Gas Detection —

Portable Gas Detection for Safety in Confined Spaces

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The Safety Company

Portable Gas Detection for Safety in Confined Spaces – An Overview

In today's working environment confined spaces and confined space entry are on-going areas of review. Nearly all workers can expect to come in contact with a gas detector during their working career but few have the opportunity to understand the basics.

In essence gas detectors are used to detect or provide some confidence the atmosphere contained in the confined space is contaminant free. This is critical as the most common workplace reportable injuries in confined spaces are related to air quality or contamination.

Initial selection is very important especially with technology available in sensors giving previously unattainable response times (under 10 seconds to full range)*. Existing industry instruments, whilst meeting previously accepted norms can be up to 10 times slower. Knowing this is vital in entering and working in potentially dangerous confined spaces.

Of course FULL certification including both the electrical AND performance standards is equally important. As the saying goes you can't be half pregnant and if it is important to have a certified product then it should be fully certified to all applicable local standards. Performance standards assure the sensors do respond as they should.

MSA is the industry leader in gas detection and detection technology. The following is part extract

An Overview

Battery-powered, direct-reading instruments are classified into two groups - single-gas instruments or multiple-gas instruments - typically monitoring one or a combination of the following atmospheric conditions:

1. oxygen deficiency or enrichment;
2. the presence of combustible gas; and
3. the presence of certain toxic gases.

Depending on the capabilities of the instrument, monitoring can be conducted simultaneously for oxygen and combustible gas, or for oxygen, combustible gas and toxic gases. These devices are commonly referred to as 2-in-1, 3-in-1, 4-in-1 or 5-in-1 alarms.

No matter which type of instrument is used to check environmental gas concentrations, regular monitoring should be performed because a contaminant's level of combustibility or toxicity might increase even if it initially appears to be low or non-existent. In addition, oxygen deficiency can occur unexpectedly.

Take Home – Regular and ongoing atmospheric monitoring is best practice in a confined space.

Atmospheric Composition

To determine the composition of an atmosphere, reliable instruments should be used to draw air samples. If possible, do not open the entry portal to the confined space before this step has been completed. Sudden changes in atmospheric composition within the confined space could cause violent reactions, or dilute the contaminants in the confined space, giving a false low initial gas concentration.

When testing permit-required spaces for acceptable entry conditions, always test in the following order:

1. oxygen content
2. flammable gases and vapors
3. potential toxic air contaminants

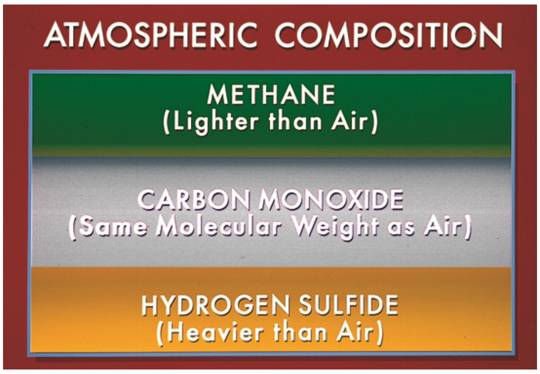

Figure 1

Comprehensive testing should be conducted in various locations within the work area. Some gases are heavier than air, and tend to collect at the bottom of a confined space. Others are lighter, and are usually in higher concentrations near the top of the confined space. Still others are the same molecular weight as air, so they can be found in varying concentrations throughout the space. This is why test samples should be drawn at the top, middle and bottom of the space to pinpoint varying concentrations of gases or vapors (see ***Figure 1)***. The results of the atmospheric testing will have a direct impact on the selection of protective equipment necessary for the tasks in the area. It may also dictate the duration of worker exposure to the environment of the space, or whether an entry will be made at all. Substance-specific detectors should be used whenever actual contaminants have been identified.

Take Home – Know what is likely and sample broadly to establish levels before and during work in confined spaces. Single point detection may miss critical changes and issues.

