Choosing the Best Ventis™ Pro5 Combustible Sensor for Your Application

The Ventis™ Pro5 offers three combustible sensors: the catalytic bead, the methane (CH_4 IR) infrared, and the hydrocarbon (HC IR) infrared. Each of these sensors has special characteristics making it well-suited for some applications, yet potentially unsuitable for others. Choosing the right sensor and technology can be challenging at times. This application note will discuss each of the technologies available for detecting combustible gases and provide you with information and guidance on choosing the best sensor for your application.

Catalytic Bead Sensors

What are They and How Do They Work?

Catalytic bead sensors are the most widely used sensor type for the detection of combustible gases and vapors. These sensors start with wire being wound into two coils. The coils are then doped with catalysts making one coil active and the other blind to the presence of combustible gases. Next, the coils are matched, creating the sensing and reference beads of the sensor. Finally, the beads are built into a balanced, resistive circuit. A fixed voltage is applied and both beads heat up to a very high temperature. When a combustible gas comes in contact with the sensor, the active bead begins to burn the gas causing it to increase in temperature. Since the reference bead is blind to the combustible gas, its temperature does not change. The increased temperature of the active bead creates an imbalance in the circuit and this imbalance is converted into a gas reading. Because combustion is taking place within the sensor chamber, the sensor is designed and built so that it is flameproof and will not act as an ignition source if exposed to a combustible atmosphere.

The Pros and Cons of Catalytic Bead Sensors

As with all sensors, there are advantages and disadvantages to the catalytic bead sensor. Due to their widespread use and relatively straightforward design, they are the most economically priced combustible sensor, which is often a significant advantage. Another significant advantage of this sensor, beyond its proven track record of performance, is that it is actually burning the combustible gas. This means, in theory, that any gas that is combustible can be detected. However, this huge advantage can also be a drawback when it comes to power consumption and instrument runtime. Providing the voltage for this sensor to burn gases, as described above, requires more of the instrument's power than any other type of sensor. Another potential drawback that stems from the sensor burning the gas is that, since oxygen is required for combustion, the catalytic bead sensor will not detect combustible gases in a severely oxygen-deficient atmosphere. Another potential issue to be aware of when using this sensor is that some substances may inhibit or poison the sensing bead limiting its ability to detect gas. Inhibitors include halogenated compounds containing one or more of the following: astatine, fluorine, chlorine, bromine, or iodine. A catalytic bead sensor that has been exposed to an inhibitor may, over time, partially recover the sensitivity lost. Sulfur-based compounds, such as H_2S and SO_2, silicone-based compounds that are in a curing state, and lead compounds are classified as poisons. A catalytic bead sensor that has been exposed to a poison will likely never recover any lost sensitivity.

Infrared Sensors

What are They and How Do They Work?

Infrared sensors are the second most common sensor type used for the detection of combustible gases and vapors and are gaining in popularity. As gas enters the sensor, it is exposed to a beam of infrared light. This infrared light may come from either an incandescent or Light Emitting Diode (LED) source. Specific light wavelengths, which are absorbed by combustible gases, are then measured with an optical detector. The response of the optical detectors is optimized to a specific gas type, frequently either propane or methane. As the concentration of gas in the sensor increases, more light is absorbed proportionately, which increases the signal from the detector. This signal is then sent to the microprocessor where it is compared to a reference point of zero combustible gas. The combustible gas concentration is generated in terms of the characterized gas (i.e. propane or methane).

