Check Before Entering Confined Spaces

White Paper by:

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ABSTRACT:

Any confined space should be considered dangerous and it is pertinent for workers' safety that a thorough check takes place prior to entry. The Occupational Safety and Health Administration (OSHA) clearly defines the proper procedures for confined space entry in 29 CFR 1910.146, General Environmental Controls, Subpart J, Permit-required confined spaces. The confined space must be checked in advance of and just prior to entry, and the atmosphere must be monitored throughout the work period. A confined space must be considered dangerous and monitored for oxygen deficiency/enrichment, combustible gases, and toxic gases and vapors. This paper addresses portable electronic gas monitors and mentions direct reading colorimetric tubes in relation to confined space work.

INTRODUCTION:

Safety is a core value at Uniphos Envirotronic Inc., with the goal of ensuring that all detection and monitoring equipment provides reliable and immediate indications of toxic and flammable gas concentrations. This is particularly important when dealing with confined spaces.

Figure 1. Portable electronic gas monitor.

Entering a confined space occurs daily for workers across a wide range of industrial settings. Some of the more common settings are manure pits, electrical vaults, wells, sewer systems, grain silos, refineries, steel mills and underground mines.

A portable electronic gas detector is the most practical (Figure 1) device for pre-checking a confined space as well as for constantly monitoring during the working period. A monitor such as this can be fitted with a flexible sampling line, allowing it to be inserted into a confined space to check the air before entry.

GAS MONITOR DESIGN:

Understanding the overall design of a typical gas monitor can be a great help in selecting the appropriate device. The sensor is likely the most important component inside a gas monitor.

Monitoring Targeted Substances – Portable gas monitoring systems may be designed for a single substance or can be fitted with multiple sensors. A multiple sensor design is often driven by OSHA requirements, which specify confined space monitoring by following this detection sequence: oxygen, combustible gases and any potential toxic contaminants (29 CFR 1910.146, page 4551, Section (ii)(c)). Oxygen readings must be taken prior to testing for combustibles, because a minimum of approximately 15% oxygen is necessary for proper operation of a conventional catalytic oxidation (CAT) sensor. A catalytic sensor will burn the combustible gas and therefore requires a minimum amount of oxygen to be present. If the oxygen level is too low, the catalytic sensor may read too low or give no reading at all. It is important to follow the requirement to take the oxygen reading first, the combustible second and finally the toxic gas reading.

Sensor Types – The most common sensor technologies used in gas monitors are electrochemical (EC), catalytic oxidation (CAT), infrared (IR) and photo ionization detector (PID). Other types may also be used depending on the technology used by the instrument manufacturer.

SENSOR CHARACTERISTICS:

EC oxygen sensors can measure the volume of oxygen over the range of 0-25% when installed in a gas monitor.

EC Toxic Gas Sensors can be used to detect and monitor CO, H_2S, SO_2, Cl_2, and many other toxic gases. Electrochemical sensors can accurately measure targeted gases at parts per million (ppm) levels.

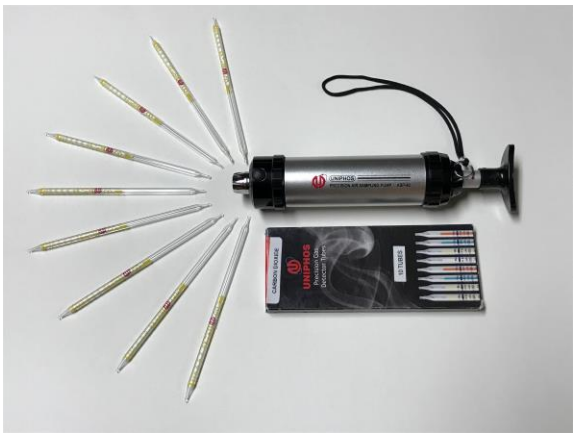
CAT Sensors can detect a wide range of combustible gases and are typically calibrated to measure in the range of 0-100% of the lower explosive limit (LEL). In addition, CAT sensors are notorious for being *poisoned* from silicon, sulfur and chlorine, resulting in reduced sensitivity and shortened life of the sensor.

IR sensors are useful for carbon dioxide or combustible gases. Unlike catalytic sensors, IR sensors are not subject to poisoning and do not require oxygen to operate, also they tend to last more than five years. However, there is a cost associated, and IR sensors are more expensive than CAT sensors.

PID Sensors are used to detect low concentrations of volatile organic compounds (VOC), such as gasoline for benzene concentrations, other aromatics and aliphatic hydrocarbons. The standard energy for a PID lamp is 10.6 eV, but at least two others are available, namely 9.8 and 11.7 eV. These lamp assemblies tend to be fragile and quite expensive. Some manufacturers offer instruments that accept pre-filter tubes to provide benzene or 1,3-butadiene specific measurements using such tubes as the Uniphos PID Pre-filter tubes (Figure 2).

