The wonders of wireless

Cara Stephens, Innovative Wireless Technologies, Inc., explains how to select wireless gas monitors to improve health, safety and productivity in underground coal mines.

Monitoring of toxic and combustible gases is critical to the health and safety of miners working in underground coal mines. Coal mine operators must have continuous information on the presence of combustible gases, such as methane (CH_4), as well as the products of combustion from fires, such as carbon monoxide (CO). Early and accurate detection of these gases is crucial to being able to correct hazardous conditions in the mine atmosphere before they impact the health and safety of miners.

A network of gas monitors installed throughout the mine allows for continuous monitoring and collection of atmospheric data. In the US, Code 30 of Federal Regulations, Part 75 requires monitoring of CH_4, CO, and oxygen in certain areas of the mine including near working sections and along belts. Many underground coal mines also cover expansive areas where workers are not generally located. Constant monitoring of remote and abandoned areas underground for hazardous conditions can be impractical as it is often cost prohibitive to install, maintain and operate a wired gas detection system in these locations.

Figure 1. Wireless gas monitors are easily installed in working areas without cables and remain operational even during power outages.

Figure 2. Devices with long battery life reduce maintenance costs.

Figure 3. Monitors that offer both internal and external antenna options ensure gas data is transmitted from anywhere in the mine.

Wireless gas monitors offer many benefits over conventional wired systems that can increase both safety and productivity in the mine as well as reduce the overall cost of owning the system. There are many considerations that should be taken into account when selecting a gas monitoring system. Some of these considerations include ease of use/installation, maintenance cost, detection accuracy and overall performance of the system, and the ability to meet applicable regulations.

Installation

A wired gas monitoring system is generally more difficult and costly to install versus a wireless system due to the long lengths of cable that may be required to power the units and transmit the measured gas readings. As a coal mine advances, it can also be challenging to monitor the working section for dangerous gases in real time due to the difficulty of moving fixed gas monitors and any cabling associated with them. Wired systems create single points of failure due to wire breaks which may bring down an entire section of monitors. In addition, monitoring remote and abandoned areas of the mine can also be impractical due to the time and cost required to install gas monitors, power systems and run cable.

A network of wireless gas monitoring devices simplifies installation. Battery-operated wireless gas monitors do not require long lengths of cable for power or transmission of data. This equals faster working section moves. Measured gas readings as well as any alerts and alarms are transmitted through the wireless network to a dispatch station at the surface. Wireless systems are easier to install in challenging areas such as along moving belts, in charging areas without infrastructure, and in longwall applications where equipment needs to be moved frequently.

Maintenance

Selecting a gas monitor that does not require a lot of routine maintenance reduces the time workers spend maintaining equipment underground, freeing them up for other tasks and increasing the likelihood that devices will be properly maintained in a functioning state. A battery-operated wireless gas monitor with a long battery life that allows for fast and easy battery replacement requires little routine maintenance. Devices with a long battery life and little routine maintenance may also be used to monitor the atmosphere in remote or abandoned areas of the mine. Monitoring in the returns, tailgate, bleeders and GOB areas of longwall operations can now be easily achieved without large infrastructure cost.

Sensors installed in gas monitors need to be calibrated regularly in order to maintain accuracy and meet MSHA regulations. Devices with a simple and fast calibration

procedure will reduce the time necessary to maintain sensors in a calibrated state.

Reliability

The availability of reliable, real-time gas measurements provides knowledge of potentially hazardous atmospheric conditions that is critical to health, safety and rapid response times in mines. Wireless gas monitors offer an increase in reliability over gas monitoring systems that rely on long lengths of installed cables. Cables can be damaged or cut during normal mine operations, resulting in loss of gas detection in the affected areas. Redundancy in the system increases reliability, but installing additional units and running additional lengths of cable can be cost prohibitive.

