GASTEC

SUPPLEMENTING
YOUR ELECTRONIC
GAS DETECTOR
WITH GASTEC TUBES

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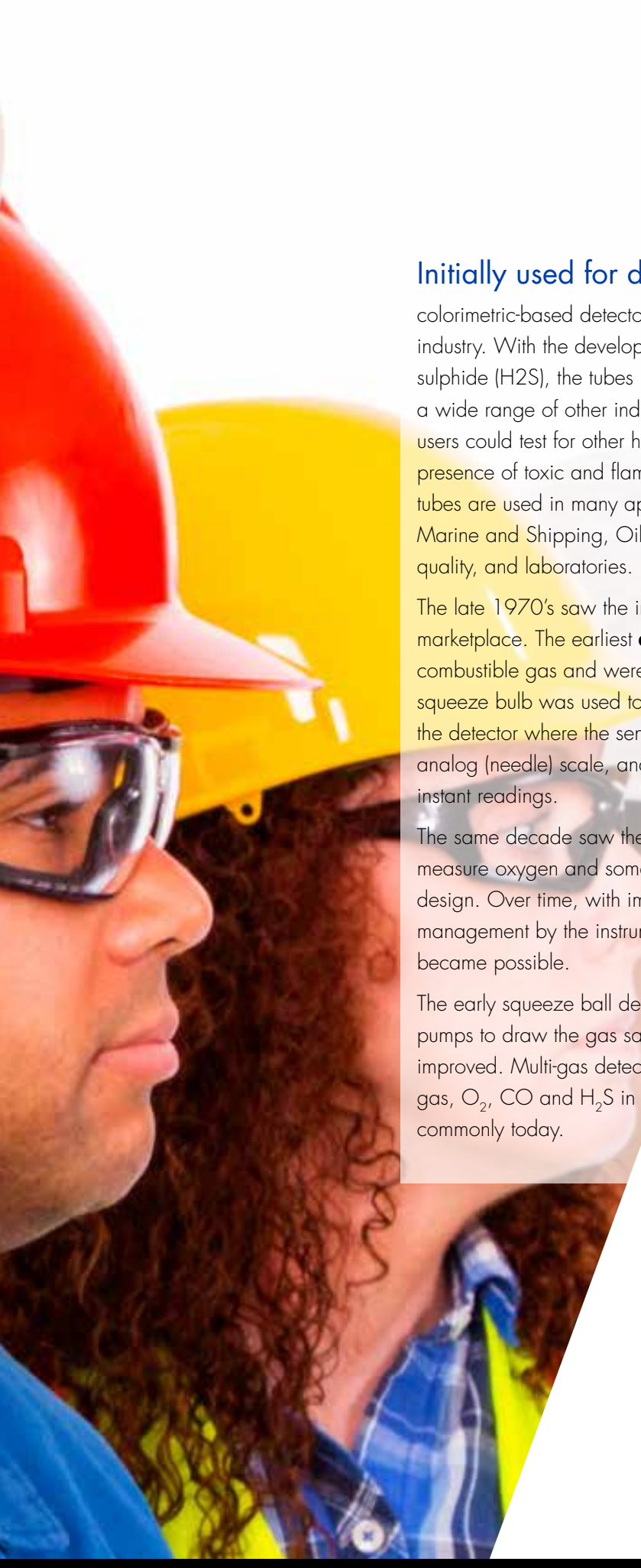

Initially used for detecting carbon monoxide (CO),

colorimetric-based detector tubes first came into widespread use in the mining industry. With the development of detector tubes for other gases like hydrogen sulphide (H2S), the tubes became relevant to municipal sewer entry and a wide range of other industrial applications. Further development meant users could test for other hazardous conditions like oxygen deficiency or the presence of toxic and flammable gases for the very first time. Today, Gastec tubes are used in many applications including Fire and Hazmat response, Marine and Shipping, Oil Refining and Chemical processing, Air and Water quality, and laboratories.

The late 1970's saw the introduction of electronic gas detectors to the marketplace. The earliest **electronic gas detectors** were designed to measure combustible gas and were first used to take one reading at a time. A manual squeeze bulb was used to draw the air sample through a hose assembly into the detector where the sensor was located. Readings were displayed on an analog (needle) scale, and like detector tubes, were mainly used for taking instant readings.

The same decade saw the introduction of **portable instruments** used to measure oxygen and some of the earliest models also used a squeeze bulb design. Over time, with improvements in battery technology and power management by the instruments, **continuous monitoring** became possible.

