Infrared Technology

Not all infrared monitors are created equal

‘Photoacoustic infrared technology enables gases to be detected at extremely low levels due to its inherent stability and reduced cross&#151sensitivity.’‘There is no zero point involved&#151providing more accurate and reliable readings.’ By Allan Roczko

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When protecting your employees and operational processes from toxic and combustible gases, it’s critical to choose a gas detector that provides the most accurate and reliable monitoring possible. With so much at stake, using the most advanced technology possible is your best option. Since there are so many types of facilities, gas detection needs can vary greatly. Some facilities require monitors to identify gases at the lowest possible levels. Other facilities use combustible gases that require explosion&#151proof monitors. It’s possible to utilize a single gas detection monitor for all of the challenges mentioned above&#151one that utilizes photoacoustic infrared technology.
Photoacoustic infrared technology enables gases to be detected at extremely low levels due to its inherent stability and reduced cross&#151sensitivity. To understand photoacoustic infrared technology, it is important first to understand how traditional infrared technology works. Infrared detection uses infrared light to detect the presence of gas. When a gas is exposed to the infrared light, it absorbs some of the light’s energy. Specific gases absorb light at specific wavelengths, allowing gases to be identified by measuring the absorption of light at these wavelengths. Optical filters are used to pass *only* the particular band of wavelengths for the gas of interest. Infrared technology has been used for many years with great success for ambient gas level detection. Historically, one of the most commonly used forms of infrared detection has been absorptive infrared technology. In an absorptive infrared monitor, a sample of the gas in question is introduced into the monitor’s measurement chamber and exposed to infrared light. Simultaneously, a sample of an inert gas (usually nitrogen) is present in a separate measurement chamber within the same monitor, and is known as the reference gas. By using an inert gas, one ensures that no absorption takes place and that all the infrared light passes through the chamber. This provides an accurate baseline from which to measure light absorption by the gas in question, as the detector compares the amount of light transmitted through the sample and the reference cells. The monitor can determine the concentration of gas present in the sample by the ratio of light that is transmitted by the sample gas to the light that is transmitted by the reference gas. For example, if the amount of light transmitted through both cells is equal, then the sample cell does not contain the gas of interest. Conversely, the difference between the amount of light transmitted through the sample and

reference cells can be used to quantitatively determine the concentration of gas in the sample cell.

How It Works

Photoacoustic infrared technology builds upon the success of basic infrared technology for ambient gas monitoring. This technology also exposes the gas sample to infrared light, but unlike absorptive infrared, the reading is based on what happens to the gas *after* it absorbs the infrared light. With this method, a comparison to a reference sample is not required, so a direct gas reading is obtained.

In a photoacoustic infrared instrument, a gas sample is introduced into the measurement chamber of the monitor, and the sample is exposed to a specific wavelength of infrared light. If the sample contains the gas of interest, it will absorb an amount of infrared light proportional to the concentration of gas present in the sample. However, photoacoustic infrared analysis extends beyond simply measuring how much infrared light is absorbed. Photoacoustic infrared technology observes what happens to the gas once it has absorbed the infrared light. The molecules of any gas are always in motion, and as they move around inside the measurement chamber, they generate pressure. When a gas absorbs infrared light, the molecules' temperatures rise, and they begin to move more rapidly. As a result, the pressure inside the measurement chamber increases, creating an audible pulse that can be detected by a sensitive microphone located inside the photoacoustic infrared monitor. The gas is then irradiated with pulsed infrared energy, and as the molecules absorb this energy, they heat and cool. The pressure also changes as a result of the heating and cooling of the molecules measured by the detector. The gas is exhausted, a fresh sample enters the cell, and the sampling process is continuously repeated. Because the optical filter will only pass the particular wavelength of light for the gas in question, a pressure pulse indicates that the gas is present. If no pressure pulse occurs, then no gas is present. The magnitude of the pressure pulse indicates the concentration of the gas present and the stronger the pressure pulse, the more gas that is present. The microphone inside the monitor can detect the smallest of pressure pulses, enabling it to detect even the lowest levels of gas.

