Application Note

Comparison of optical detection systems for Infrared (IR) Hydrocarbon gas detection



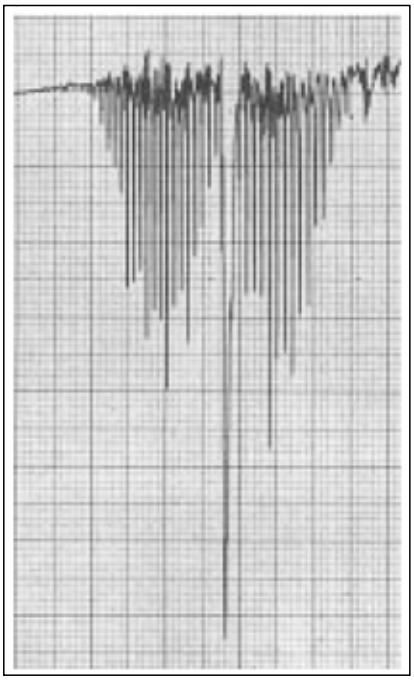

Figure 1 - IR Spectrum of Gas phase Methane

Most molecules absorb light in the Infrared (IR) region of the electromagnetic spectrum.

This light is absorbed by chemical bonds between atoms and the light energy absorbed is characteristic of the molecule itself. Similar molecules absorb light of similar wavelengths and most Hydrocarbon gases absorb infrared light at approximately 3.4 microns. Please see Figure 1.

In practice, IR gas detectors compare the amount of light at a certain wavelength where Hydrocarbon molecules absorb light (known as the sample) with an area of the electromagnetic spectrum where no such absorption occurs (known as the reference). The measurement made is a ratiometric change in intensity at the two wavelengths of light.

To make these measurements a source of IR light, a light sensitive detector and a method of excluding light of wavelengths other than sample and reference is required. In order to minimise the effects of cross-interference, the sample and reference wavelengths are tuned to the specific gas species, i.e. Propane.

The strength of absorption must also be considered because a weak absorption requires a long path length through the gas. This means that a point detector with a path length of a few centimetres and a sample wavelength of 3.4 microns might be used with a reference wavelength of 3 microns. This gives a good absorption at the sample wavelength and avoids absorption at the reference by water vapour and Carbon Dioxide (CO_2). However, the device design needs to be robust because liquid water is almost opaque in this region of the IR spectrum and must be excluded from the path of the light.

Sources of instability

With a Point IR gas detector, one objective is to produce a device that does not require calibration and is resistant to drift in span and zero. This gives the maximum confidence in the operational performance of the detector and reduces the cost of ownership.

Maximised uptime and performance is a key benefit of IR gas detection over catalytic bead based detectors, which require regular calibration due to loss of sensitivity through their operational life.

The IR principle relies on the physical properties of the molecules to be detected and is a highly stable detection solution for Hydrocarbons. However, in practice there are electronic and mechanical drift issues that can compromise the stability offered by some IR gas detectors. This stability is achieved by the configuration of the optical system itself.

The source of light, normally an incandescent lamp, may drift in two ways. Firstly, the absolute intensity of the light may increase, decrease or even fluctuate. This must be distinguished from signal changes due to absorption by gas. Secondly, the emission spectrum of the source may change with time. This is known as a change in the “colour temperature” of the source.
A change in colour temperature results in a relative change in intensity of the sample and reference wavelengths.

Optical configurations

There are a number of possible optical configurations that can be used:

- Single source single detector
- Dual source single detector
- Dual detector single source
- Dual source dual detector

Configurations can also feature the light filters at the source or at the detectors.

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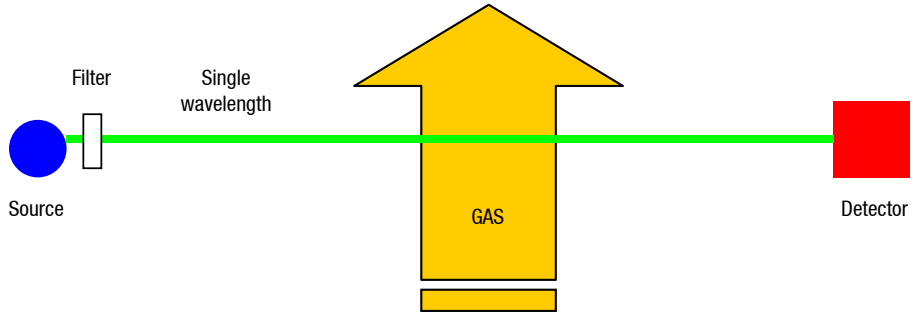
Single source, single detector

Only the sample wavelength is selected and measured at the detector. If the intensity of the source changes through source ageing, this can be interpreted as a positive or negative gas reading depending on the direction of change.

