MSA **Gas Detection**

Photoacoustic Infrared Detection (PAIR)
versus Non-Dispersive Infrared Detection (NDIR)

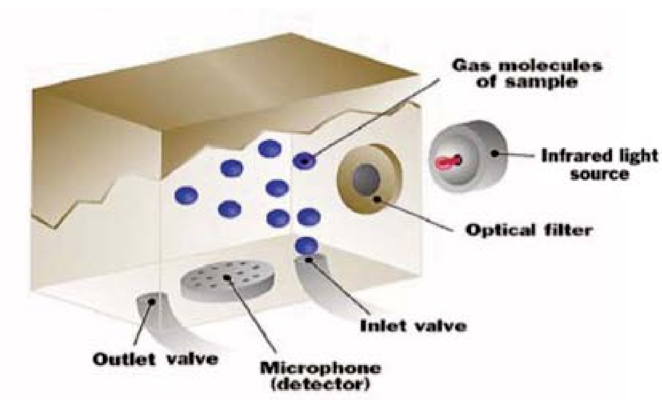
How does PAIR gas detection technology work?

When using a photoacoustic infrared instrument, a gas sample is introduced into the monitor's measurement chamber and the sample is exposed to a specific wavelength of infrared light. If the sample contains the gas of interest, that sample will absorb an amount of infrared light proportional to the gas concentration that is present in the sample.

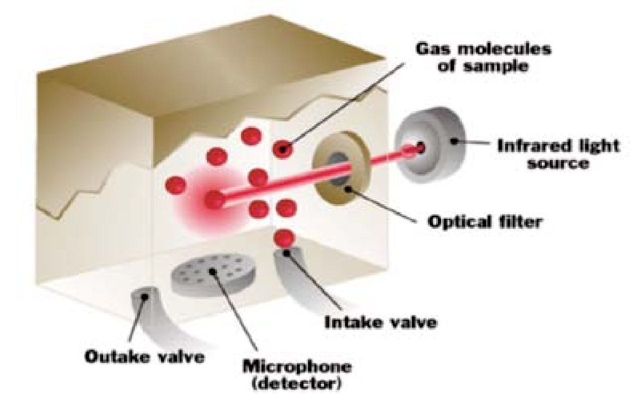
Photoacoustic infrared analysis, however, extends beyond simply measuring the amount of infrared light that is absorbed; this technology actually detects what occurs after the gas is absorbed.

Always in motion, gas molecules move around the inside of the measurement chamber, generating pressure. When gases absorb infrared light, the temperature of the molecules rises and they begin to rapidly move. As a result, measurement chamber pressure increases, creating an audible pulse that can be detected. A highly sensitive microphone is located inside the photoacoustic infrared monitor to detect even the smallest of pressure pulses, enabling detection of even the lowest gas levels.

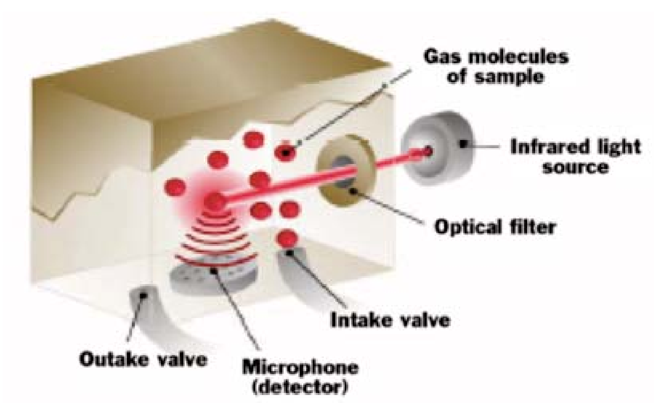
The monitor's optical filter allows only that particular light wavelength of the gas in question; a pressure pulse confirms the presence of that gas. The premise is simple; if no pressure pulse occurs, then no gas is present. The magnitude of the pressure pulse indicates the gas concentration present. The stronger the pressure pulse, the more gas that exists.



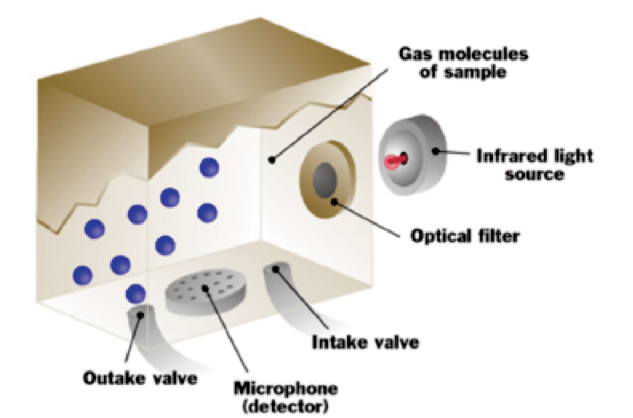
1 *Sample gas enters the measuring cell.*



2 *The gas is irradiated with pulsed infrared energy. The pressure changes as a result of the heating and cooling of the molecules and is measured by the detector.*



3 *The gas molecules heat and cool as they absorb the infrared energy. The pressure changes as a result of the heating and cooling of the molecules measured by the detector.*



4 *The gas is exhausted and a fresh sample enters the cell. This sampling process is continuously repeated.*

