Dräger

At the heart of gas detection systems

DRÄGERSENSOR®

Dräger. Technology for Life®

When there's danger in the air ...

ST-6053-2004

... this can quickly pose a high risk to humans, the environment, and all types of property and systems. Recognize the threat before it is too late.

Detecting hazards – quite simple in principle

WHY IT IS WORTH KNOWING MORE ABOUT GAS DETECTION SENSORS

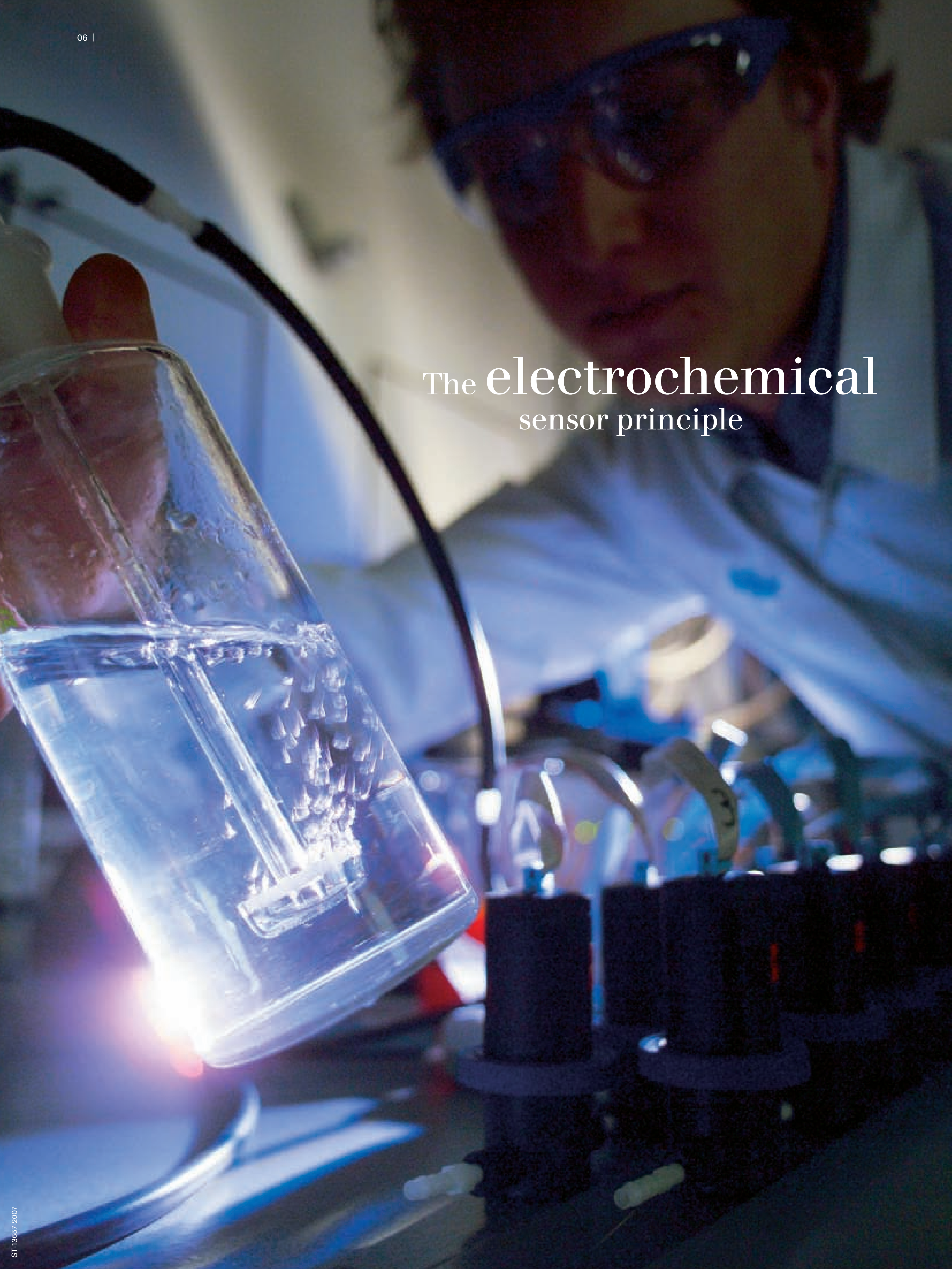
Our sensory organs are often unable to detect airborne hazards, or cannot do so early enough. Toxic or flammable gases and vapors can build up, reaching hazardous concentrations, or there may be insufficient oxygen in the air. Both of these scenarios can have life-threatening consequences.

