Nevada Nano

Molecular Property SpectrometerTM (MPSTM) 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.

Catalytic ("Cat") Bead Sensors

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 flammable gases (from hydrogen to heavy hydrocarbons)
- Built-in environmental compensation

Key limitations:

- 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.
- Not fail-safe. Poisoned or burned-out sensors appear to be operating normally. Once discovered (via bump check or re-calibration, e.g.) the sensor must be replaced.
- 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.)

Non-dispersive Infrared (NDIR) Sensors

How they work: Infrared light is passed through a small chamber exposed to the air. Flammable gas molecules absorb certain wavelengths of this light more than others. Using a pair of detectors with different filters, the intensity of light detected in the wavelength range a flammable gas absorbs is compared to the intensity from a range it does not absorb. The difference is proportional to the concentration of flammable gas present.

Key advantages:

- Long life
- Resistant to contamination and poisoning
- Fail-safe (built-in sensor diagnostics detect inoperable sensors)
- Lower power
- Built-in environmental compensation

Key limitations:

- Hydrogen and acetylene cannot be detected (because these do 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.
- 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. (See Figure 1.)

Molecular Property Spectrometer™ (MPS™) Flammable Gas Sensor

Technology Comparison Guide

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.

Key advantages:

- Long life
- Resistant to contamination and poisoning (the measurement is purely physical, not a chemical reaction)
- Fail-safe (built-in sensor diagnostics detect inoperable sensors)
- Lower power
- Built-in environmental compensation
- Detects full range of flammable gases (from hydrogen to heavy hydrocarbons)
- Accurate to 12 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 detectors 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

	Cat Bead	NDIR	MPS
Responds to full range of flammable gases	Yes	No	Yes
Measures up to 100% v/v gas concentrations	No	Yes	Yes
Real-time auto calibration to full range of gases	No	No	Yes
Gas classification	No	No	Yes
Environmental range	Excellent	Good	Excellent
Poison resistance	Poor	Excellent	Excellent
Calibration interval	Poor (0.25 yr)	Good (0.5 yr)	Excellent (1 yr)
Lifetime	Poor (2 yr)	Excellent (5 yr)	Excellent (5+ yr)
Power consumption	Poor (>150 mW)	Poor (>105 mW) Excellent (<5 mW)	Good (<20 mW)
Response time	Good/Excellent	Good/Excellent	Good/Excellent
Fail-safe, self-diagnostic capability	No	Yes	Yes
Cost	Low	Higher	Competitive

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

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

GAS	MPS™	Pellistor (Cat Bead)	NDIR
methane	±3		
propane	±5		
butane	±5		
isopropanol	±5		unknown
pentane	±5		
hexane	±8		
hydrogen	±5		NOT DETECTED
toluene	±5		unknown
xylene	±10		unknown
ethylene	±15		
ethane	±5		
propylene	±10		unknown

KEY
±0-15 %LEL error
±16-30 %LEL error
>30 %LEL error

Table 2: The representative detection capability and accuracy for 12 common flammable gases, based on calibration using a single gas (methane). The %LEL error levels correspond to a delivered concentration of 50 %LEL.

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.

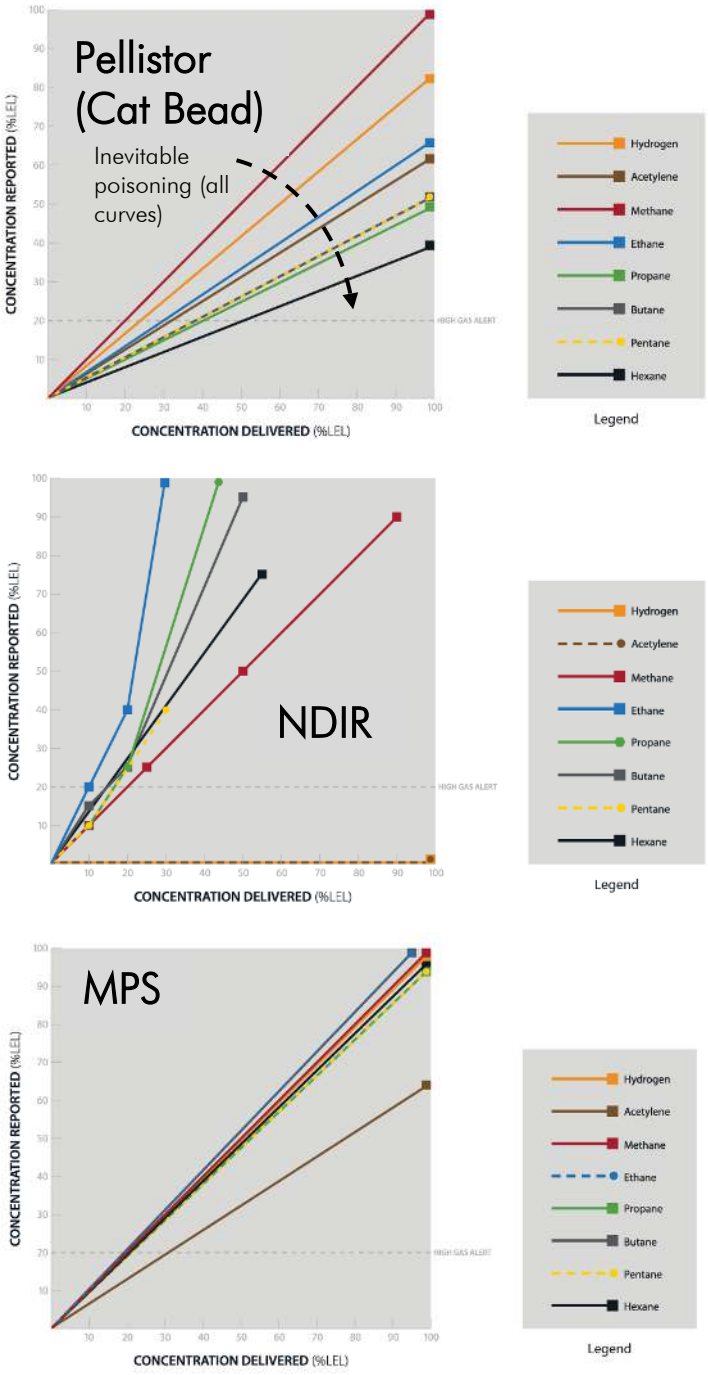

Figure 1: The delivered vs. reported concentrations of selected flammable gases for each of the three sensor types when calibrated to methane. Figures adapted from "Combustible Gas and Its Detection," from Blackline Safety.