Gas Detection Selection

The More You Know, the Better

By Bradley J. Day, Industrial Scientific Corporation

It's 7:00 AM at a local Waste Water Treatment Plant and you are attending a safety meeting. During the meeting the conversation turns to portable gas monitors and the boss turns your way and has just slated you to investigate what new gas monitors should be purchased. *(Gulp)* Your mind starts to whirl, you do not know the first thing about gas monitors except that there are so many different types! How do you select the right type of portable gas monitors to purchase?

The job may at first seem daunting until you break down the different types of portable gas monitors that are available. In this article we will explore these types of instruments and this may help in determining which type may be best for your application.

In the world of portable gas monitors there are primarily two different types: multi-gas and single gas.

Multi-gas – Just as the name implies, this type of instrument can detect more than one gas at a time and display the readings simultaneously on the instrument's display. This is most useful for confined space entry where at minimum oxygen, combustible gas and any known toxic gases must be monitored prior to entry. One of the most common multi-gas instrument types is the four gas instrument with oxygen, LEL (lower explosive limit) aka combustible gas, carbon monoxide and hydrogen sulfide. Because these are the most common hazards that may be encountered in a confined space, this instrument configuration is very popular. But wait! There may be other toxic gases that may need to be considered before buying such an instrument. Many of these four gas instruments cannot be reconfigured to accept other toxic gases like, for example, chlorine or sulfur dioxide. Check your application to ensure that the instrument that is being purchased can detect the gases that you are most concerned with. In this case you may need to upgrade to a five or even a six gas instrument to ensure that all toxic gas hazards have been addressed. The next thing to consider is sample draw capabilities. If the instrument is to be used for confined space entry evaluations then the instrument must have the ability to draw a sample from a confined space. This can be accomplished by using an attached sample draw pump or some multi-gas instruments have a built-in pump. The pump will pull the sample up through tubing or through a probe and deliver that sample to the instrument for detection. Multi-gas instruments that do not have pumps are working off the principle of diffusion, allowing the gas to simply diffuse through the sensor openings. The diffusion type multi-gas instrument would then be considered a personal monitor and should not be used for confined space evaluations.

Single Gas – Single gas instruments will have only one sensor for detecting and therefore display only one gas reading. These instruments are mainly for personal protection monitoring and would not be used for confined space entry. Single gas instruments have the advantage of being smaller and less expensive than multi-gas therefore this type of monitor is less cumbersome to wear and typically requires less training to operate. To further simplify these instruments, some do not offer a display, just an audible, visual and maybe a vibrating alarm to let the user know if the gas levels are too high. Some are designed so that once the instrument is turned on it will continuously monitor for the gas and will automatically shut down once the instrument has exceeded its designed life expectancy. These single gas instruments are usually available in many different gas types and some can be reconfigured to different sensors in the field by removing the old sensor and replacing it with a new sensor type.

Once you have made the decision whether a multi-gas and/or a single gas instrument will fulfill your gas detection needs, you then need to look at the type of sensor technology that is being employed in the instrument. There are primarily four different types: Catalytic Diffusion, Electrochemical, Infrared, and PID. Being that the sensor is the heart of the instrument, understanding its capabilities and limitations is imperative in selecting the correct type of gas monitor.

Catalytic Diffusion – This sensor is also known as the LEL sensor which is designed to detect combustible gas concentration at or below the lower explosive limit. This type of sensor is designed to detect most combustible gases because of its principle of operation. Inside a combustible sensor are two filaments. One is called a sensing bead and the other is a temperature compensating bead. The sensing bead is coated with a catalyst that will oxidize the combustible gas for detection but the temperature compensating bead is coated with a material to make it blind so it will stay at a constant temperature. This will cause a temperature difference between the two beads in the presence of combustible gas. The instrument will turn this into an LEL reading on the display of the instrument.

Advantages:
- Very common technology for detection of combustible gas levels.
- It can detect most combustible gases.
- Very reliable with long life expectancy.