The reliability with which harmful airborne substances can be detected depends to a large extent on the sensors that are used. It is essential for the gas detector and sensor to be adapted perfectly to each other. Hazards must be identified in good time and dependably, and false alarms leading to production downtime and the like must be avoided. You entrust the safety and protection of your personnel, equipment and property to a perfectly working sensor.

MEASURING GASES IN ELECTRICAL UNITS

The sensor is the most important component inside a gas detector. It converts the measured variable, e.g. a gas concentration, into an electrical signal. Depending on the sensor type, this is achieved by either chemical or physical processes. To obtain a meaningful and informative measured value readout, many factors have to be taken into account. Response times must be short, susceptibility to error low, and reliability high. The better the sensor, gas detector and central unit are designed to work together in accordance, the more reliable the measurement results will be. In industrial gas detection applications, three sensor technologies in particular are used on account of their excellent properties: electrochemical, catalytic and infrared measurement.

In former times, miners took canaries with them into the mine shaft. They made hazardous changes in the air underground easily visible: while the bird sat on its perch, everything was fine, but if it was lying on the floor, there was the threat of danger. The birds tended to come to a sticky end, and the miners were only able to escape the same fate if they were able to get to safety in time. This very simple method of hazard detection was unable to identify which airborne substances posed the threat, nor their concentrations. Most importantly, however, the warning often came too late for effictive protective steps such as escape, ventilation or oxygen supply to be taken.



The electrochemical sensor principle

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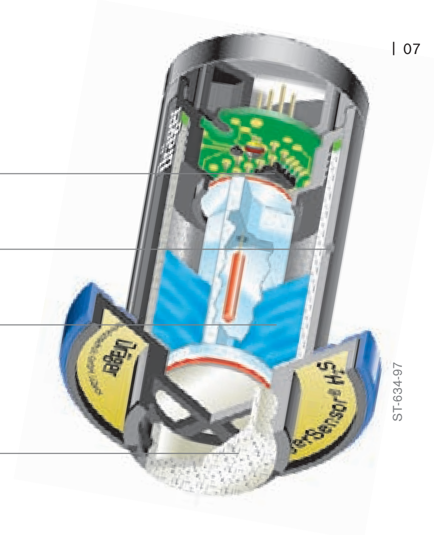
Cross-sectional diagram
Electrochemical Dräger Sensor



ELECTROCHEMICAL SENSOR

Electrochemical sensors work in a similar way to batteries. When the target gas is present, a small electrical charge is generated chemically between two electrodes, and displayed in the measuring head. The signal strength is proportional to the concentration.

One fundamental requirement is to achieve a stable sensitivity and good selectivity under all normal ambient conditions. The sensors must be able to reliably withstand the tough conditions prevailing in an industrial setting, and do this 24 hours a day, all year round.

Over the years, Dräger has developed and placed on the market many different sensors for all kinds of gases and applications. We make the know-how we have built up and the individual performance of the sensors available so that you can perform your monitoring tasks. To this end, every sensor is equipped with an electronic memory chip (EEP-ROM) containing individual information: look-up tables for measured value compensation, coefficients for mathematical calculations, timing elements for process control and control bits for various special functions.

This intelligence means that a high signal quality can be achieved, which in turn results in a long service life with minimal maintenance requirements. This minimizes the overall costs of ownership of the gas warning system.

PLUG-AND-PLAY EQUALS SMART SENSOR

Once a sensor has been manufactured, it is tested in the production department using the target gas. The individual data collected during this process, as well as many other standard parameters, are recorded and logged in the sensor memory. When the sensor is later connected to an intelligent Dräger transmitter, the instrument reads out this data and can perform the necessary configuration.

The adopted settings guarantee the highest possible measurement performance and user-friendly configuration. The calibration is stored in the sensor before leaving the factory, meaning that the sensor is ready for use immediately.

On the basis of this plug-and-play principle, Dräger offers its customers electrochemical sensors for more than 100 toxic gases and oxygen, all of which can be used with the same universal transmitter. This gives you maximum flexibility and quick readiness for use.