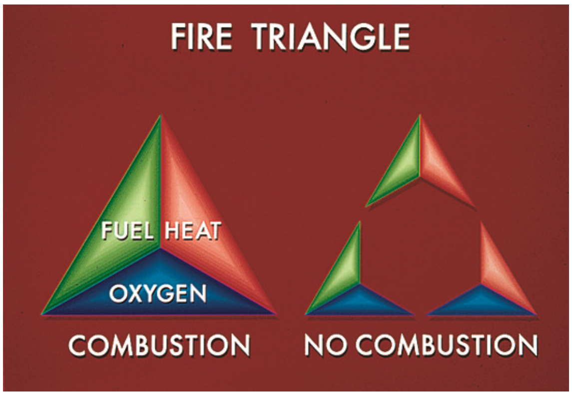

Figure 2

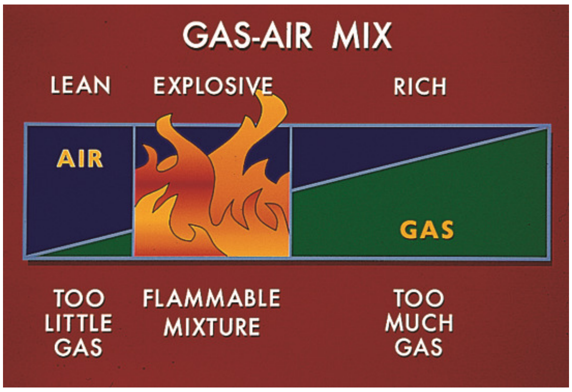

Figure 3

Combustible Gases

In order for combustion to occur, there must be three elements:

1. fuel
2. oxygen to support combustion
3. heat or a source of ignition

This is known as the fire triangle, but if you remove any one of the legs, combustion will not occur (see ***Figure 2)***.

The percentage of combustible gas in the air is important, too. For example, a manhole filled with fresh air is gradually filled by a leak of combustible gas such as methane or natural gas, mixing with the fresh air. As the ratio of gas to air changes, the sample passes through three ranges: lean, explosive and rich (see ***Figure 3***). In the lean range, there isn't enough gas in the air to burn. On the other hand, the rich range has too much gas and not enough air. However, the explosive range has just the right combination of gas and air to form an explosive mixture. Care must be taken, however, when a mixture is too rich, because dilution with fresh air could bring the mixture into the flammable or explosive range. An analogy is the automobile that won't start on a cold morning (a lean atmosphere because the liquid gasoline has not vaporized sufficiently), but can be flooded with too much gasoline (a rich atmosphere with too much vaporization). Eventually, when the right mixture of gas and air finally exists (explosive), the car starts.

How Combustible Gas Monitors Work

To understand how portable combustible gas detection instruments work, it is first important to understand what is meant by the Lower Explosive Limit (LEL) and Upper Explosive Limit (UEL). When certain proportions of combustible vapors are mixed with air and a source of ignition is present, an explosion can occur. The range of concentrations over which this reaction can occur is called the explosive range. This range includes all concentrations in which a flash will occur or a flame will travel if the mixture is ignited (see ***Figure 3***). The lowest percentage at which this can happen is the LEL; the highest percentage is the UEL.

Most combustible instruments display gas concentrations as a percentage of the LEL. Some models have gas readouts as a percentage by volume. What's the difference?

For example, the LEL of methane (the major component in natural gas) is 5 percent by volume, and the UEL is 15 percent by volume. If we slowly fill a room with methane, when the concentration reaches 2.5 percent by volume, it is 50 percent of the LEL; at 5 percent by volume it is 100 percent of the LEL. Between 5 and 15 percent by volume, a spark could set off an explosion.

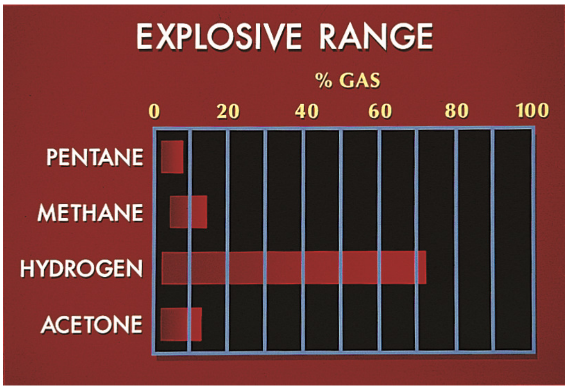

Figure 4

Different gases need different percent by volume concentrations to reach 100 percent of the LEL (see Figure 4). Pentane, for example, has an LEL of 1.5

percent. Instruments that measure in percent of the LEL are easy to use because, regardless of the gas, you are most concerned with how close the concentration is to the LEL.

Take Home – LEL varies according to gas type. A conservative calibration (eg Pentane) can give a broad level of safety warning (This should be a Pentane stimulant to guard against known Methane Blindness in some LEL sensors).

