Background gas detection technology

In the beginning, there was the canary: The delicate finches warned miners of dangerous gases below ground. If they stopped chirping, the miners had to hurry to the surface. Such crude and inexact methods for determining gas concentrations in the atmosphere are now ancient history. Today, precision instruments monitor the concentration of dangerous gases and flammable vapors. Compact, small, robust and flexible multi-gas detection instruments represent the state of the art.

Gases and vapors are not inherently harmful — after all, they make up the Earth’s atmosphere. It is only in instances where their concentration exceeds or falls below critical values that they can become a threat. Exceeding these values, which vary from substance to substance, leads to toxicity and explosion hazards, while a concentration of oxygen that is too low poses a risk of suffocation. This is why portable gas detection equipment is used in so many different areas of application in a number of different industries, with scenarios ranging from individual employees or smaller work groups to major deployments, such as the industrial shutdown of an entire petrochemical plant.

Targeting local conditions

The extremely heterogeneous scope of applications is what makes the development of portable gas detectors so challenging. Have toxic gases accumulated above waste water, 30 meters down in the lower level of the sewer system? Can an employee safely enter the tanker truck that was just emptied? Where is the leak in the transport line? Have flammable vapors been generated in a petroleum processing plant? And is the atmosphere still safe where cable is being installed underground?

These questions reflect typical applications for portable gas detection equipment: Personal monitoring, pre-entry and control measurements, area monitoring, and searching for leaks are key applications. Sensor design is not fundamentally different from that of stationary gas detection equipment, with catalytic, electrochemical, and infrared sensors being the most commonly used solutions (see Dräger Review 381, pp. 22–27). In order to comply with increasingly stringent limit values and occupational safety requirements, which are already very demanding, there is a need for even more precise measurement technology.

In contrast to stationary systems, which can be custom-configured for specific local conditions and the substances expected there, portable measuring devices must be suitable for use in a variety of scenarios. This requires a high degree of flexibility, and multi-gas instruments are ideally suited for satisfying this need. Companies that want to provide better protection for their employees by using new measurement equipment are also following the trend to these versatile devices.

Scheduled for release in the second half of 2009, the new Dräger X-am 5600 multi-gas detector, which is equipped with a dual infrared (IR) sensor for flammable gases and vapors as well as carbon dioxide, is designed with employee protection in mind. The product can detect and measure up to six different gases simultaneously. This device packages reliable infrared technology into a particularly compact design at an attractive price, making state-of-the-art personal gas detection equipment available for wide-scale procurement. The X-am 5600’s long “on-person” operating times and large number of units in service shows that, in addition to reliability, compact devices with good ergonomics and low procurement and maintenance costs are very much in demand for personal protection applications.

With an eye on overall costs

The operating costs of the X-am 5600 are significantly lower, for example, than those of catalytic sensors. And as Ulf Ostermann, Portfolio Manager at Dräger and responsible for portable gas detection equipment, explains, this benefits the companies: “This factor—the total cost of ownership—is lower with infrared technology than with electrochemical and catalytic sensors. That’s because IR sensors are more robust and require less maintenance. The higher procurement price relative to instruments using other measurement technology is therefore amortized over a reasonable period.”

Bernd Römer of BIS Prozesstechnik GmbH believes this development toward compact multi-gas instruments with their tremendous flexibility is a step in the right direction. Römer, an expert for gas detection technology and a member of the company’s management board, states, “The wide range of applications and the high degree of flexibility mean that the X-am 5600 is a good choice for safety devices that are to be used for personal monitoring and leak detection.”
The Dräger X-am family

The new X-am 5600 portable gas detector with infrared sensor technology is designed for long operating times. As with the other members of the X-am family it shares the compact mobile phone design. The entry-level solution in this line of products is the X-am 2000 for the measurement of flammable gases and vapors, oxygen, carbon monoxide, and hydrogen sulfide. At the upper end of the product range is the X-am 5000, a five-gas instrument. Its catalytic Ex sensor can be precisely adjusted for specific measurement tasks, and the device also supports custom sensor configurations. Whereas this type of device is intended primarily for personal monitoring, larger devices such as the X-am 3000 and the X-am 7000 are intended mainly for pre-entry measurements, confined spaces monitoring and leak detection. The Dräger X-am 7000 can be equipped with a combination of electrochemical, catalytic, infrared, and photoionization sensors.
of the Expert Committee for Chemistry, Subject Group “Measurement and Warning Devices for Hazardous Gas Concentrations” of the Employers Liability Insurance Association of the Chemical Industry (MEWAGG), also emphasizes the need for a broad range of personal gas detection instruments. Users require relatively simple devices for defined, recurring tasks as well as modular, high-end equipment.

Fast and safe

Many users deploy a very wide range of devices. The Hamburg Sewage Authority (HSE, a company of Hamburg Wasser), uses short-term tubes for the targeted measurement of momentary concentrations, whereas the Dräger X-am 7000 is used for pre-entry measurements and area monitoring, according to Gerd Götte, Team Leader of HSE System Operations. The primary parameters measured are oxygen concentration, flammable gases, and hydrogen sulfide, which are the critical gases for the sewage experts who care for one of the oldest and largest sewage systems in Germany.

What are the most important capabilities of a multi-gas detector? In addition to featuring a robust design, Götte explains, it should offer fast reaction times, pre-entry measurement at a depth of as much as 30 meters via an extension hose, and a sound concept for maintenance and calibration. Dräger always devotes a great deal of attention to this aspect of service and organization when it comes to its portable gas detection technology. The keyword here is service efficiency, because simple and dependable operation in the field depends on reliable calibration and configuration.