The early squeeze ball designs were eventually replaced with motorized pumps to draw the gas sample and the run time of the gas detectors improved. Multi-gas detectors that were capable of measuring combustible gas, O_2, CO and H_2S in a single instrument came next and are still used commonly today.

TUBES ARE NOW available for more than **500 DIFFERENT** APPLICATIONS

CONTINUOUS MONITORING

Continuous measurement is an important differentiator between colorimetric detector tube technologies and electronic gas detectors.

For applications where a hazardous gas concentration could develop without warning within the timeframe of a confined space entry or other setting, continuous monitoring should be considered.

There are challenges with electronic gas detectors that sometimes limit their utility. These may include cross-sensitivity of sensors with interfering gases, temperature or humidity limitations, gas concentrations beyond the range of the sensor, the unavailability of appropriate sensors, and the need to constantly bump and calibrate the sensors. Despite the advantages of electronic detectors, there are many applications where colorimetric detector tubes continue to provide a suitable alternative. When colorimetric tubes are used in conjunction with electronic detectors, they can provide a more accurate and complete picture of the gases present and better understanding of the risks.

CONFINED SPACE ENTRY

All jurisdictions in Canada have regulations dealing with confined space entry.

All jurisdictions in Canada have regulations dealing with confined space entry. For example, entering sewers for maintenance work generally involves monitoring combustible gases (LEL), oxygen (O_2), hydrogen sulphide (H_2S), and carbon monoxide (CO). Sensors for these gases are readily available for modern electronic gas detectors and can be substituted or augmented with a range of other sensors including nitrogen oxides (NO, NO2), ammonia (NH3), sulphur dioxide (SO_2), carbon dioxide (CO_2), chlorine (Cl2) and chlorine dioxide (ClO_2), hydrogen cyanide (HCN), phosphine (PH_2), hydrogen (H_2), and a few other gases. These specialty gas sensors can add significantly to the operating cost of your gas detectors. They tend to be more expensive to purchase and require separate calibration gases and regulators as well. Gastec Tubes for nitrogen oxides, ammonia, chlorine and chlorine dioxide offer an attractive, easy to use, calibration free alternative.

The examples listed above are all **inorganic gases,** evidenced by the lack of carbon and hydrogen (C and H) together in any of the formulas. Electronic gas detector manufacturers have made great strides in developing sensors for measuring inorganic compounds with the exception of a very small number of organics. These include ethylene oxide (C2H4O), formaldehyde (CH2O) and methyl mercaptan (CH4S). For the vast number of organic compounds (such as alkanes, alkenes, amines, aromatics, alcohols, or ethers) there are still no chemical specific sensors.

In these instances, Gastec Tubes can be used to determine the gas concentration.

HAZARD ASSESSMENTS

Hazard assessments are required for each individual confined space or other potentially dangerous environment to ensure that all gas hazards are identified and appropriate gas detection and personal protective equipment is used.

Assessments will commonly identify several gas hazards including combustible gases, oxygen deficiency, and other possible toxic substances that present chronic or acute threats. Where specific hazards are identified that cannot be addressed with an electronic gas detector, colorimetric tubes can often be used to test before entry and periodically during the work progression.

A great example is the use of trichloroethylene (C2HCl3) at a dry cleaning facility. Where oxygen deficiency and combustible gases can be present in conjunction with a toxic organic, then a gas detector could be used to continuously monitor for flammability and oxygen deficiency, while the organic may be tested directly with a detector tube.

PHOTOIONIZATION DETECTORS (PID)

In recent years, Photoionization Detectors (PIDs) have been incorporated into electronic gas detectors to detect a broad range of organic gases and volatile organic compounds (VOC's).

These broad band, non-specific sensors use a UV lamp to ionize gas and measure the resulting current. In order for a PID to respond to a substance, the energy output of the lamp must be greater than the Ionization Energy (IE) of the gas. Most lamps on the market have an output of 10.6eV. The more aromatic the organic compound, the stronger the signal - a reflection on the ease by which electrons can be stripped from the compound. **Aromaticity** refers to compounds such as benzene having alternating single and double bonds, and thus take little energy to ionize.

