

Cost Optimisation by the Appearance of High-Class IR Gas Sensors on Platform Basis

For the efficient monitoring and optimisation of processes, the appearance of reliable sensors is essential. The application area is not only contracted on the production, but besides it comprises the domains of stocking, shipment, controls, as well as the security.

Besides established magnitudes like temperature or pressure, the detection of gases became more important in recent years, because meanwhile, they are deployed in many processes.

Infra red gas sensors are ideally suited for these functions, and by the intelligent appearance costs can be reduced, and their range of application is considered more precisely in the following article.

There are lots of different gas sensors on the market, which makes it harder to choose the most suitable technology for the application.

As the question of cost affects the direction in the consumer area and in general commercial applications, the reliability and the maintenance costs are of higher significance in the industrial area.

Because IR gas sensors have been more expensive, as for example pellistors or semiconductor gas sensors in the past, this technology was only subjected to very ambitious equipment, for example in petrochemical constructions or in analysis technology,

As a result, the manufacturers of gas sensors modulated their product spectrum nearly complete on a specific area, and a technology transfer from up to down, as is customary in the automobile industry didn't happen.

The smartGAS Mikrosensorik GmbH from Heilbronn ambulates a whole different way.

The aspiration of the company is the wide adoption of IR technology, in price sensitive areas, too, without cutting back the quality and reliability.

IR Technology - The Principle

At the construction of IR gas sensors, you utilize the character of a multiplicity of gases, to absorb radiation in the infrared area between 0.7 µm and 12 µm.

As any IR active gas has its own characteristic ("fingerprint"), it absorbs only the radiation of a single, specific wavelength, so you are able to differentiate the gases accurately, based on this characteristic.

Due to the fact, that the infrared radiant sources normally emit a mix of several wavelengths, the acclamation on the gas to be measured will be achieved with a so called interference filter.

To put it simply, it only lets the area of IR radiation pass, which is relevant for the measured gas. All of the other wavelengths are shielded in this way.

The achievement is, that the gas sensor works selectively and only reacts on the substance for which measurement he was built for.

Other gases like steam or other effects can therefore be blinded out.

The exact construction of an IR gas sensor is described in fig. 1.

This is the basic assembly of an IR gas sensor as offered by the smartGAS Mikrosensorik GmbH. The radiant source emits infrared radiation, which runs through the optical path (cuvette) and is focused back on the detector by mirror optics.

The interference filter is integrated in the detector for the adjustment on the gas.

Now if the gas enters the cuvette, the molecules cause an attenuation of the primal radiant intensity I at the detector.

This change ΔI can be calculated after the Lambert-Beersche-law:

$$\Delta I = I_0(1 - e^{-\alpha c L})$$

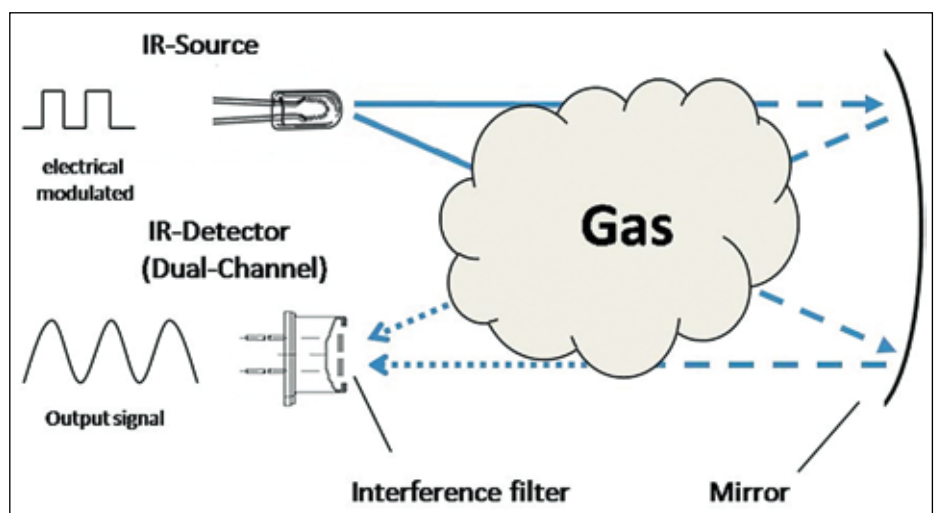
I_0 = radiant intensity without gas

α = absorption coefficient (specific for the respective gas)

L = length of the absorption distance

c = gas concentration

Therefore it allows a high precision declaration about the concentration.