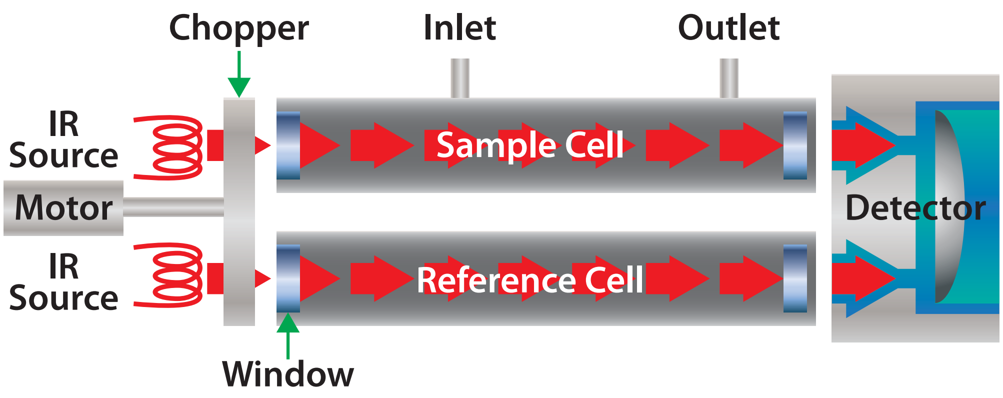
How does NDIR gas detection technology work?

NDIR is also referred to as absorptive infrared detection. When using an absorptive infrared monitor, a gas sample is introduced into the monitor's measurement chamber and is exposed to infrared light.

Simultaneously, an inert gas sample (usually nitrogen) is present in a separate measurement chamber within the same monitor and is known as the reference gas. Using inert gas ensures that no absorption takes place and that all infrared light passes through the chamber. This process provides an accurate baseline from which to measure light absorption by the gas in question.

The detector compares the amount of light transmitted through the sample and reference cells. The monitor can determine the gas concentration that is 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.



Why does MSA prefer PAIR technology to NDIR technology?

Threshold Limit Value (TLV) refers to the concentration of airborne substances to which workers can be repeatedly exposed without experiencing adverse health effects. The purpose of gas detection instruments is to help ensure safe working environments by identifying the presence of gases at concentrations equal to or lower than the TLV. With certain gases, the TLV can be extremely low, requiring a detection method that is able to identify gas at miniscule levels. The higher an instrument's sensitivity, the lower the level of gases it can detect.

Detection limits for many NDIR monitors can be well above the TLV of many gases. In order to achieve the ppm level that can be detected by a PAIR monitor, instruments must have longer sample chambers. Non-dispersive infrared detectors are an acceptable choice only when higher detection levels are adequate.

Zero stability, or maintaining a stable baseline, is critical for low ppm detection; instability can compromise low level detection by causing inaccuracy, false alarms and limited detection levels.

A common problem with NDIR monitors is that the zero derived from the sample to reference ratio has a tendency to drift based upon a number of factors including usage, age, temperature, unpredictability of the light source, and physical changes to the detector over time.

Non-dispersive infrared detectors have to perform an auto-zero or re-zero in order to maintain stability. Auto-zero occurs more frequently during temperature changes, and due to the frequency of the auto-zero, purge lines can become contaminated, resulting in increased maintenance to replace airline filters or scrubbers.

Why does NDIR technology need to auto-zero and PAIR does not?

When comparing PAIR and NDIR technologies, the difference lies in direct measurement versus comparative measurements.

Photoacoustic infrared technology offers zero stability, eliminating the need for zero drift adjustment. A direct gas reading is obtained because there is no need for a reference point, ensuring continuous monitoring. No zero point is involved, providing the most accurate and reliable readings.

Because NDIR monitors compare sample gas readings to reference gas, it is critical that the balance between cells is maintained. If this balance is not preserved, the monitor must be calibrated or re-zeroed to ensure correct zero point. Otherwise, the monitor may present a false alarm or become unable to detect the gas in question at low concentrations.

Another shortcoming of NDIR technology is that the re-zeroing process takes the instrument offline, taking time away from the sampling process.

What is the best technology to choose when considering cross-sensitivity?

Cross-sensitivity is the ability to differentiate among various gases that may be present within a single gas sample, and is a key factor to consider when choosing the most appropriate technology for use in detection of toxic and combustible gases.

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.

Monitors using PAIR technology are designed to minimize cross-sensitivity through the use of specific optical filters. Given the stability of photoacoustic infrared technology and the use of optical filters, sensitivity and selectivity can be achieved for low ppm detection.

Technology		
	Photoacoustic	**Non-Dispersive**
BASIC PRINCIPLES	Measures direct infrared light absorption for a specific gas	Compares air sample to inert gas stored in monitor.
ZERO DRIFT	Drift is eliminated; no reference gas comparison is needed	Drift is inevitable due to changes in temperature, pressure and contamination of reference cell.
SENSITIVITY	Higher sensitivity for low level gas detection (Meets safety standards as low as 1 ppm)	Detection limits can be well above the TLV of many gases. To achieve the ppm level that is detectable by a PAIR monitor, gas detection instruments must use longer sample chambers.
COST EFFICIENCY	Saves money; no fresh air sampling lines are needed; lower detection levels for faster response	Requires repeated auto-zero processing, resulting in frequent replacement of airline filters or scrubbers due to dirt and contaminants.
DOWNTIME	None	Re-zeroing process takes instrument offline.

MSA The Safety Company

MSA gas detectors using PAIR technology

Chemgard® Gas Monitors, Chillgard® L Series and Chillgard RT Monitors employ photoacoustic infrared technology for refrigerant and toxic leak detection.

Note: This Bulletin contains only a general description of the products shown. While uses and performance capabilities are described, under no circumstances shall the products be used by untrained or unqualified individuals and not until the product instructions including any warnings or cautions provided have been thoroughly read and understood. Only they contain the complete and detailed information concerning proper use and care of these products.

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