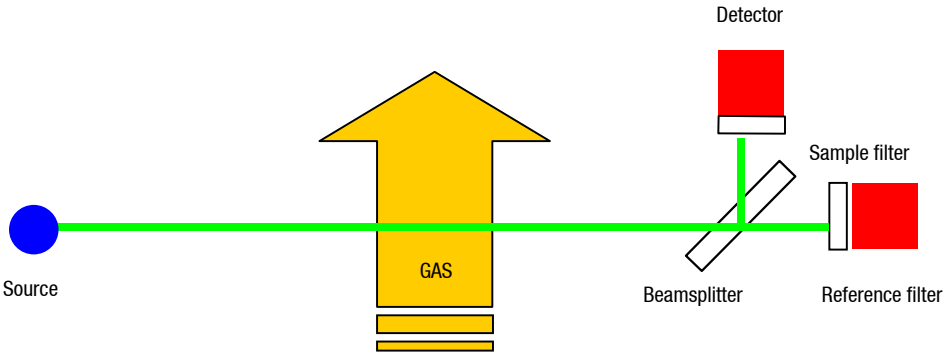
Changes in detector sensitivity will also result in an upscale or downscale drift. In addition, there is no discrimination between drift in sensitivity and blockage of the light path. This means that dirt or moisture on an optical surface can be mistaken for gas.

This type of system is only suitable for applications where calibration and operational checks are carried out on a daily basis, e.g. a portable gas detector.



Two filtered detectors, single source

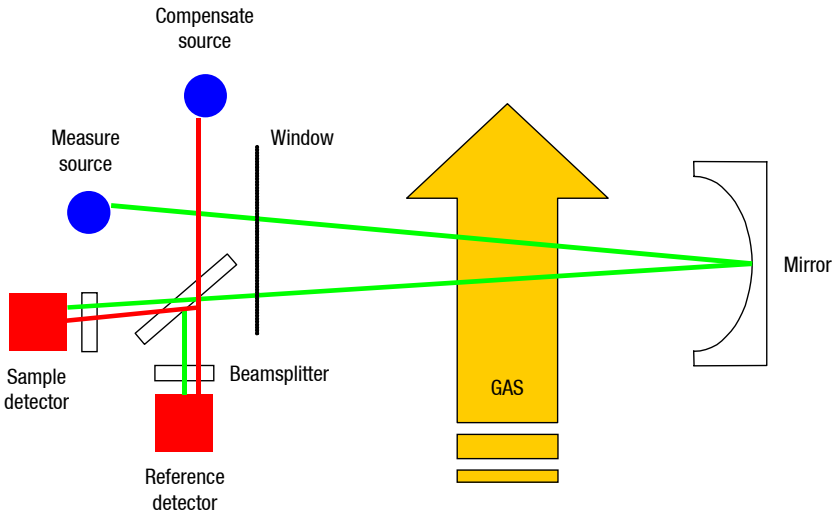
This type of system features two detectors that are filtered for sample and reference wavelengths of light. The source is susceptible to colour changes, which can be mistaken for zero drift or gas but the use of two detectors discriminates between overall changes in source intensity. There is the potential for spurious alarms with this system type because any detector drift can be interpreted as a ratio change.



Two filtered detectors, two sources

One source provides an external path and falls on both detectors, whilst the second source forms a path within the instrument and falls on both detectors. The two sources are modulated at different frequencies and the signals on the detectors are demodulated to determine which source contributes the signal measured on the detector. This type of system takes into account atmospheric effects as there is a comparison between internal and external paths. The external path gives a raw ratio change between the sample and reference wavelengths and this is compared with the internal path to ensure that the detector has not changed in sensitivity.

There is an attempt at compensating for source drift, but this relies on the two sources drifting or changing colour at the same rate. In practice, this often doesn't happen so the source drift compensation is inadequate for all conditions of change. The two detectors experience light from both sources and so compensation for detector changes in sensitivity can be adequately made.