The Pros and Cons of Infrared Sensors

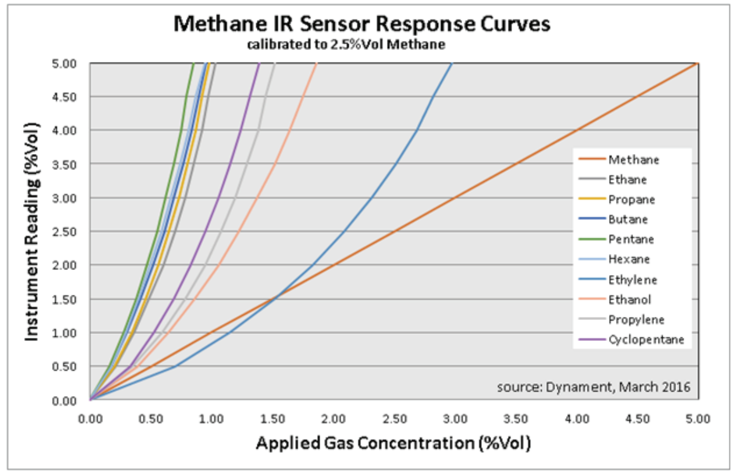
Similar to the catalytic bead sensor, there are advantages and disadvantages to the infrared combustible sensor. The IR combustible sensor has a significant advantage over the catalytic bead sensor due to its lower energy consumption. While the catalytic bead combustible sensor is the most power-hungry gas sensor, an IR combustible sensor with an incandescent lamp uses less power resulting in increased instrument runtime. An IR combustible sensor with an LED source uses even less power. When comparing runtime of three identical instruments with the same power source, one configured with a catalytic bead sensor, one with an IR sensor with incandescent lamp, and one with an IR sensor with LED lamp, the catalytic bead sensor unit may run 12 hours, the incandescent IR sensor unit may run 36 hours, and the LED IR sensor unit may run continuously up to ten days. The increased runtime between charging is a huge advantage for the IR sensors. Another advantage is that IR sensors can operate in oxygen-deficient environments making them well-suited for purging applications and for detecting combustible gases in other inert atmospheres. A third advantage for the IR sensor is that unlike the catalytic bead sensor, it does not get damaged by poisons and inhibitors. Of course there are also some disadvantages related to IR sensors. The largest disadvantage is that IR sensors are blind to some combustible gases including hydrogen, acetylene, acrylonitrile, aniline, and carbon disulfide. Another potential issue with IR sensors is that their output can be greatly affected by high humidity and changes in ambient temperature and pressure.

Differences in Infrared Sensors

Catalytic bead sensors have an inherently linear response. This means that while the instrument is calibrated to a specific gas, in the presence of other gases, the readings will be linear and have a relatively close correlation factor. Infrared sensors have a much different behavior. The Ventis Pro5 offers two distinct infrared sensors for detecting combustible gas: the methane IR sensor (CH_4 IR) and the hydrocarbon IR sensor (HC IR).

Methane IR Sensor (CH_4 IR)

The methane infrared sensor has a very non-linear response for any combustible gas other than methane. As an example, the methane IR sensor will have a linear response in the presence of methane, but in the presence of pentane it will read higher than actual on an LEL scale. Due to the non-linear response of this sensor to other gases, correlation factors cannot be easily applied as they can with a catalytic bead sensor. The overall sensitivity of the sensor to methane also makes it suitable to detect methane on a scale from 0–100% of volume. Below is a chart that illustrates the non-linear response of the methane IR sensor to other gases.



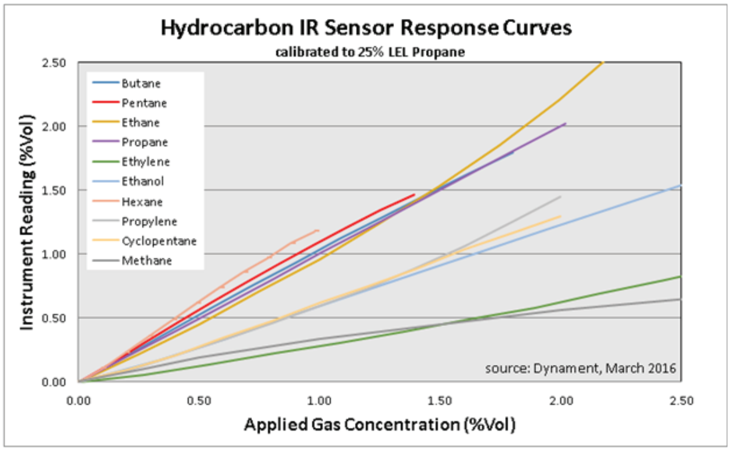
The table below shows the actual concentration of several applied combustible gases using the above chart for reference.