Disadvantages:
- Will not work in inert environments (must have oxygen present for oxidation on the sensing bead to take place).
- The sensor can be poisoned by silicone or lead.
- Can only detect combustible gases at or below the lower explosive limit (LEL).

Electrochemical Sensors - This type of sensing technology is used primarily for detection of toxic gases and oxygen. Inside a toxic sensor are two, three or in some cases four electrodes made of a precious metal in a bath of an electrolyte solution. Toxic gas entering the sensor will cause an electrochemical reaction proportional to the amount of toxic gas in the environment. This causes energy to be released from the sensor that the instrument will turn into a ppm (parts per million) reading to appear on the display of the instrument.

Advantages:
- Available in a wide variety of toxic gas types.
- Very common and trusted technology.

Disadvantages:
- Varying life expectancy.
- Some electrochemical sensors will exhibit a cross sensitivity to other gases.

Infrared Sensors - This type of sensing technology can be employed for detection of combustible gas, methane gas (natural gas) and carbon dioxide. Inside this type of sensor is an incandescent lamp illuminating a chamber with an optical sensor on the opposite side. When gas enters the chamber, the gas will absorb the light energy causing the optical sensor to see less light energy. This will translate into a reading on the instrument in proportion to the amount of light absorbed.

Advantages:
• Can be used for detection of methane (natural gas) up to 100% by volume.
• Can detect combustible gases in the LEL range.Can work in inert environments (does not need oxygen to operate)

Disadvantages:
• LEL infrared sensor can only detect a select group of combustible gases.
• Will not be able to detect the combustibility of hydrogen.
• Some infrared sensors may exhibit a cross interference to humidity.

Photolonization Detector (PID) – With this technology the user can now measure very low concentrations of volatile organic compounds (VOCs). This technology works well for emission testing, leak testing or anytime someone needs to quantify the amount of volatile organic compounds in the air. Inside the PID sensor is an ultraviolet (UV) lamp that will ionize the gas. This will cause the molecule to release an electron, making the compound positively charged. Also inside the sensor are electrodes that will detect the ionized molecule and deliver that information to the instrument's display in ppm or sub ppm range.

Advantages:
• Can detect a broad range of VOCs in sub-ppm concentrations.
• Not susceptible to poisons or damaged by high gas concentrations.

Disadvantages:
PID sensors can only quantify the gas concentration not qualify the VOC type.
The user must know what type of VOC being monitored to ensure that the lamp's photon energy can ionize the gas.

One of the final aspects of selecting the proper gas detector that must be addressed would be that of maintenance. Regardless of the type of instrument purchased, it will need routine maintenance performed to keep that instrument in tiptop shape. Calibrations, bump tests (function tests), sensor change out and filter replacement are examples of periodic maintenance that may need to be performed. Many companies offer calibration stations or docking stations. This ensures that the calibrations and bump tests are being performed properly and takes care of all the necessary record keeping. Some instruments are designed so that sensor change out can be performed by the user while others require the instrument be serviced by the manufacturer. Some companies offer a comprehensive service plan through their docking stations to automatically determine instrument serviceability and will replace the instrument or the component when a fault has been discovered. This type of program will allow the user to outsource their gas detection program to the manufacturer eliminating all maintenance concern of that product.

To review instrumentation selection, first evaluate the gas hazard type, determine if you need a single gas or multi-gas instrument, evaluate the sensor technologies that may work best for the application and understand the maintenance requirements of the product selected. With the basics of portable gas detection understood, the selection of an instrument type does not have to be as daunting of a task as one might initially think.

Bradley J. Day is a Training Specialist with Industrial Scientific. Brad has been working for Industrial Scientific Corporation for 15 years as a Training Specialist and can be reached at 412-490-1858 or e-mail at bday@indsci.com.

Reprinted from the November 2008 Issue of

INDUSTRIAL HYGIENE NEWS
SAFETY • IAQ • HOMELAND SECURITY • INSTRUMENTATION
Providing Occupational Safety & Health Information Since 1978