Because the sensor and the transmitter are developed and manufactured by Dräger under one roof, the different properties of the two components can be designed to function perfectly together, resulting in the greatest possible customer benefit in terms of performance characteristics.

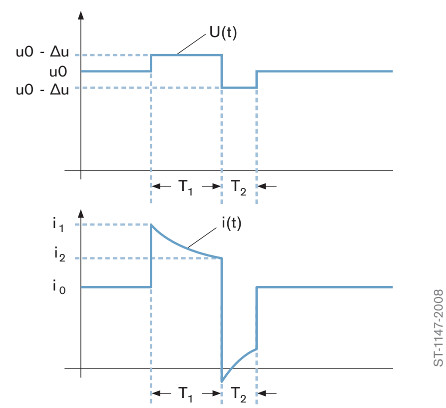
Stored intelligence

PRESSURE COMPENSATION FOR A LONGER SERVICE LIFE

Electrochemical Dräger Sensors can be used in a temperature range of – 40 °C to + 65 °C (– 40 °F to + 150 °F). To achieve such an extreme temperature span, sophisticated mechanical and electronic compensation mechanisms are needed. A patented porous housing made of Teflon surrounds the sensor and, in the event of changes in pressure, allows the enclosed air to equalize pressure with the ambient air without any of the chemicals escaping. In case of temperature changes, air pressure fluctuations and the absorption of water due to humidity in the air, mechanical stress is completely eliminated.

The result is a constant level of sensitivity and an outstanding service life of several years.

Demonstration of pressure compensation
Immersion in warm water: on the left, chemicals released due to positive pressure; on the right, effective compensation of positive pressure without damage to the sensor.



Sensor test
Test pulse (top) and sensor response (bottom).

ORGANIC ELECTROLYTE OPENS THE DOOR TO PPB MEASUREMENT

Not all gases can be detected using standard electrochemical technology, so for special applications Dräger has developed an organic electrolyte on a polycarbonate basis. Thanks to their better signal-to-noise ratio, these sensors can detect extremely low gas concentrations in the 10 ppb (parts per billion = 1:1,000,000,000) range. What is more, the sensors show less cross sensitivity to standard toxic gases which can be present in very low concentrations in the ambient air. This results in lower detection limits, while nonetheless virtually ruling out false alarms.

FUNCTIONAL SAFETY WITH PATENTED SENSOR TEST

The gas detector regularly performs a sensor test. This test is controlled on the basis of individual data from the memory device to ensure optimal testing of every sensor type in accordance with its properties. The test involves using an electrical pulse to stimulate the sensor, similar to exposing the sensor to gas. The sensor must now respond by emitting the corresponding output signals. This ensures that the correct measurement signal will be generated when gas reaches the sensor's measurement electrode. The test has no effect on the sensor's normal measurement function.

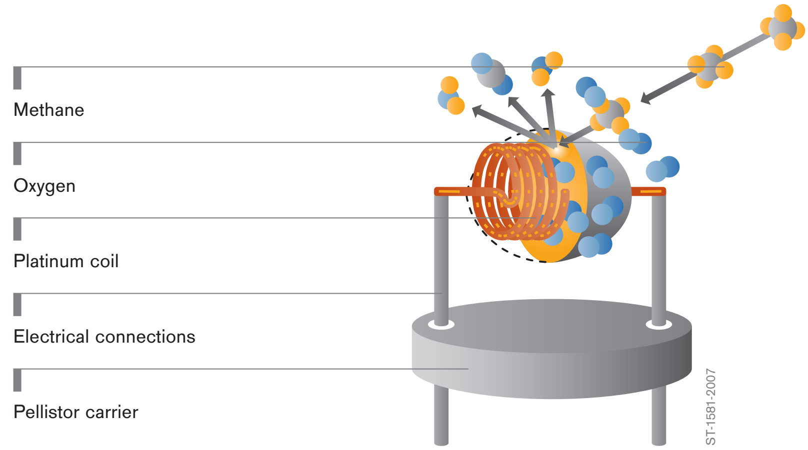
This guarantees a high level of reliability and availability of the electrochemical measurement function.

SELECTIVE FILTERS TO PREVENT FALSE ALARMS

Exchangeable selective filters increase sensor performance in terms of selectivity. Once a filter is used up, it can easily be removed for a replacement filter. This is an effective means of suppressing certain irritating cross-sensitivities.