▲ Fig. 1: Construction of an IR gas sensor

List of detectable Gases*



- SM - smartMODUL^{BASIC}**
- IR-technology
 - Dual beam principle
 - High selectivity
 - Long time stable (10 years)
 - Bus capable via Modbus ASCII



- SMC - smartMODUL^{CONNECT}**
- Based on smartMODUL^{BASIC}
 - 4-20mA / 0 – 20mA
 - 0 – 1V / 0 – 2,5V
 - RS 485 via Modbus ASCII
 - USB for programming and testing



- SMF - smartMODUL^{FLOW}**
- Based on smartMODUL^{BASIC}
 - Robust enclosure
 - Hose connections
 - Bus capable via Modbus ASCII



- SMP - smartMODUL^{PREMIUM}**
- Based on smartMODUL^{CONNECT}
 - Robust enclosure
 - Hose connections
 - 4-20mA / 0 – 20mA
 - 0 – 1V / 0 – 2,5V
 - RS 485 via Modbus ASCII

Pictures are only examples. Other enclosures and dimensions possible.

Gas	Model	Measurement range
Acetylene C ₂ H ₂	SM-AYL	0-2,3 Vol.-% (0-100% LEL)
Ammonia NH ₃	SM-NHL SM-NHT	0-15,4Vol.-%(0-100% LEL) 0-1000 ppm
Butene C ₄ H ₁₀	SM-BUL	0-1,4 Vol.-% (0-100% LEL)
Carbon dioxide CO ₂	SM-CDT SM-CDM SM-CDH SM-CDX	0-5000 ppm (0-100% TLV) 0-2 Vol.-% 0-20 Vol.-% 0-100Vol.-%
Carbon monoxide CO	SM-COM SM-COH	0-20000ppm 0-10 Vol.-%
Ethane C ₂ H ₆	SM-EAL	0-2,4 Vol.-% (0-100% LEL)
Ethylene C ₂ H ₄	SM-EYL	0-2,4 Vol.-% (0-100% LEL)
Methane CH ₄	SM-MAL SM-MAX	0-4,4 Vol.-% (0-100% LEL) 0-100Vol.-%
Propane C ₃ H ₈	SM-PAL	0-1,7 Vol.-% (0-100% LEL)
Sulfur hexafluoride SF ₆	SM-SF6	0-1000 ppm (0-100% TLV)
Tetrafluoroethane R134a	SM-F134a	0-1000 ppm

* Other gases and measurement ranges on request

▲ Table: Embodiments, gases and measurement ranges of the smartMODUL

Evaluated by a μ -controller, the sensor is now able to communicate with a host system and processes can be navigated selectively.

Cost Driver Diversity of Species

Considered on the time line in the past years specific measurement processes have been established in a multiplicity of uses.

In particular the low-priced pellistors and semiconductor gas sensors are used in monitoring of flammable gases as in the classical safety engineering. One of the reasons therefore is that the IR technology by comparison, has been too expensive.

Therefore it was especially used for gases that can not be measured by the above-mentioned operations or in uses where reliability and low

maintenance were appreciated. Still, to this day it is not exceptional that manufacturers of gas warning devices and gas monitoring devices apply several measurement processes within an equipment line.

The pellistors and semiconductors are often used for price sensitive duties or for flammable gases and additional for IR sensors for special appliances like the detection of carbon dioxide or gases in higher concentrations.

This diversity of species leads to hidden costs that are only apparent at second appearance and that are underappreciated frequently. The sensor manufacturers normally focus on a single measurement principle which they specialize on.

On the customers side (construction manufacturers) there is a logistic complexity needed, to assure the acquisition of the components of several

distributors. That includes costs for establishing the technological requirements, for incorporating three different forms of sensors in one equipment line.

In many cases, different devices and interfaces and software are made parallel, which excludes synergy effects by quantities.

The development effort is much bigger and the ministration of the products and the backup of the quality cost a lot of money.

In the end, the activation, the training of the employees and customers, the fitting accommodation and the maintenance work have to be adjusted.

Vantages of the Platform Strategy

A solution, to correct the above described disadvantages and to reduce the

consequential costs would be an agreement on one single technology, in ideal case only from one manufacturer.

To realise this, the smartGAS Mikrosensorik GmbH has been working on amplifying the product spectrum and to become one of the first full-range suppliers of IR technology for customers from most different areas, for a long time.

The smartMODUL arose from a consistent technologic platform, which is meanwhile produced in four embodiments and for 17 different gases and measurement ranges (table).

For simplification of the integration in customer equipment, the interfaces were adapted to current standards, which is an advantage that reduces time and costs for development. So the smartMODUL offers not only a RS485 interface with MODBUS Protocol in the versions SMC and SMP, but optionally the signal transfer per analog output, too.

It can be chosen between 0-20 mA, 4-20 mA as well as 0-1 V and 0-2.5 V. The input voltage range can be chosen between 12 V and 30 V and is low-loss stabilised by high-quality switch regulator.

In the versions SMF and SMP, gases can be obtained out of a process by hose connection and can be applied to the smartMODUL for analysis.

