Detecting danger

The role of gas detectors and high precision calibration gas mixtures in mining safety

By Stephen B. Harrison, Principal, Germany at Nexant

It is a sad fact that mining is one of the more dangerous civilian professions that has existed since the onset of industrialisation. However, the good news is that great strides are being taken to improve the safety of miners all around the world.

For example, according to data published be the US Department of Labor, the number of mining fatalities in the US coal industry in the decade of the 1990s was 32 per 100,000 miners; in the first decade of this millennium, this fell to 27 fatalities and for the seven full years of this decade, the average has reduced to 17 fatalities per year per 100,000 miners. So, what is behind this tremendous increase in mining safety?

One area is the use of highly reliable gas detectors that miners permanently wear when working underground, or fixed gas detection systems installed at strategic locations in the mine.

Gas detection in the mine

Gas detectors used in mining typically contain a range of different gas sensors for methane, hydrogen sulfide (H_2S), carbon dioxide (CO_2), carbon monoxide (CO) and oxygen.

Sophisticated electronics convert the impulses from the sensors into display readouts of the various gas concentrations and produce audible and visible alarms when high levels of toxic and flammable gases are present or when low levels of oxygen are detected. Furthermore, data logging is used to capture the readings and alarms that may have been generated or silenced. This data is often used by incident investigation teams to identify root causes and make recommendations to avoid similar occurrences in the future.

Keeping portable gas detectors serviceable on a daily basis

Gas detectors are one of the most important safety devices that a miner uses. His helmet and his lamp would also rank in this 'must have' category.

Before entering the mine, the lamp can be tested for functionality with a visual check. But how can we ensure that the gas detectors are working? This is done with a functionality test using cylinder gas mixtures at the beginning of every day, or in harsh environments at the beginning of every worked shift.

Fixed detection systems are used underground in classified areas where explosive or IDLH (Immediately Dangerous to Life and Health) atmospheres may form and will not necessarily have human presence for control. It is also essential to periodically test fixed gas detectors that are installed underground. In this case a smaller portable cylinder with perhaps 1 or 2 litres capacity of the required 'bump test' gas mixture will be taken underground.

Gas detector testing, maintenance and sensor calibration

The sensors used in the gas detectors generally rely on electrochemistry and many of the sensors require calibration or replacement at prescribed intervals to avoid the problems of 'drift' in the measured result. This calibration event differs to the daily functional test because a functional test is good enough to say that the detector functions, but it is not a precisely controlled calibration event.

Whilst the functional test generally occurs at the mine pit head, the calibration generally takes place at an off-site service laboratory. Alternatively, the detector can be returned to the manufacturer's service facility for a general overhaul which may also involve replacement of some of the sensors contained in the gas detector.

On this topic of gas sensor calibration, Jackson Machado, the Brazil National Service Supervisor at MSA informs us that, "in Brazil we have the Cgcre which is responsible for the General Coordination of Accreditation, it is a division of our national metrological institute INMETRO. This is the agency responsible for the accreditation of laboratories."

"They require the issuance of a calibration certificate based on the use of gas mixture cylinders which are classified as primary standards. They do not, however, generally specify a minimum calibration frequency, leaving this requirement to be governed by other standards."

For both portable and fixed detectors, the instrument reading should be as close as possible to the certified concentration of the standard gas cylinder which should also have the smallest as possible measurement uncertainty. Machado confirms, "If a good match between the detector reading and the calibration gas is not immediately achieved during the initial verification, a full calibration procedure is performed to ensure that the detector can be returned to service in full working order."

> **"If a good match between the detector reading and the calibration gas is not immediately achieved during initial verification, a full calibration procedure is performed"**

Sensor calibration gas mixtures

The local availability of functional test gas mixtures is generally high. Many major industrial and specialty gas suppliers around the world are able to produce cylinder gases for this purpose because the certification and accreditation requirements are relatively straight forward.

The availability of accredited ISO Guide 34/ISO 17034 calibration gas mixtures is, on the other hand, not such a simple matter. And, the issue becomes more complex when the gas mixture should contain corrosive gases, such as H_2S, or a number of different gases be present in the same cylinder, as is called for when calibrating gas detectors that are fitted with multiple sensors for use in the mining industry.

Coming back to the voice of Machado at MSA Brazil, "We can source accurate functionality test gases from well known suppliers such as Portagas and Calgaz but, the regulations that we must follow mean that we must use a primary standard reference material for calibration. To source that level of gas mixture, we have chosen to import products from Coregas in Australia. Their certified ISO Guide 34/ISO 17034 reference material gas mixtures contain the components that we need at the required target concentrations. And, most importantly for the calibration, they meet the highest metrological standards as required by Cgcre, the agency that accredits laboratory operations in Brazil."

Sophisticated calibration gas mixtures

The high level of sophistication associated with these reference material gas mixtures means that cylinders must often be sourced from overseas specialty gases suppliers such as Coregas Pty Ltd in Australia.

Victor Chim, Business Development Manager at Coregas, commented, "Our pedigree has grown up from serving our mining customers in Australia. We have been working very closely with them and with the national accreditation body NATA for many years to develop a range of ISO Guide 34/ISO 17034 calibration gas mixtures that can be used as reference materials for gas detector sensor calibration."

The Australian National Association of Testing Authorities (NATA) are one of the foremost accreditation authorities worldwide and are widely considered to be the leading authority in the Asia-Pacific region.

When calibrating gas detectors with multiple sensors it is most convenient to use gas mixtures with multiple components. From a metrological point of view, this is also the most robust way to calibrate the detector because each sensor is exposed to the full cocktail of gases that might be present in the underground air and thereby any cross-interferences will be observed.

Blending multiple components together in a single gas cylinder saves the laboratory service technician the time of switching between multiple cylinders of binary mixtures. Chim adds, "We push the envelope of innovation as far as safety and science will allow. So, we will blend components together if they neither explode in the cylinder nor react. For example, this limits the amount of methane that we can add to a gas detector mixture and it is most common to include methane up to 50% of the lower explosive limit (LEL). Higher concentrations are possible, but require highly specialised gas mixture preparation techniques."