If you are looking to benchmark through a comparison between a diesel and electric mine, then the ventilation requirement could be reduced by as much as 60-70%. **CMJ**

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