Figure 2. PID Pre-filter tubes.

Figure 3. Detector tubes and manually operated pump.



Detector Tubes are very useful in checking confined spaces because in many cases there are no suitable electronic sensors. A detector tube is a hermetically sealed glass tube (Figure 3) containing an inert solid or granular material such as silica gel, alumina resin, pumice or ground glass. The inert material is impregnated with or mixed with one or more reagents which change color when specific types of air contaminants are introduced. The length of the color change or stain, or the intensity of the color change as compared to comparative standards indicates the amount of material present. This definition comes from "Air Monitoring Instrumentation," by Carol J. Maslansky and Steven P. Maslansky.

There are literally hundreds of detector tubes available to identify and quantify a wide variety of organic and inorganic chemicals.

ELECTRONIC CIRCUITRY:

Safety is a key feature of any gas monitor. Intrinsically safe designs ensure that the available electrical and thermal energy in the gas monitor are always low enough that ignition of the hazardous atmosphere cannot occur.

Common intrinsic safety approval ratings for gas monitors are Class I, Division 1, Groups A, B, C and D, and Temperature Rating T4.

Class I locations – areas in which flammable gases or vapors may be present in the air in sufficient quantities to be explosive.

Division. 1 - substance referred to by class is normally present.

Typical Class I Area Substances –

Group A: Acetylene

Group B: Hydrogen, ethylene oxide and other manufactured gases

Group C: Acetaldehyde, cyclopropane, ethylene, diethyl ether, and other light organic gases

Group D: Acetone, benzene, butane, gasoline, hexane, isoprene, naphtha, natural gas (methane), propane, and many other organic vapors

Temperature Rating T4 – The surface temperature of any part of the gas monitor will not rise above 135°C.

GAS MONITOR HOUSING:

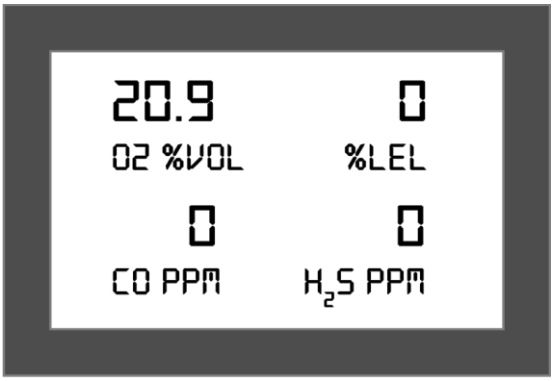
The gas monitor housing material is often a thermoplastic polymer. Manufacturers are always trying to develop a housing that is much lighter in weight than metal and more chemically resistant. Most housings are a "clam" design with a top and bottom connected with sealing material to prevent the ingress of dust and water. Ingress Protection (IP) of IP65 or IP67 is the level of protection for most monitors on the market.

UNDERTAND THE MEASUREMENT UNITS:

A gas monitor will be calibrated in units appropriate for its sensors and the gases or vapors being monitored. Figure 4 represents a common configuration for a multi gas monitor.

Combustibles are most commonly expressed in % LEL, O_2 in % Volume and toxic gases in ppm.

Figure 4. Monitor display concentrations in units relevant to the specific gases.



MAINTAINING THE GAS MONITOR:

Checking the air in a confined space and monitoring throughout the work period is essential in protecting a worker's health and safety. It is the responsibility of the individual and company to ensure the monitor is working properly. The monitor should be bump tested every day before using it or at the shift change if the monitor is changing hands.

According to the document, "ISEA Statement on Validation of Operation For Direct Reading Portable Gas Monitors": *Bump Test (Function Check) - A qualitative function check where a challenge gas is passed over the sensor(s) at a concentration and exposure time sufficient to activate all alarm indicators to present at least their lower alarm setting. The purpose of this check is to confirm that gas can get to the sensor(s) and that all the alarms present are functional. This is typically dependent on the response time of the sensor(s) or a minimum level of response achieved, such as 80% of gas concentration applied. Note this check is not intended to provide a measure of calibration accuracy.* This document also provides pertinent information on a calibration check and full calibration and is available on-line.

While there is much more to cover about selecting a gas monitor for confined space entry, the purpose of this paper is to get us all thinking about ensuring the safety of our employees. The selection of the best gas monitoring or measurement device is based on the prevailing conditions. When in doubt, don't enter a confined space, but rather consult a professional such as an industrial hygienist or safety engineer.

For more information:

Contact Uniphos Envirotronic Inc. for more information on how gas monitors and gas detection equipment can benefit your workers in situations where they might be entering confined spaces.

Call 1.844.247.0450 (toll free)

Or visit us at www.uniphosamericas.com