The catalytic sensor principle

Principle of operation of a catalytic sensor



HOW CAN FLAMMABLE GASES BE MEASURED?

Easy – by burning them. But not, of course, using a naked flame, as they are supposed to be detected before they form a flammable mixture with air. Chemists describe this process as oxidation, which requires air (oxygen), fuel and a substance which will enable a reaction between the two, namely a catalyst which is attached to a heat-resistant ceramic body.

Yes, this is just the sort of catalytic converter which you would find in your car. The only difference is that it is of virtually no interest whether the catalytic converter in your car becomes even hotter than it is already as a result of the oxidation reactions (e.g. when hydrocarbons which have not yet combusted become water vapor and CO_2) – all that matters is that it should be as effective as possible.

We, on the other hand, are interested in the slight increase in temperature which occurs during this type of oxidation process because, as is commonly known, any oxidation involves a heat of reaction, which is a measure of the number of reactions that have taken place. And a few clever tricks are all that is needed to actually coax a measurement signal out of a catalyst which allows the proportion of flammable gas in the ambient air to be determined.

First, we need a much smaller catalyst and a lot of oxygen, which we extract from the volume of a small and highly porous ceramic bead which first has to be baked. This involves making a “dough” out of optimized catalyst and metal salts and using a special production process to ensure a high level of porosity. After heating for a short time, the result is a stable ceramic body which contains an extremely finely distributed catalyst. The bead is only about 1 mm in size, and roughly as permeable for the gas as fired clay.

To heat the bead to the perfect temperature for the intended oxidation process, it contains a miniature immersion heater, a small electrically heated platinum coil. The current is carefully selected to ensure that the bead will not become too hot, but also not too cold – the perfect temperature to obtain the highest possible measurement signal is roughly 450 °C (850 °F).

Measurement signal? Yes, because platinum changes its electrical resistance very precisely in relation to temperature. If the resistance is known, the temperature is known, and if the temperature is known, the concentration of the oxidized gas is known.

Unfortunately, however, the ambient temperature also changes, and by a great deal more than the temperature caused by the heat of combustion (which is just a few °C). To be able to use the sensor at ambient temperatures of – 50 °C to + 85 °C (– 60 °F to + 185 °F), the ambient temperature additionally needs to be measured. To do this, a similar type of bead is used, though this time of course without a catalyst.

Absolute reliability

Such beads are known as pellistors, a made-up term created from the words pellet and resistor. The pellistor without the catalyst (compensator) is used to measure the ambient temperature, while the pellistor with the catalyst (detector) is used to measure the ambient temperature plus heat of combustion, where the difference between the two signals – a measure of the gas concentration – is generated electrically.

For pure air, the difference must of course be zero, which is why this is set to zero in the associated electronics. When both pellistors are then exposed to, for example, 0.85 % by volume propane, the associated electronics only has to be adjusted so that it displays “50 %LEL”. Thereafter the settings are left unchanged, and the detector is "calibrated to propane".

In this context, 50 %LEL means that the propane gas concentration is already hazardous but far from flammable. Only once the LEL (the lower explosion limit) is exceeded by 100 % can propane ignite in air, i.e. only above 1.7 % by volume.

Although there is virtually no end to the possibilities offered by catalysts, the main priority when manufacturing high quality catalytic bead sensors is to attain sensor properties such as high effectiveness, signal stability, solidity, resistance to catalyst poisoning, reproducibility and, above all, outstanding durability and short response times – Dräger achieves this with its extensive know-how acquired during the course of 30 years. After all, catalytic bead sensors need to be operated continually for months at a time, without requiring maintenance, and must be able to reliably detect very slight temperature differences – frequently in hostile climatic conditions.

What is more, the sensor must of course not become an ignition source itself in the event that concentrations in excess of 100 %LEL are present. The two beads, at temperatures of roughly 450 °C (850 °C), would no doubt be able to ignite many gases and vapors, were it not for the ignition protection measures in place. Thanks to the solid explosion proof design and the gas-permeable sintered metal discs, flashback into the hazard area is reliably prevented – that is true explosion protection.