Combustible Gas Sensors

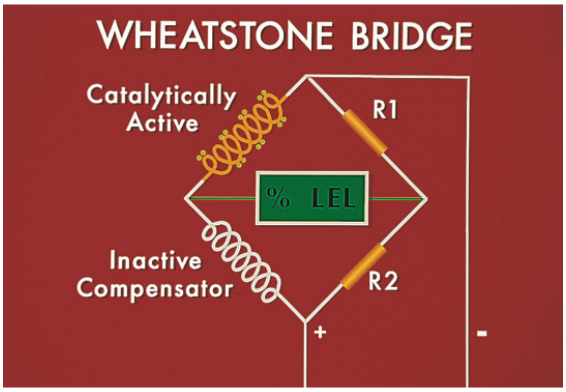

Figure 5

Single-gas sensors for monitoring combustible gases and vapors are generally calibrated on Pentane and are designed for general-purpose monitoring of hydrocarbon vapors. Such instruments operate by the catalytic action of a heated platinum filament in contact with combustible gases (see ***Figure 5***). The filament is heated to operating temperature by an electric current. When the gas sample contacts the heated filament, combustion on its surface raises the temperature in proportion to the quantity of combustibles in the sample. A Wheatstone Bridge circuit, incorporating the filament as one arm, measures the change in electrical resistance due to the temperature increases. This change indicates the percentage of combustible gas present in the sample.

Take Home – LEL sensors "burn" gas in the atmosphere on a heated filament (pellistor). They measure atmosphere combustion and are non selective.

Toxic Gas Sensors

Toxic gas monitors use electrochemical cells. If the gas of interest enters the cell, the reaction produces a current output proportional to the amount of gas in the sample. With these instruments, audible and visible alarms sound if the gas concentration exceeds a preset level. These devices are well suited for use in confined spaces containing motors or engines, which can generate large quantities of CO, as well as in sewers, waste treatment plants and "sour crude" processing stations which tend to have hazardous volumes of H_2S.

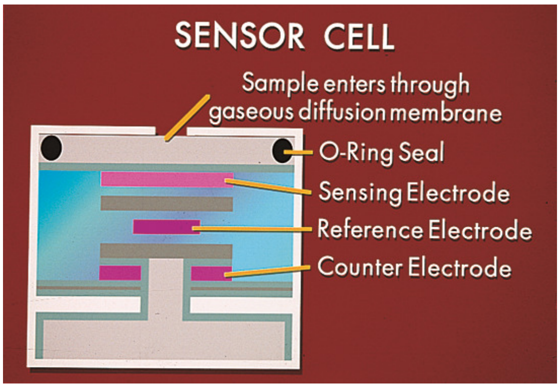

Figure 6

Multiple-Gas Monitors for Oxygen and Combustible Gas

In most applications where LEL is measured it is necessary to determine both oxygen and combustible gas levels simultaneously. In this application 2-in-1 gas detection devices as a minimum should be used. This allows both critical elements of the fire triangle to be measured and a true LEL value determined.

Sensors measure 0 to 100 percent of the LEL and oxygen from 0 to 25 percent.

Take Home – True LEL values require knowledge of Oxygen content and LEL sensors do not work in oxygen depleted atmospheres.

Multiple-Gas Monitors for Oxygen, Combustible and Toxic Gases

Toxic gases and vapors, may be inhaled and/or absorbed through the skin, are frequently found in confined spaces. Sometimes, atmospheric hazards can also displace oxygen and may incapacitate the body's ability to maintain respiration. Some toxic gases and vapors can also cause long-term physical damage to the body in cases of repeated exposure.

Instruments are available for simultaneously measuring the LEL of combustible gases, oxygen levels and toxic levels (in parts per million) of H2S, CO and other toxic gases. Alarms alert the user to unsafe conditions such as high LEL, low and high oxygen levels and or high toxicity. Suitable instruments also measure long term exposure to background toxic gases known as Time Weighed Averages and provide alarms for these risks.

Remote sampling pump adapters are available to convert diffusion-type instruments into pump-style instruments. These must be electrically certified for use with the instrument by the instrument certifying agency to ensure full compliance.

Take Home – Check all certifications on all electrical components to be used in a confined space.