It is very difficult to strip an electron from a C-C bond. A double bond, however, is more easily stripped from an electron and thus easier to ionize. The inability of PIDs to see most smaller organics (C5 or less) turns out to be a benefit, since most of the biologically hazardous organics tend to be C6 or greater. Being able to ignore methane but be able to see hexane is an advantage, since the former is a less toxic hazard than the latter. The use of the PID as a broadband sensor for **Volatile Organic Compounds (VOCs)** is enormously useful and allows for the fast, accurate detection and quantification of a wide range of organic hazards. A PID cannot, however, be used to identify what the hazard being measured actually is. Substance specific Colorimetric tubes are often used for this purpose. The PID is used to **quantify** the substance and the tube is used to **identify.**

For example, a PID could be used to quantify that VOCs are present in significant quantities in a particular environment. Knowing the potential (Toluene) organic hazards, specific detector tubes could then be used to test for the presence of specific VOCs. A reading on the toluene detector tube would be compared to the reading on the PID to see if the majority of the PID reading is in fact toluene. With the detector tube being used to identify the toluene, the PID can now be used to continuously monitor the area and appropriate measures can be implemented.

Electronic gas detectors have advanced significantly over the past decades. Most advances have been in terms of size, power, and the ability to log data. The typical electronic gas detector today is smaller, lighter, runs longer, and has a number of ancillary features related to data-logging and alarming. Other supporting products such as docking systems have also allowed for more efficient fleet management. One thing that has not changed very much in the past 30 years is the number of gases that can actually be measured. There continues to be approximately the same number of inorganic sensors, while organic sensors remain rare. This is mainly due to limits in electro chemistry and our continued reliance on this technology for detecting and monitoring gas concentrations.

We've looked at the most obvious reason for the continuing use of detector tubes, namely the lack of an alternative electronic sensor. There are, however, many industries that continue to use detector tubes despite electronic alternatives. Detector tubes for H2S remain in wide use throughout the oil and gas industries. This is due to a number of other advantages of detector tubes as well as some limitations on the electronic detects which we will now explore.

CALIBRATION

Bumping a gas detector (sometimes referred to as a 'function test') involves exposing a detector to a known concentration of gas and ensuring the instrument gives the proper reading.

As sensors age, their signal output decreases (drifts) and has to be adjusted or **calibrated** to maintain an accurate reading. Other reasons why sensors might drift over time can include external changes in temperature or humidity, or internal factors such as power loss and sensor age. Regardless of why a sensor fails a bump test, it needs to be calibrated. This is usually accomplished by putting the instrument into a calibration mode and using the same calibration gas that was used to bump test to re-establish the sensors accuracy. In the case of a defective or consumed sensor, the calibration will fail and the sensor would need to be replaced and the detector again calibrated.

ELECTRONIC GAS
DETECTORS
are only accurate if they are
BUMP TESTED
REGULARLY
and calibrated when required.

In order to bump and calibrate electronic detectors, it is necessary to have calibration gas, a regulator with an appropriate flow rate, and some tubing to connect them together. In recent years, docking systems have been developed to try and simplify this process. The docking systems work well at a facility level, but can present a challenge if the detectors are used in the field away from the location of the dock. Calibration gases also need to be kept up to date as they have a shelf life. Expiry dates **for various gases differ and** are typically stamped on the cylinder label.

In contrast, detector tubes are calibrated during the manufacturing process. This calibration is tube specific and is usually good for three years, though there are some examples of shorter shelf life. The expiry date is stamped on the tube box so all the user needs to do is look at the date on the box to ensure that the detector tube has not expired. For a field technician operating at a distance from a supporting facility, this is a big advantage. With no calibration issues, the need for any supporting equipment for field use is eliminated. Especially where only spot measurements are required, the ability to deploy and maintain a detector tube system in the field often makes it a preferred choice over an electronic alternative.

COLORIMETRIC DETECTOR TUBES

There are a number of colorimetric detector tube designs on the market.

All consist of a graduated detector tube and either a piston or bellows pump designed to pull a specific volume of air through the tube. Regardless of which kind of pump is being used, it is important to note that the components are tested and certified as systems by the respective manufacturers - **you cannot mix brands between the pumps and the tubes.**

The critical parameter in the pump is that it delivers the correct volume of air as designed. Gastec pumps are always leak tested before being used. This is easily accomplished by inserting an unopened Gastec detector tube into the Gastec pump and pulling the piston all the way back (100ml). The piston locks in place at this position, and since the tube is still closed, no air will flow and the pump will maintain its vacuum. Turning the handle to unlock, the vacuum will then pull the handle all the way forward. As long as the pump's handle returns fully forward, no vacuum was lost, there is no leak in the pump, and the system is ready to be used.

