

# Technical Memo, Measuring Flammable Gas Mixtures with the PureAire MPS™ Flammable Gas Monitor

## Overview

The PureAire MPS™ Flammable Gas Monitor, which incorporates the Molecular Property Spectrometer™ (MPS™) Flammable Gas Sensor by Nevada Nano, provides an advanced method for classifying and measuring flammable gases. This system categorizes gases into six types:

1. Hydrogen
2. Hydrogen-containing mixtures
3. Methane (or natural gas)
4. Light gas or gas mixture
5. Medium gas or gas mixture
6. Heavy gas or gas mixture

This capability is based on analyzing molecular properties, including the molecular weight of the gas or the average molecular weight of gas mixtures. The MPS sensor provides an accurate representation of the lower explosive limit (LEL) for both pure gases and gas mixtures, offering improved performance over traditional sensor technologies.

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## Internal Calculation Process

### Lower Explosive Limit (LEL) and Molecular Weight

The MPS sensor estimates the %LEL (lower explosive limit) by assessing the molecular weight of a gas or gas mixture. This is important because the LEL concentration of a gas is typically correlated with its molecular weight. For mixtures, the MPS sensor considers the average molecular weight of all gases present, yielding a more accurate %LEL than competitive sensors when presented with complex mixtures.

### Le Chatelier's Mixing rule

To calculate the composite %LEL of gas mixtures, the MPS sensor applies Le Chatelier's mixing rule. This rule considers the contribution of each gas in the mixture based on its mole fraction ( $x$ ) and respective LEL percentage. The formula is as follows:

$$\%LEL_{mix} = \frac{1}{\sum_i \frac{x_i}{\%LEL_i}}$$

Where:

- $x_i$  is the mole fraction of gas  $i$  in the mixture
- $\%LEL_i$  is the LEL concentration of gas  $i$

This rule provides the total %LEL for a mixture of flammable gases, allowing the sensor to accurately monitor environments containing multiple gas types.

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## Example Calculation

Let's walk through an example with a mixture of three flammable gases: methane, ethane, and propane.

### Case 1:

- **Methane:** 0.2 volume fraction of 50.4 %LEL methane (600 mL of 50.4 %LEL CH<sub>4</sub> gas in a 3-liter total gas volume)
- **Ethane:** 0.5 volume fraction of 47.0 %LEL ethane
- **Propane:** 0.3 volume fraction of 49.5 %LEL propane

The expected %LEL for this mixture is calculated as follows:

$$\%LEL_{mix} = \frac{1}{\left(\frac{0.2}{50.4} + \frac{0.5}{47.0} + \frac{0.3}{49.5}\right)} = 48.4\%LEL$$

Using this method, the PureAire MPS™ Flammable Gas Monitor provides a highly accurate reading. In this case, the reported %LEL by the MPS™ sensor was **51 %LEL**.

### Case 2:

- **Methane:** 0.5 volume fraction of 50.4 %LEL methane
- **Ethane:** 0.25 volume fraction of 47.0 %LEL ethane
- **Propane:** 0.25 volume fraction of 49.5 %LEL propane

Expected %LEL:

$$\%LEL_{mix} = \frac{1}{\left(\frac{0.5}{50.4} + \frac{0.25}{47.0} + \frac{0.25}{49.5}\right)} = 49.3\%LEL$$

In this scenario, the monitor reported **52 %LEL**.

### Case 3:

- **Methane:** 0.8 volume fraction of 50.4 %LEL methane
- **Ethane:** 0.2 volume fraction of 47.0 %LEL ethane

Expected %LEL:

$$\%LEL_{mix} = \frac{1}{\left(\frac{0.8}{50.4} + \frac{0.2}{47.0}\right)} = 49.7\%LEL$$

In this case, the MPS™ sensor reported **47 %LEL**.

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## Conclusion

The PureAire MPS™ Flammable Gas Monitor uses advanced molecular-property-based analysis to calculate the %LEL of both pure gases and complex mixtures. By applying Le Chatelier's Mixing rule, it can accurately assess flammable gas concentrations even in environments with multiple gases. This ensures safety and compliance in various industrial applications.