Benefits of Photoacoustic Infrared Monitors

The term Threshold Limit Value (TLV) refers to the concentration of airborne substances under which workers can be repeatedly exposed without adverse health effects. The purpose of gas detection instruments is to ensure that gases are identified at concentrations equal to or lower than the TLV to ensure a safe working environment. With certain gases, the TLV can be extremely low, requiring a detection method that can identify very low levels of that gas. The higher an instrument's sensitivity, the lower the levels of gases it can detect.

Absorptive infrared monitors can easily detect gases in percent by volume or high part&#151per&#151million (ppm) levels; however, the detection limits for many absorptive infrared monitors can be well above the TLV of many gases. In order to achieve the required ppm level of detection, these instruments need to have longer sample chambers, increasing the overall size of the monitor, as well as the cost. Photoacoustic infrared monitors can detect gases at low ppm, and even part&#151per&#151billion (ppb) levels due to the high sensitivity and stability of their microphone. This microphone can detect small pressure pulses, allowing photoacoustic infrared monitors to detect the presence of a toxic compound before the concentration reaches the TLV for many gases. Zero stability, or maintaining a stable baseline, is very important for low ppm detection. Instability can compromise low&#151level detection by causing inaccuracy, false alarms, and limited detection levels. A common problem with absorptive infrared monitors is the fact that the zero derived from the sample to reference ratio has a tendency to drift based on a number of factors. These factors include application, age, light source variability, and physical changes in the detector over time. Because the absorptive infrared monitor reading compares the readings of the sample gas to the reference gas, it’s critical that the balance between cells is maintained. If not, the monitor must be calibrated or re&#151zeroed to ensure a correct zero point. Otherwise, the monitor may present a false alarm, or become unable to detect low concentrations of the gas in question. Another downfall to this technology is that the re&#151zeroing process takes time away from the sampling process. Photoacoustic infrared technology offers zero stability because it eliminates the need to adjust for zero drift. There is no zero point involved&#151providing more accurate and reliable readings. Cross&#151sensitivity, the ability to differentiate between various gases that may be present within a single sample, is a key factor to consider when choosing gas detection technology. When testing for a specific toxic or combustible gas, it is quite possible that another gas with similar absorption characteristics is present in the chamber. Even ambient air can cause cross&#151sensitivity problems due to the variability of carbon dioxide or relative humidity in the atmosphere. For example, if a monitor is cross&#151sensitive to CO_2, merely breathing on the monitor can cause a false reading. Photoacoustic infrared monitors, like other infrared monitors, are designed to minimize cross&#151sensitivity through the use of specific optical filters. Given the stability of photoacoustic infrared technology and the use of optical filters, one can achieve the sensitivity and selectivity required for low ppm detection. For installations that require detection of a toxic or combustible gas at very low levels, particularly in an environment where cross&#151sensitivity is an issue, photoacoustic infrared monitors are an excellent choice, as they provide precise, low&#151cost, high&#151performance monitoring for a variety of gases. These monitors can currently detect more than 60 common industrial gases including carbon monoxide, carbon dioxide, cleaning agents, heat transfer fluids, and a host of common industrial chemicals, with many other possible applications. Photoacoustic infrared monitoring systems can be expanded to observe up to eight separate locations. Additional sensors can be added within the same instrument enclosure to monitor non&#151infrared detectable gases such as catalytic bead sensors for combustible gas detection and electrochemical sensors for monitoring oxygen, carbon monoxide, and other toxic gases. Absorptive infrared monitors are often a suitable choice in gas detection, particularly when higher detection levels are acceptable. However, when the situation calls for an extremely low&#151level alarm in the presence of other gases, and when reliability is critical, photoacoustic infrared monitors offer the best package of performance and value.

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