This begins with a daily function check (bump test) using a test gas. This is followed by calibration of the sensors, which is performed at intervals ranging from one month to one year, depending on the technology used. Finally, the annual inspection ensures that all elements of the gas detector function properly. The bump test, which must be performed prior to any safety-related use of the device, is an established part of the daily routine when dealing with portable gas detectors, just like registration documentation, and cleaning. Simple, fast, and reliable test routines therefore are also part of the complete package that comes with Dräger devices.

There are good reasons for the frequent testing: After all, the instruments are relied on to ensure the health and safety of employees. A portable gas detector is really “put through the wringer” during its service life, according to Römer. Such devices are subjected to heat and must be able to deliver accurate results in clouds of dust and under damp conditions. “Robustness inside and out” together with simple, reliable function testing are the expert’s top priorities. The standard for the IP 67 protection class describes the balancing act that is expected of the housing, which must be water-tight yet permeable to gases and vapors. And the function test includes a check of membrane permeability.

Experience that matters

The experts at Dräger not only design the devices, they also offer customers comprehensive service that covers all aspects of portable gas detection technology. “The service behind the devices is a factor every bit as important as the functionality,” explains Thielo Hammer, Sales and Marketing Manager of Dräger Shutdown & Rental Management (SRM) Europe. Dräger uses SRM to cover...
short-term needs for measurement and safety equipment in applications including shutdowns of large production plants, up to and including offshore oil rigs. “DrägerService works closely with the customer and Dräger SRM to ensure that the devices are properly calibrated for the target gas,” says Hammer.

And Michael von Gahlen, Operation Manager of Dräger SRM, is confident that any industrial customer who has experienced Dräger portable gas detectors on an SRM assignment will often choose equipment from the Pac and X-am product lines for its daily operations. “I use our own devices for major international shutdown projects and have witnessed the good performance of tens of thousands of Dräger gas detectors in action,” reports von Gahlen.

And that’s also enough to convince customers of the outstanding performance of the detection equipment—ranging all the way to the simple and reliable handling of the associated Dräger E-Cal station and the bump test station for the function tests and calibrations that are required by applicable regulations. Peter Thomas

Sensors: A “nose” for the job

Sensors are the “noses” of gas detectors. They must be sensitive to the target gas, which they accurately detect even in various mixtures. Here is an overview of the most important Dräger sensors.

**Dual sensor DrägerSensor XXS CO\textsubscript{2} compensated:** Thanks to this product’s four-electrode technology, in which two separate measurement electrodes are used in addition to the counter-electrode and the reference electrode, this electrochemical sensor for detecting carbon monoxide is not affected by the cross-sensitivity to hydrogen that is typical of such measurements. Whereas the first measurement electrode measures carbon monoxide and hydrogen together and thus accepts the effect of cross-sensitivity, the second electrode detects only hydrogen. The precise correction factor for the display of the hydrogen-compensated CO value is calculated from these two signals. The carbon monoxide level displayed deviates by only +/- 15 ppm at 1,000 ppm hydrogen in the atmosphere measured. Only carbon monoxide is used for function testing.

**DrägerSensor XXS O\textsubscript{2}:** This O\textsubscript{2} sensor from the XXS family boasts a particularly long service life because it features innovative three-electrode technology. The electrochemical sensor is equipped with a counter electrode, a reference electrode, and a measurement electrode. This design allows non-consuming operation, which is impossible with conventional oxygen sensors. The patented design is reflected in the Dräger sensor’s expected service life of more than five years, which is three to four times longer than that for commercial two-electrode sensors containing lead. This in turn results in significantly lower maintenance costs.

**DrägerSensor IR CO\textsubscript{2}:** Infrared technology offers important advantages over electrochemical and catalytic sensors in portable gas detection equipment. Foremost among them are the high measurement accuracy compared to electrochemical sensors, not to mention significantly lower maintenance requirements as a result of enhanced long-term stability: Whereas the expected service life of an infrared sensor is over five years, electrochemical CO\textsubscript{2} sensors generally must be replaced after one year of use. The DrägerSensor IR CO\textsubscript{2} is a transducer that uses the infrared absorption principle to detect a carbon monoxide concentration in the atmosphere. The sample gas is exposed to broadband, multiply reflected infrared radiation in a cuvette. If the sample gas in the cuvette contains carbon monoxide, a portion of the IR radiation in a typical range of wavelengths is absorbed. Measurement with the dual-element detector quantifies this absorption.

**DrägerSensor IR Ex:** This miniaturized infrared transducer relies on the infrared absorption principle to determine hydrocarbon concentrations quickly and precisely. The sample gas diffuses into the measurement cuvette through an IP 67 protection class membrane. The broadband infrared radiation is absorbed in a specific range of wavelengths as a function of the hydrocarbon concentrations. The sensor uses two narrow-band interference filters to measure the degree of absorption, from which it calculates the hydrocarbon concentrations. Besides ensuring rapid response and having a long service life, the advantages of these sensors include their insensitivity to sensor poisons and their suitability for use in inert (oxygen-free) atmospheres. The Ex signal from the infrared sensor can be coupled in the Dräger X-am 5600 with an electrochemical hydrogen sensor to obtain a complete Ex signal.