Molecular Property Spectrometer™ (MPS™) Flammable Gas Sensor

Technology Comparison Guide

Introduction

The MPS™ represents the first completely innovative technology for flammable gas detection in over 40 years, and was designed to overcome the shortcomings of existing technologies. This guide provides a categorical comparison of the MPS vs. existing technologies, including their sensing methods and corresponding advantages and limitations.

Pellistor (Cat Bead) Sensor

How they work: A pair of small beads—one coated with a chemical catalyst, the other with an inert material—are both heated to a high temperature (400-500°C) using heaters (e.g., coiled platinum wire) built into their cores. In the presence of a flammable gas, the catalyst-coated bead produces an exothermic reaction, causing it to heat up more than the reference bead. This temperature difference can be measured using a resistance bridge circuit, the output of which is proportional to the concentration of the flammable gas present.

Key advantages:

- Low cost
- Detect full range of combustible gases

Key limitations:

- Every gas heats the catalytic bead differently, so calibration to a single gas (e.g. methane) means the sensor will output inaccurately for all other gases. (See Figure 1.)
- As the sensor is "used up" the device needs calibrating
- Only accurate for the one gas it is calibrated to
- Common chemicals—including silicones, chlorine, and acidic gases—deactivate, or "poison," the catalyst bead. This can happen gradually, or within minutes, depending on the environment.
- Flammable gases at high concentrations can "burn up" the catalyst, deactivating the sensors.
- Prolonged exposure to combustible gases may cause a pellistor LEL sensor's zero reading to shift (or drift), resulting in inaccurate readings.
- Not fail-safe. Poisoned or burned-out sensors appear to be operating normally. Once discovered (via cumbersome bump check or re-calibration, e.g.) the sensor must be serviced and eventually replaced.

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Non-dispersive Infrared (NDIR) Sensors

How they work: This technology works by using infrared light to detect different wavelengths absorbed by gases. These sensors consist of an infrared source, a detector, an optical filter, a gas cell, and signal processing mechanisms. Infrared light is absorbed as a particular gas passes through an active filter, while infrared light that does not interact with the target gas goes through a reference filter. The sensor determines the difference between these two transmitted light intensities to develop a gas concentration.

Key advantages:

- Long life
- Resistant to contamination and poisoning
- Gases may be sensed in anaerobic conditions

Key limitations:

- Hydrogen cannot be detected (because it does not absorb infrared light).
- The open chamber can allow in humidity, fog, and ambient IR light, all of which cause interference.
- Susceptible to moderate changes (0.6 to 2.0 °C/min) in temperature/humidity (e.g. moving from freezing cold outdoors to warm, humid indoors during winter). Some products freeze their output during temperature transitions
- Transient environmental conditions can cause gas readings to be inaccurate.
- Every gas has a unique absorption profile, so calibration to a single gas (e.g. methane) means the sensor will output inaccurately for all other gases.

MPS™ Flammable Gas Sensors

How they work: A micro-electromechanical system (MEMS) transducer—comprising an inert, micrometer-scale membrane with an embedded heater and thermometer—measures changes in the thermal properties of the air and gases in its proximity. Multiple measurements, akin to a thermal "spectrum," as well as environmental data are processed to classify the type and concentration of flammable gas(es) present, including gas mixtures. We call this TrueLEL™.

Key advantages:

- No Calibration needed
- Greater than 5 year life
- Resistant to contamination and poisoning (the measurement is purely physical, not a chemical reaction)
- Fail-safe (built-in self-test: sensor diagnostics detect inoperable sensors)
- Lower power than Pellistor & most NDIR
- Built-in environmental compensation
- Detects full range of flammable gases (from hydrogen to heavy hydrocarbons)

- TrueLEL™: Accurate to over a dozen flammable gases with a single calibration to methane. See Figure 1. To achieve this with Cat Bead or NDIR sensors, the user would need to deploy sensors for every gas of interest.
- Gases are automatically classified into one of the following categories: hydrogen; hydrogen-containing mixtures; methane (or natural gas); light, medium or heavy gases/mixtures.

Comparison Matrix

	MPS	Cat Bead	NDIR
Responds to full range of flammable gases	Yes	Yes	No
Capable of up to 100% v/v gas concentrations	Yes	No	Yes
TrueLEL™	Yes	No	No
Gas classification	Yes	No	No
Environmental range	Excellent	Good	Good
Poison resistance	Excellent	No	Excellent
Calibration interval	Excellent (None)	Poor (0.25 yr)	Fair (1 yr)
Lifetime	Excellent (5+ yr)	Poor (2 yr)	Excellent (5 yr)
Power consumption	Excellent (<20 mW)	Poor (>150 mW)	Most Poor (>105 mW)
Detects Hydrogen	Yes	Yes	No
IEC 60079-29-1 compliant	Yes	Yes	Yes
Total Cost of Ownership	Low	High	Fair

Table 1: Relative performance in key categories of the three main sensor types.

Table 2 compares the %LEL accuracy one can expect when detecting eleven of the most common flammable gases using the MPS as compared to cat bead and nondispersive infrared (NDIR) sensors.

Gas	MPS	Pellistor	NDIR
Methane	+ 3%LEL		
Propane	+ 5%LEL		
n-Butane	+ 5%LEL		
n-Pentane	+ 5%LEL		
n-Hexane	- 20%LEL		
n-Heptane	+ 12%LEL		
n-Octane	+ 5%LEL		
Acetone	+ 20%LEL		
MEK	+ 5%LEL		
Toluene	+ 12%LEL		
Hydrogen	+ 5%LEL		

KEY
±0-15 %LEL error
±15-20 %LEL error
>±20 %LEL error

Table 2: The representative detection capability and accuracy for some common flammable gases, based on calibration using a single gas (methane). The %LEL error levels correspond to a delivered concentration of 50 %LEL.. For a full list, please see the MPS technical datasheet.

Conclusion

The new MPS Flammable Gas Sensor delivers accurate flammable gas measurement without the limitations inherent to catalytic bead and NDIR flammable gas sensors. MPS Flammable Gas Sensors open the opportunity to upgrade existing detectors and to introduce new applications where low-maintenance, accurate measurement of multiple gases, stability over broad environmental conditions, and low power are critical to the application.

Figure 1 below: The delivered vs. reported concentrations of selected gases, when calibrated to methane.