Applied Combustible Gas	Instrument Reading
2.1%vol (78%LEL) Ethylene	2.5%vol (50%LEL) Methane
1.2%vol (36%LEL) Ethanol	2.5%vol (50%LEL) Methane
1.1%vol (55%LEL) Propylene	2.5%vol (50%LEL) Methane
0.7%vol (23%LEL) Ethane	2.5%vol (50%LEL) Methane
0.65%vol (31%LEL) Propane	2.5%vol (50%LEL) Methane
0.6%vol (32%LEL) Butane	2.5%vol (50%LEL) Methane
0.55%vol (39%LEL) Pentane	2.5%vol (50%LEL) Methane

In most cases the actual applied gas concentration is lower than what is being reported by the instrument. However, that is not always the case as we can see for ethylene and propylene. When using the methane IR sensor to detect gases other than methane, it is important to know the actual combustible gas in the atmosphere and how the methane IR sensor responds to that particular gas.

Hydrocarbon IR Sensor (HC IR)

Unlike the methane IR sensor, the hydrocarbon IR sensor will have a more linear response to multiple gases when calibrated to propane. The chart below shows the response of the hydrocarbon infrared sensor to various gases.



Calibrating this sensor to propane allows us to calculate the actual concentration of the hydrocarbon gases being applied using the correlations factors below.

Sample Gas	Correlation Factor*
Butane	0.97
Pentane	0.89
Hexane	0.8
Ethanol	1.65
Ethylene	3.43
Propylene	1.69
Ethane	1.01
Cyclopentane	1.62
Methane	3
Chloromethane	0.966
Ethylene Oxide	0.845
Methanol	2.22
Toluene	1.18
Isopropanol	1.43
Acetone	3.28
Xylene	1.51
Ethyl Acetate	1.69
Dichloroethane	8.57

*The above correlation factors only apply to gas concentrations expressed in % volume terms and up to 2.5% vol. The correlation factors may vary from sensor to sensor with tolerance of +/- 25% deviation.

If we apply the above correlation factors to the instrument's gas reading we can convert the reading from propane to the actual gas being applied. The drawback to this sensor is the limited response to some gases like methane, ethylene, and dichloroethane. This is indicated in the chart above where the correlation factor is three or greater.

Which Sensor is Right for Me?

We've now discussed the function and pros and cons of each technology and the differences between the two specific IR sensors being offered in the Ventis Pro5: the CH_4 IR sensor and the HC IR sensor. The chart below will act as a quick guide to help you choose the best Ventis Pro5 combustible sensor for your application.

Which Combustible Sensor Technology is Better Suited for the Application: Catalytic Bead or Infrared?

Advantages: Catalytic Bead Sensor	Advantages: Infrared Sensor
• Will encounter many combustible gases including acetylene and hydrogen	• Long instrument runtime is major concern
• Sensor will be exposed to high humidity environments and large changes in temperature and pressure	• Instrument will be used for detection in oxygen-deficient atmospheres
	• Environment exposes sensor to numerous catalytic bead poisons and inhibitors

Which Infrared Sensor is Better Suited for the Application: CH_4 IR or HC IR?

Advantages: CH_4 IR sensor	Advantages: HC IR Sensor
• Will only be detecting natural gas or methane reading only in % vol CH_4 is acceptable	• Will be detecting a wide range of combustible gases and accepts its low response to methane, ethylene, and dichloroethane
• Will be primarily detecting methane or natural gas but may encounter other known combustible gases in the atmosphere	• Can identify the gases being detected and is comfortable applying correlation factors if necessary
	• Requires readout in % LEL rather than % vol

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