White Paper

Unlocking the value proposition of calibration-free “Bench” Infra-Red Hydrocarbon Gas Detectors

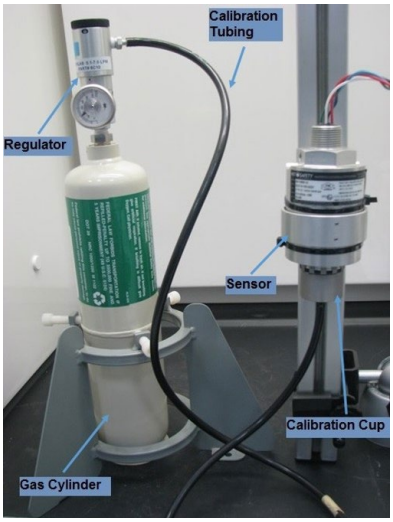
EMERSON

Industry seeking cost-savings and better performance

Plant operators, consultants, and contractors face increasing challenges to balance safety and cost-savings. Offshore Oil & Gas production facilities, and FPSOs continue to seek innovations that enable cost reductions on **remote operations.** LNG facilities and refineries have large areas that need many hydrocarbon point gas detectors as part of its LOPA (Layers of Protection Analysis) implementation. Having more than 500 hydrocarbon point gas detectors in FPSOs is a common installation practice.

Direct costs and opportunity costs

The traditional way of calibrating and function testing a hydrocarbon gas detector is for a service person to bring a methane gas cylinder into a hazardous area to perform an on-site maintenance service. While safety paperwork such as RAMS and permit-to-work is always completed, there is always an **unknown safety risk** element with such practices especially around bringing personnel on site that may be unfamiliar with the process and risks.



On-site function testing or calibration takes considerable time - even for just one detector, and 100 detectors can take up to 100 manhours. If one manhour costs $200, this scope of work can easily cost **$20,000 in manhours only**. Cost of buying gas cylinders, storage, disposal, transportation and other costs can easily further increase costs by $5,000 or more each year for a small site.

Background of calibration and errors in the field

The need for field calibration is driven by sensor drift problems. Most sensors drift over time and cause hydrocarbon gas detectors to lose accuracy. This is proven by function testing which is generally followed by a zero and span calibration. However, calibration is a delicate art, and calibration outside a controlled laboratory environment can introduce significant inaccuracies.

- When a user calibrates a gas detector, the following uncertainties are introduced:
- Atmospheric pressure can vary by 10% which directly influences the detector reading as the typical ranges are - low 962mb (-5%), normal 1013mb, high 1063mb (+5%).
- Altitude. Ambient pressure varies by about 1.1% for every 100-meter change in altitude
- Gas cylinder accuracy. A gas cylinder typically only has an accuracy of 2% (sometimes only 5% or 10%) and has a short shelf life.
- Flow rate - The technician must ensure the regulator is set to the correct flow rate - too fast or too slow means over or under pressurizing the detector which affects the reading, and the sample tube must be as short as possible and be in good condition with no kinks or splits and fitted correctly to the calibration adaptor.

The sum of these **uncertainties is more than 12%**, and hence, a gas detector calibrated in the field is unlikely to have an accuracy of better than 12% compared to the factory calibration.

Bench Infra-Red technology

There are essentially two types of point gas detectors – one that has a sensor housing that allows gas to be diffused inside for detection, and the other one, a “Bench IR” is like a mini open-path gas detector in which the gas just passes through an open sensing area.

A ‘Bench IR’ can be characterized as having very good accuracy and repeatability specifications, quick response time, recovers quickly from getting wet, easy to clean optical surfaces and has long maintenance and calibration intervals.

Typically, these are short-path detectors, with NDIR beams traversing a distance between 1 to 40 centimeters, and this technology captures target gases moving through this space. These detectors are primarily built as single-piece assemblies with the sources and receivers located in the same compartment.

These Bench IR gas detectors are used to provide solutions fitting a variety of special applications where conventional point gas detector source designs are not rigorous enough for arduous applications such as offshore industries where the environmental conditions are very challenging.

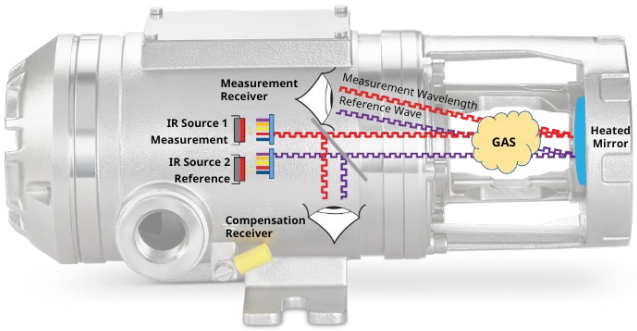
The transmitter body contains both the source and detector, with a reflecting surface at the end of the duct to send the beam back. Since the beam is passing through the gas twice, this effectively doubles the amount of IR absorption, boosting sensitivity.

When used this way, it is possible to create detectors using special capabilities such as Fourier Transform calculations (FTIR), dispersive optical elements, and other features to provide built-in specialized functionality such as:

- Very high sensitivity.
- Very fast response.
- Tunability for specific gas sensitivity and identification.
- High false-alarm suppression.

While point source and open path designs continue to be the primary solution for environmental hydrocarbon gas monitoring for safety purposes, bench designs can further be assigned to specific tasks where their special configurations are particularly useful. For example:

- Gas turbines—fuel leaks in enclosures.
- Gas compressors and pumps—leaks around valves and gasketed connections.
- Valve clusters in tank farms—leaking valve stems and fittings.
- Ductwork—fuel drawn into airstreams.
- Within extractive gas detection solutions



Performance Leaps by the Rosemount 625IR eliminates safety issues and maintenance costs

The Rosemount 625IR Fixed Gas Detector is designed with the capability to **continuously monitor for drift and self-compensate in the field.** The following features ensure no calibration is needed for its lifetime.