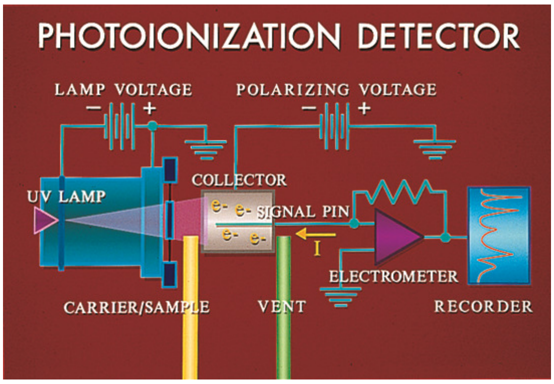

Figure 7

Photoionization Devices for Toxic Gases and Vapors

A photoionization detector, uses ultraviolet light to ionize molecules of chemical substances in a gaseous or vaporous state (see ***Figure 7***). A real-time digital readout allows the user to make an immediate determination of gas and vapor concentrations. Depending upon calibration input, gas and vapors are measured over a 0.1 to 10,000 ppm scale. Most PID detectors can be sensitive to signal loss due to humidity. Advanced technology design is available that removes humidity blindness. Understanding humidity impact is important as signal loss is mis-interpreted by affected detectors as gas readings and can cause false alarms.

Although PID's detect many compounds often called Volatile Organic Compounds (VOC) they are relatively non-selective. Instruments often contain libraries of conversion factors however these only convert a signal so if the incorrect compound factor is applied the reading will be wrong.

Take Home – Ensure the VOC is confirmed if using a specific library reference to measure. The PID signal will aggregate the signal from ALL VOC's in the sample together.

Detector Tube Sampling Systems

Detector tube-type devices are recommended for conducting quick evaluations of potential hazards that cannot otherwise be measured. With detector tubes, a known volume of air is drawn through the tube, using a manually operated or battery-powered sampling pump.

If gas or vapor is present in the air, chemically treated granules in the tube are stained a different color. By measuring the length of the color stain within the tube, users can determine concentration levels.

Most tubes available today are made of glass, have break-off tips, and are filled with treated chemical granules. They generally have a shelf life of 24 to 30 months.

One type of pump frequently used with a detector tube is a compact, bellows-type device. Accurate and repeatable sample flows can be assured by a shaft that guides the bellows during compression. Some models feature an end-of-stroke indicator that lets the user know when a full air sample has been drawn. Models with an integral stroke counter eliminate the tedious recording of multiple pump strokes.

Take Home – These devices are generally less accurate and are mostly used qualitatively to determine a compound is present. They are chemical and subject to aging and variation due to heat and other environmental factors.

Calibration

To ensure the accuracy of all monitoring and detection equipment, calibration should be performed regularly. If the instrument reading differs significantly from the values of the known standard, the instrument should not be used until it has been adjusted or, if necessary, repaired.

This is the most abused area of gas detection. ALL manufacturers indicate regular (mostly at least daily) tests of instruments in use and re-calibration if required. The Australian standards indicate a higher degree of test. These tests should cover all sensors as all sensors are critically important to work in confined spaces.

Take Home – A correctly calibrated gas detector may be the only thing standing between a worker and a potential catastrophic injury. Gas detectors for personal safety must be tested before use.

*MSA Altair™ X-cell sensors independently tested and certified.

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Our Mission

MSA's mission is to see to it that men and women may work in safety and that they, their families and their communities may live in health throughout the world.

MSA: Because every life has a purpose.

MSA – The Safety Company
1000 Cranberry Woods Drive
Cranberry Township, PA 16066 USA
Phone 724-776-8600
www.MSAsafety.com

U.S. Customer Service Center
Phone 1-800-MSA-2222
Fax 1-800-967-0398

Pacific Asia Region
MSA Singapore
MSA S.E Asia Pte Ltd
35 Marsiling Industrial Estate Road 3,
#04-01, Singapore 739257
Phone: +65 6350 4500
Fax: +65 6350 4505

MSA Australia
Phone: 1300 728 672 / +61 02 9688 0333
Fax: +61 2 9896 1835

MSA Indonesia
Phone: +62 21 6409 000
Fax: +62 21 641 2831

MSA Malaysia
Phone: +603 8724 8208/9208
Fax: +603 8724 2208

MSA New Zealand
Customer Service
Phone: 0800 441 335

MSA Philippines
Phone: +63 9209 742 191

MSA Thailand
Phone: +66 2617 8211
Fax: +66 2617 8214

For sales enquiry, contact us here.

www.MSAsafety.com