Sensor accuracy and performance

MSHA regulations in the US require methane and carbon monoxide sensors used in atmospheric monitoring systems (30 CFR Part 75.351) or used for fire detection along the belt (30 CFR Part 75.1103) to be tested and listed by a third-party nationally recognised testing laboratory (NRTL). NRTL testing verifies the performance of a particular gas monitor meets specific requirements from a published standard. Examples of such standards in North America are ANSI/ISA-92.00.01 for toxic gas sensors, such as CO and 60079-29-1 for detection of flammable and combustible gas sensors, such as CH_4.

These standards include test requirements for various sensor metrics including accuracy, response time, long-term stability and performance over temperature and humidity. Selecting gas monitors with verified performance ensures long-term compliance and the highest accuracy of gas readings creating a safer work environment.

False alarms and sensitivity to interfering gases or poisons

Another aspect to consider when selecting a gas monitor is the sensitivity of some gas sensors to the presence of interfering gases or poisons. The presence of interfering gases can result in 'false' CO alarms that hinder early and reliable fire detection in underground coal mines. Mine workers can learn to ignore repeated 'false' alarms which can ultimately jeopardise safety in the event of a mine fire or other hazardous atmospheric condition.

For example, many electrochemical carbon monoxide sensors have a high cross-sensitivity to hydrogen (H_2) gas. Battery-powered mining equipment, such as scoops, require charging stations underground to charge the lead acid batteries used in the equipment. These lead acid batteries produce flammable H_2 gas during the charging process. If the H_2 is not properly dispersed, it can build up and increase the risk of fire or explosion. Per MSHA regulations (30 CFR Part 75.340), underground battery charging stations that are not housed in non-combustible structures can be equipped with a fire suppression system and ventilated with intake air that is monitored for CO.

CO monitors used to monitor this air in the vicinity of battery charging stations should not be affected by H_2 so as to prevent 'false' CO alarms due to the presence of H_2. 'False' CO alarms can also be produced by emissions from diesel equipment used at the mine. In addition to jeopardising safety, false alarms can also be distracting and time consuming if they need to be investigated. Selection of carbon monoxide gas sensors with lower cross-sensitivity to interfering gas or sensor systems that can compensate for the presence of these interfering gases will reduce the number and frequency of 'false' alarms.

Careful selection of methane sensors is also important. Catalytic methane sensors are sensitive to 'poisons' in the atmosphere. The life span of a catalytic sensor can be drastically reduced if exposed to poisons that reduce the sensitivity of the sensor to methane. These poisons include silicone found in oils, lubricants, and compounds found in machinery. Nondispersive infrared (NDIR) methane sensors are not vulnerable to poisons in the atmosphere, resulting in a sensor with a longer lifespan that does not need to be replaced as frequently.

The many benefits of wireless gas monitors and available sensor options will be considered by coal mine operators prioritising the health, safety, and productivity of workers underground.

There are a number of available wireless gas monitor products designed to address the various considerations above. One example is Innovative Wireless Technologies' (IWT) SENTINEL™ Wireless Gas Monitor (WGM).

The WGM is a battery powered device with a built-in wireless transceiver and replaceable sensor module sub-assemblies that allow monitoring of up to four gases with a single device. The device is part of the fixed infrastructure of the company's ad-hoc wireless mesh network and wirelessly transmits gas sensor readings via the network to a dispatch station above ground. It displays real-time gas sensor readings at the unit and allows for easy calibration of the sensors onsite. Furthermore, the device has a 4 – 6 month battery life depending on the combination of installed sensors and has options for internal and external antennas for extended range.

The WGM is MSHA approved for use in permissible areas, and multiple CO sensor configurations have been tested and listed for performance by a NRTL. The device can also be configured with CO and H_2 sensors that can be used to compensate for the presence of hydrogen gas near battery charging stations and calculate an adjusted CO reading that can be displayed at the dispatch station above ground to reduce the number of false alarms.

Overall, the device is designed to provide accurate, fast, reliable gas measurements for early detection of hazardous atmospheric conditions, improving health and safety of workers in underground coal mines. WC