The 625IR is designed with **Solid state IR sources** instead of filament bulbs. Solid state IR sources are much more repeatable than filament bulbs that are traditionally used for creating IR, and because of better repeatability, they naturally drift less. These solid state IR sources can also be turned on and off much faster than filament bulbs, which means a greater measurement resolution.

Two independent IR sources which are independently controllable are used to create a 'measurement' and 'reference' beams of IR. Many manufacturers use a single filament bulb, then put the light through a splitter, and then through IR filters. This design used by most manufacturers means the product cannot 'cannot adjust' the IR concentration for just the measurement or reference wavelengths.

Two independent receivers are used: One receiver just for verification to verify that the IR energy levels from the measurement and reference sources are correct. The second receiver is used primarily to detect gas concentration and for any obscurations on the lenses. This second receiver is also used for verification of the IR energy levels from the sources.

Because there are two fully independent sources and two fully independent receivers, this means the product can check all IR levels against each other and make small internal adjustments if any levels are different than expected. Thus, there is no observable drift:

- IR source 1 energy level is compared in compensation receiver and measurement receiver
- IR source 2 energy level is compared in compensation receiver and measurement receiver
- IR source 1 energy level and IR source 2 energy level are checked against each other in compensation receiver
- IR source 1 energy level and IR source 2 energy level are checked against each other in measurement receiver

There is also an auto zero feature. This is only active when gas is not detected, and only minor adjustments are made within the stated accuracy of +/-2% LEL versus factory calibration. **This auto zero feature runs continuously.**

Heaters on its optical surfaces dissipate moisture, while multiple optical-protection accessories provide continuous detection without causing unplanned downtime.

These bedrock elements of architecture build a fast, safe, reliable modern optical gas detector that does not need field calibration.

Key Considerations When Choosing a High-Performance NDIR Hydrocarbon Gas Detector

Since gas detectors are often exposed to external weather elements, how a gas detector would perform in tough weather conditions must be a key consideration. For example, offshore and high humidity applications are challenging for any NDIR gas detector. Water absorbs IR energy, and a conventional NDIR gas sensor may not perform if there are traces of water inside the sensor housing.

Such applications would require a Bench IR design with heated optics to remove traces of water droplets on the optics.

Unlike a process gas analyzer, the accuracy specification may not be as critical for a point gas detector. As mentioned above, every field calibration injects inaccuracies into a gas detector. Hence, a gas detector with a high level of accuracy is unlikely to retain factory accuracy standards after a field calibration. As such, a Bench IR gas detector that does not require field calibration because it has in-built drift compensation capabilities to tackle drift issues, will perform with consistent accuracy in the field.

Another element that causes sensor drift are components that age fast. Old electronics designs with lower tolerance components and low-grade filament lamps contribute significantly to sensor drift issues, and often these issues are only found after these detectors are installed in the field.

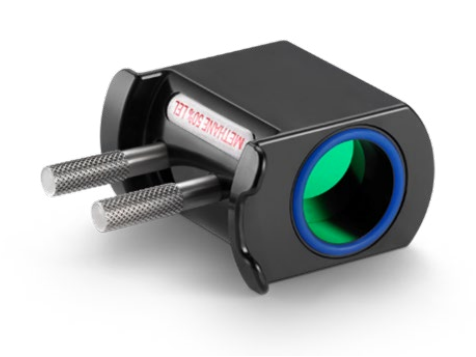
Function or Bump Testing of Gas Detectors

Very often, safety procedures require operators to perform function testing (sometimes called bump testing) of gas detectors periodically, typically once or twice per year. 625IR has a SIL2 certified proof test interval of 5 years and advanced health diagnostics which means pre-planned maintenance activities can be extended much further than previously possible. This can help save significant operational maintenance budget.. While function testing is less cumbersome than performing full field calibrations, such activities introduce safety risks into a site. Contractors or service engineers frequently carry methane gas cylinders into hazardous sites to perform these function tests on gas detectors similar to procedures used in field calibrations.

Function testing is therefore a very costly activity with a lot of money and time spent on manpower and equipment.

Fortunately, the practice of using optical filters for function testing gas detectors has been used for open-path gas detectors for many years and is an industry accepted procedure. Since a Bench IR detector is essentially a mini open-path gas detector, the philosophy of using optical filters to function test a Bench IR detector should provide the same value proposition to an operator.

Figure 1. Installing calibration-free hydrocarbon gas detectors with gas-free bump testers in demanding applications such as FPSOs provides tremendous value proposition and cost-savings.



With a gas-free tester, the operator can fully eliminate the safety risk of bringing gas cylinders into hazardous sites for function testing, and at the same time save on many hours of maintenance manpower.

The Rosemount 625IR gas-free tester is specially designed to **replace gas cylinders** for function testing. With a simple toolless insertion into the IR beam path, it immediately simulates an approximate 50% LEL methane concentration. In a couple of seconds, the bump test procedure is completed without hassle.

Summary

With the launch of Rosemount 625IR, operators now have a much improved technology of gas detection that follows the same fundamentals of other gas and flame detection technologies such as ultrasonic gas leak detection, open path gas leak detection and flame detection – no field calibration and only period function testing as required by individual plant safety procedures.

End users and contractors now have tremendous opportunities to make significant savings in their installation and maintenance budgets by using calibration-free hydrocarbon gas detectors such as the Rosemount 625IR, and also reap the benefits of utilizing gas-free function testers.

For additional information, visit:
Emerson/625IRInfraredGasDetector
Emerson/QuickerSimplerGasDetection

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