Once the leak check is completed, preparations can be made to collect a sample. Each end of the tube can now be inserted into the Tube Tip Breaker on the pump, the two ends opened, and the tube is reinserted into the pump. The pump handle is then pulled back to either the 50ml (1/2 pump stroke) or 100ml (full pump stroke) position, and the technician waits as the vacuum dissipates. A finish indicator on the Gastec pump handle indicates that the vacuum is completely dissipated and the colouration on the tube is now read, much like reading the increments on a thermometer. If further testing is required, the old tube is replaced with new tubes and the process is repeated.

VERSATILITY

For many gases, there are a number of different detector tube ranges available.

This allows detection in ranges above that of a typical electronic detector. High levels can often cause an electrochemical sensor to over-range resulting in a shorter sensor life. Many sensors will recover over time, but calibration is advised before re-use. This issue is avoided with detector tubes. If the concentration over-ranges the tube, either a new tube is inserted and a smaller volume is taken, or a higher range tube can be used. If we use Hydrogen Sulphide (H2S) as an example, the typical sensor found in a handheld electronic gas detector would have a range of 0 – 100 ppm or 0 – 500 ppm. This is not sufficient for many gas detection applications. There are 11 different Gastec Tubes for the detection of H2S with ranges from 0.05 ppm to 40,000 ppm (40% by volume). This allows the proper tube to be selected for the application at hand.

A number of Gastec accessories extend the versatility of the system. A one hand adapter allows the pump to be used with just one hand. This is a valuable tool when working in challenging areas where the user is required to manage other tools or take the sample in a hard to reach space. When used, the adapter is closed and the pump handle is pulled back to take a reading. The vacuum is maintained while the technician gets into position to take the sample. When ready, pressing a button on the adapter releases the vacuum and allows the air to flow through the detector tube.

Testing vertical spaces can be a challenge. In the case of a tank, manhole, or pit, an extension hose can be used to acquire a sample away from the pump. The tube is placed at the end of the hose and lowered into the space. Pulling back on the handle draws the required volume of air through the tube. Once the finish indicator shows the vacuum has dissipated, the extension hose is pulled back up and the tube can then be read. Multiple lengths are available. A sampling pole is also available for horizontal remote sampling, which allows sampling up to 9.2 feet (2.8m).

Colorimetric detector tubes can be used in hot and cold environments. Furnace and vehicle exhaust gas testing can be accomplished with Gastec tubes by using a hot probe. Since detector tubes aren't designed to measure above 40°C, the Gastec hot probe is designed to bring exhaust gases down to an acceptable temperature so that an accurate tube measurement can be obtained. In winter temperatures, tubes should be kept warm in a pocket right up until they are needed for use.

TIME WEIGHTED AVERAGE (TWA) CONCENTRATIONS

Passive dosimeter tubes are used for monitoring time weighted average (TWA) concentrations over time. Using a tube holder, they are typically attached to a pocket or lapel and will measure the TWA for up to 10 hours.

The target gas is passively sampled (as opposed to using a pump) and the colour stain increases over time. To read the tube, the stain reading (ppm.hrs) is simply divided by the number of hours it has been worn. This is not the same thing as measuring the real-time gas concentration, but it is a useful measurement for compliance purposes since it references the TWA compliance level and lets the worker know when they are in danger.

SUMMARY

Like most technologies, electronic sensors and colorimetric tubes come with both strengths and weaknesses.

It's critical to know your application and any potential hazards in order to determine how to use each technology most effectively to obtain accurate results.

Used together, colorimetric tubes can be used to strengthen your gas detection program. Tubes can be used to confirm that sensors on the gas detector are measuring the correct gas and are giving accurate readings. In turn, the gas detectors can then be used to provide continuous monitoring, and the user can have greater confidence that they are accurately monitoring the gas hazards. In cases where hazards are suspected but cannot be monitored with existing gas detectors because there are no gas specific sensors available, colorimetric detector tubes can be used to expand your measuring capability.

The list of gas – specific electronic sensors available for most gas detectors is short. There is a much larger list of Gastec tubes available, both in terms of specific gases, but also in terms of ranges that can be measured. When deciding which measuring technology is most suitable for a given application, the answer may be both. When used together, the result is a better understanding of the hazards at hand and greater safety for your employees.

For more information on colorimetric tubes and the Gastec detection system, please visit our **website.**

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