DETECTING DANGER – THE ROLE OF GAS DETECTORS AND HIGH PRECISION CALIBRATION GAS MIXTURES IN MINING SAFETY

Gas Detection in the Natural World

The tiny cpA neuron in a mosquito's nose can detect an elevated level of carbon dioxide (CO_2) in the air that results from human breathing from more than 20 metres away. Human beings, on the other hand, have no sensory perception for CO_2 and the same can be said for other colourless, odourless gases such as methane and carbon monoxide.

If our noses were as sensitive at detecting CO_2 as the mosquito is, we might have avoided many mining deaths over the last century. CO_2 exists in mines for several reasons: it is an exhaust gas from internal combustion engines used to power trucks and machinery in the mine; it is produced as a by-product of explosives detonations and it can also be released, either alone or combined with methane, when a gas seam is cut through during excavation. Such outbursts of Illawara bottom gas have been relatively common when mining the Bulli coal seam in New South Wales, Australia. In 1991, on the 24th of July, one such outburst claimed the lives of three miners through CO_2 asphyxiation in the South Bulli mine, which is one of nine mines that has operated on the Illawara Coal field in the past century.

Gas Detection in the Mine

According to Jim Filov, Marketing Manager at GasTech in Wangara, Western Australia, "the types of gases to be detected varies between the resources that are being mined. In addition to CO_2, mining operators in Australia will often detect for: oxygen, methane, hydrogen, hydrogen sulphide, carbon monoxide, ammonia, sulphur dioxide and hydrogen cyanide." He adds, "Underground gas detection is generally done using portable devices and is most often based around drill rig monitoring, charge-up and re-entry work, plus testing for general methane presence in coal mines. Gas detection in surface operations is focused around processing applications with portable gas monitors for personnel, some confined space testing and fixed detection around plants."

Portable and fixed gas detection units both contain sophisticated electronics that 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. Filov adds, "In principle portable and fixed units work in much the same way, just in different packages making fixed units larger than portables. Portables are battery powered, whereas most fixed instruments have a separate power supply, usually 24V. The sensor range available for the fixed category is larger thanks to greater enclosure size meaning physically larger sensors can be used and the increased power supply also helps here. Due to their static nature, fixed units will come with varying amounts of certification as they are often purchased for one application and stay there for their lifetime. Portable units, on the other hand, will generally carry broad levels of certification from the start as they can easily be brought into different hazardous areas."

Gas Detector Testing, Maintenance and Calibration

"Bump testing" of portable gas detectors is done either once per day or at the beginning and the end of each working shift. This is a simple functional test to determine that the sensor, electronics and alarm are all in working order.

Most of the sensors used in gas detectors rely on electrochemistry and require calibration or replacement at prescribed intervals to avoid the problems of "drift" in the measured result. This calibration differs to the daily bump test because a functional test is good enough to say that the detector functions, but it is not a precise calibration. Whilst the functional test generally occurs at the pit head, the calibration generally takes place at an off-site service centre.

The frequency of testing gas detectors depends on various layers of rules or standards. For example, in Australia, NSW Resources are one of the bodies that legislate the frequency of detector testing. Manufacturers of the gas detection devices will also provide usage instructions based on field experience and best practices. These rules and standards ensure that safety requirements are met and that mining operators can comply with requirements made by insurance companies which underwrite their operations. The authorities that write these rules are also engaged in compliance validation to ensure that the gas detectors have indeed been tested appropriately.

Coming back to Jim Filov, to explain the level of control for these regulations in Australia: "Gold mines who are part of the International Cyanide Management Code will have part of their certification check related to their use of gas detection. Coal mining operations have their use of gas detection monitored closely also. However, general metalliferous mines will not be audited as heavily for this type of activity."

Gas Detector Calibration Gas Mixtures

The quality requirements for daily use functional test gas mixtures (bump test gases) are generally not as high as the gas mixtures used for the detector and sensor calibration. For the functional test gas a general certificate of analysis can be appropriate. Alternatively, a higher quality ISO17025 accredited gas mixture might be specified.

For the quarterly, half yearly or annual calibration of the gas detector, it is often required to use a traceable and accredited calibration gas mixture. For the highest levels of confidence an ISO Guide 34 (soon to be ISO 17034) accredited reference material calibration gas mixture would be selected. Steve Bond, the Service Manager at GasTech in Western Australia explains the practices in his company: "all of our calibrations, whether they are done on site at the mine or at our service centre, are conducted to the same high standard we have set out in our work instruction under ISO 9001:2015. This calls for the use of either NATA or NIST traceable calibration gas mixtures and they must demonstrate this traceability with either an ISO17025 or an ISO Guide 34 accreditation."

Traceability and Accreditation are the Keys to Precision

Steve Abbott, the National Operations Manager at Coregas Pty Ltd in Australia comments on his experience with accredited specialty gas mixtures. "Our specialty gases accreditation journey began in 1997 when we achieved ISO17025 accreditation as a calibration laboratory for gas mixtures. Subsequently, Coregas achieved ISO Guide 34 accreditation in 2002 which made us the first accredited gases reference material producer in Australia. Furthermore, the updated version of ISO Guide 34, which is called ISO 17034, will be implemented from 2018 and we will have the accreditation assessment soon. One of the main purposes of these accreditations is to demonstrate traceability and our reference materials that we use at Coregas are traceable to Australian National Standards of weights and thus to the International System of Units (SI)".

The accreditation authority responsible for Coregas production and testing operations is NATA, the National Association of Testing Authorities Australia which is the sole accreditation body in Australia. Their reputation is global and they currently hold the secretariat for the International Laboratory Accreditation Cooperation (ILAC).

When it comes to gas mixtures filling it is possible to prepare general certified (non-accredited) specialty gases calibration mixtures in small batches for speed and economy. However, most ISO Guide 34 mixtures must be prepared as single cylinders which involves more labour input per cylinder and results in higher costs of production. Coming back to Steve Abbott at Coregas, "there are four members of our Specialty Gases laboratory team who are NATA signatories for our accredited ISO Guide 34 certificates. Between them, they have 38 years of experience as NATA signatories for reference material production."

For a deeper insight into these quality considerations, it should be noted that under the correct usage and interpretation of the ISO Guide 34 standard for reference material producers, each individual cylinder must be prepared and validated for stability and homogeneity. Abbott adds: "customers often ask us for ISO Guide 34 accredited mixtures in small disposable cylinders, but we are not able to offer this for technical and quality reasons. We can fill ISO Guide 34 accredited gas mixtures into large high pressure cylinders where there is enough content to conduct several check analyses after filling to prove homogeneity and stability of the gas mixture. However, it is not possible to fill gas mixtures into smaller low pressure disposable cylinders and declare them as ISO Guide 34 compatible because the cylinders would each need to be individually analysed on several occasions over an extended period of time which would consume all, or a very high proportion, of their contents."

Abbott concludes, "at Coregas, our pedigree has grown from serving mining customers in Australia. In recent years, both our reputation and our specialty gas cylinders have been travelling abroad. For example, we are proud to be a supplier to many multi-national gas detection device manufacturers and local gas detection equipment servicing companies in Brazil."

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