This is a huge advantage at measuring toxic or explosive gases.

For easy applications, the smartMODUL offers in the basic version the possibility to communicate per 2-wire interface with a μ -controller on a direct way per MODBUS Protocol.

Alternatively there can be 2 constant adjusted signal thresholds via open-collector-outputs be occupied, if for example a signalling is only divided in pre alarm and main alarm.

In contrast to the philosophy of other manufacturers, the smartGAS Mikrosensorik GmbH positions itself not just as another supplier of standard sensors.

If required, the customer is offered

additionally to the above described possibilities, the customising of the sensors for their application.

Already at small quantities, the adaptations can be taken concerning the measurement ranges, the accuracy or temperature ranges.

For the first time, special solutions are lucrative that indeed do not accept high quantities but require highly specialised sensors.

One of the plenty advantages thereby is, that the adaptations normally refer to the interfaces or measurement ranges and not to the dimensions of the sensor.

In this way, the customer almost does not have any additional expenses in terms of development or production which means saving of expenses and time.

This also brings high advantages in competition by improved flexibility and higher measuring accuracy.

Application Examples

■ Intelligent ventilation engineering

The demand-actuated control of venti-

lation appliances in the private, public and commercial sector is an area of application with great growth potential.

Because every human being exhale carbon dioxide by normal breathing, the indoor CO₂ concentration rises to values above the natural CO₂ concentration.

This is noticed at about 1,000 ppm by tiredness, decreasing concentrativeness and headaches. The intelligent control of ventilation systems by the assignment of CO₂ as a reference parameter would therefore contribute to the improvement of the atmospheric environment and would additionally save a large part of the costs that accrue out of false ventilation and the involved power loss.

■ Safety engineering

In all areas in which is operated with gases, there is always the risk of escaping gas.

Especially the commerce with flammable gases contains a high risk potential because a highly flammable mixture can evolve easily.

If this happens, only one spark will do and it comes to an inflammation of the gas-air mixture.

Gas detectors are of high importance in these applications because perhaps they have to protect human lives.

IR gas sensors are optimally suited for this very sensitive area, because against any other operation, they work extremely long time stable and without abrasion.

There is also the fact that they work reliably as inherent to their functional principle, at high concentrations and get along without hot surfaces and components, which excludes an involuntary firing.

■ Refrigeration and air conditioning

In many areas like the food industry, cooling devices are used. This occurs in the fabrication as well as in storage and in shipment of food, like fruit or vegetables.

The as refrigerants used substances (R22, R134a, R404a...) are often flammable and almost always extremely harmful for the environment.

Therefore, the monitoring in case of a leakage is more and more appreciated.

By the appearance of robust IR sensors, accidents can be eliminated and costs caused by escaping refrigerants can be reduced.

In times of emission certificate trading for the protection of the environment, this can be an essential competitive advantage.

By the appearance of low maintenance IR sensors, downtimes of constructions can be reduced and the manufacturing can be optimised.

■ High voltage engineering

In many substations, so called cleanup gases were applied to reduce the waste-supporting arc load at activating and deactivating of large encumbrances.

A prime example is the gas sulfur hexafluoride, shortly called SF₆ that is still deployed in many constructions. This gas, which was also used for the isolation of windows, or as filling gas for tyres, is by comparison about 23.900 times as dangerous as CO₂. For this reason, a monitoring of constructions in whom it is used, is extremely important to afford an early detection of a leakage and therefore not only to protect the construction itself but also to protect the environment.

■ Analysis equipment

At the analysis of gases, the detection of their components and concentration, the reliability and accuracy are the most important criterion.

IR sensors are used in these areas, for example for measuring flue gas or in biogas analysis and provide important information.

Only by this information, the accurate control of motors is possible. In constructions in which the composition of the gases is subject to variations, processes can be improved and

adapted. This increases the efficiency factor and in this way lowers costs.

Conclusion

By the use of infrared gas sensors and the substitution of other proceedings, in many areas, costs are reduced and at the same time, the products and their availability are improved.

Less effort at the manufacturers' side by committing on one technology, better performance of the appliances, more security and at the same time less maintenance costs. These are obvious advantages. Just in times of globalisation, the optimisation of only one of these points is not enough to come to stag in the market effectively.

To push forward into new corners of the market with competitive products and to assure durable parts there, new strategies and a change of thinking in all events is essential. Thereby, the custom made adaptation of the components right up to the development of brand-new concepts that are especially fitted for the respective market plays a big role.

With the development of the smartMODUL and the consequential broadening of the possible applications, the smartGAS Mikrosensorik GmbH helps its customers to master this challenge for the long term.

By continuous cooperation, qualified support and information exchange, new switches are placed today to offer the solutions for tomorrow.

Meet us at the ELECTRONICA in Munich, Hall A2, Stand 334.

▶ INFO

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