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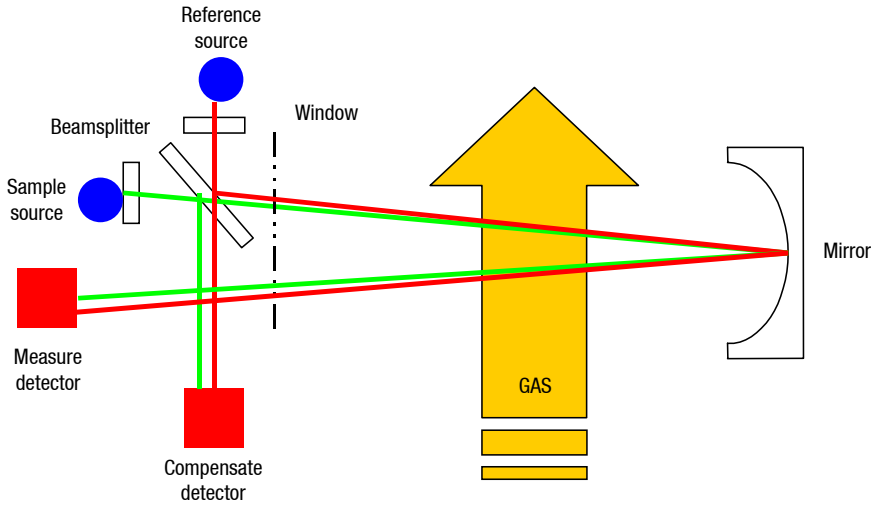
Two detectors, two filtered sources

Here both sources have an external and internal path where light at both the reference and sample wavelengths falls on both detectors. The two sources are modulated at different frequencies and the signals on the detectors are demodulated to determine which source contributes the signal measured on the detector. As only one source provides one wavelegth, a change in colour is seen as a change in intensity. This change in intensity is detected by both the internal and external path and can be eliminated through comparing ratio change on the internal path (that is never exposed to gas) and the external path (where there is the possibility of seeing gas). Changing source intensity is detected in the same manner.

A change in detector sensitivity is also compensated for; the detector experiences light at both wavelengths, and an equal proportional drop in both indicates a zero ratio change, i.e. no “gas” effects. This double compensation scheme effectively manages changes in source and detector performance caused by lifetime changes.



Dual filtered source dual detector	Double compensation. Compensates fully for first order effects
Dual source dual filtered detectors	Does not compensate for source drift. Compensates for detector drift
Single source dual filtered detector	Source drift not compensated for. Does not compensate for changes in source colour temperature
Single source single filtered detector	Not compensated, susceptible to drift, faults and alarms

Fixed gas detection

Searchpoint Optima Plus with optional HART®

Searchpoint Optima Plus is a highly stable Point IR solution certified for use in potentially explosive atmospheres. The unit’s IR detection principle offers the fastest speed of response and fail-to-safe operation, ensuring maximum uptime and stability. The development of advanced internal fault diagnostics and false alarm rejection algorithms ensures that Searchpoint Optima Plus delivers the highest level of operational integrity.

The device uses dual filtered source dual detector optics-block and is able to compensate for long-term component drift such as infrared sources and detectors. This provides Searchpoint Optima Plus with the most stable optics design possible.

Searchline Excel

Searchline Excel is a high performance Open Path IR solution designed to offer maximised uptime and immunity to sunlight, rain, fog, snow and sea spray. This is achieved by using a Xenon flash lamp that is actually brighter than the Sun at the IR detection wavelengths and solid state detectors with a wide dynamic range. The lamp is also modulated to have a unique pulse duration and shape. The receiver then uses high speed digital signal processing to validate that all the signals received have this unique signature and rejects any extraneous signals. This makes Searchline Excel the leading edge solution for Open Path IR gas detection technology.

Portable gas detection

Impact IR

The Impact range of multi-gas monitors includes the Impact IR model variant featuring a miniature IR sensor with a small footprint and relatively low battery consumption. The device provides excellent performance for the detection of Methane (linear) and other Hydrocarbons at %LEL and %Vol applications. Impact IR can also be tuned to measure Carbon Dioxide (CO_2). Benefits of Impact’s IR sensor include long-term stability and longer sensor lifetimes for CO_2 applications.

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GasAlert Extreme

Compact and affordable, GasAlert Extreme reliably monitors for any single toxic gas hazard. With easy on/off operation, this single gas detector offers extended longevity with a two year field-replaceable battery and sensor.

GasAlertMicroClip XT

The slim and compact GasAlertMicroClip XT provides affordable protection from atmospheric hazards. With simple one-button operation, this device offers ultimate ease of use and significantly reduces time spent training the user.

GasAlertQuattro

Rugged and reliable, the GasAlertQuattro four-gas detector combines a comprehensive range of features with simple one-button operation. The graphic LCD displays easy to identify icons that indicate operational information, such as bump test and calibration status for simplified onsite auditing.

Honeywell Gas Detection

Honeywell is able to provide gas detection solutions to meet the requirements of all applications and industries. Contact Honeywell Analytics or BW Technologies by Honeywell in the following ways.

Fixed Gas Detection

Honeywell Analytics
Experts in Gas Detection

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Portable Gas Detection

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