Dräger produces three types of sensor designed for gas detection systems:

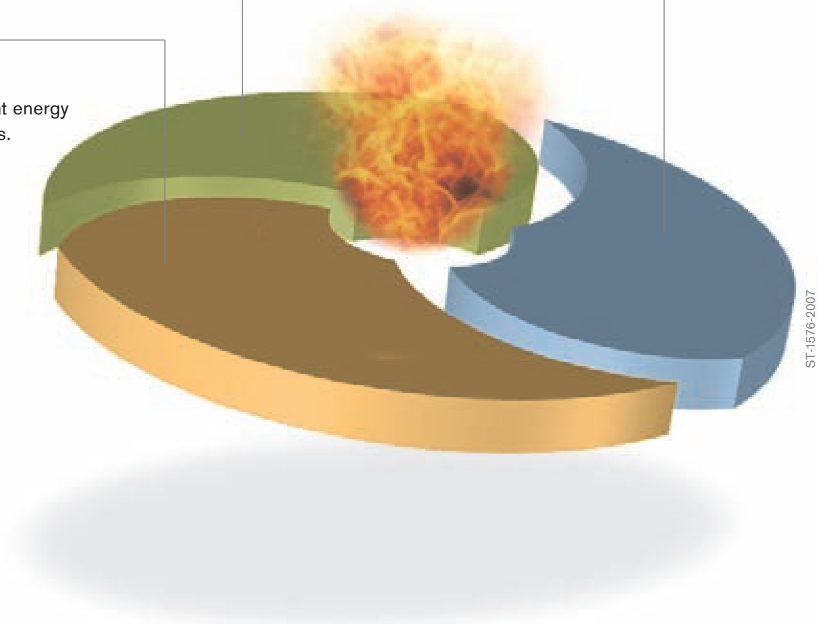
THE ALL-ROUNDER

The Dräger Polytron SE Ex PR M detector head has become the universal industry standard. It is used wherever there is a probability that flammable gases and vapors will be released in order to actively prevent a potentially explosive atmosphere from occurring (this is known as preventive explosion protection). The operator is alerted by the central unit, while at the same time a pre-alarm (e.g. 20 %LEL) causes countermeasures to be activated (e.g. fresh air is blown in to reduce the concentration of the flammable gas). If this measure fails, the concentration continues to rise and the main alarm is triggered (e.g. when 40 %LEL is reached), resulting in a forced shut-down. The Dräger Polytron SE Ex PR M with the central units Dräger REGARD Ex and Dräger Polytron SE Ex were type-examined for suitability for this application by an independent testing authority.

Air/oxygen
In sufficiently high concentration.

Gas/vapor
In sufficiently high concentration (above LEL).

Ignition source
e.g. ignition spark with sufficient energy or sufficiently high temperatures.



Explosion protection means reliably excluding at least one of the three prerequisites for ignition.

THE EARLY-WARNING INSTRUMENT

The Dräger Polytron SE Ex LC M (LC = Low Concentration) detector head is suitable for reliably detecting very low gas concentrations. It is used not so much for preventive explosion protection as for the early detection of flammable gases and vapors with concentrations far below 10 %LEL. Typical alarm thresholds are 3 %LEL and 5 %LEL, equivalent, for example, to 300 ppm and 500 ppm hexane respectively. The explosion proof sensor contains complex amplification electronics which are individually calibrated during production to a number of different parameters.

THE HEAT RESISTANT INSTRUMENT

The Dräger Polytron SE Ex HT M (HT = High Temperature) detector head is approved for use at ambient temperatures of up to 150 °C (300 °F). It is normally used in applications where extremely high temperatures are commonly found, especially for detecting leaks in the immediate vicinity of gas turbines. The temperature-resistant connection terminals are located in a galvanized cast iron housing.

ALSO AVAILABLE AS REMOTE SENSORS

The sensing heads described above, when combined with transmitters like the Dräger Polytron Ex or the Dräger PEX 3000, can also be operated as remote instruments, i.e. in areas which are difficult to access the sensor can be operated separately to the transmitter electronics.

SUITABILITY TESTING

The catalytic bead sensor has been tested for suitability for detecting many different gases and vapors by a recognized testing authority (Notified Body as stipulated by the ATEX Directive): methane, propane, acetone, acetylene, ammonia, petrol 065/095 (FAM normal gasoline), benzene, 1,3 butadiene, n-butane, n-butyl acetate, cyclopropane, diethyl ether, dimethyl ether, ethanol, ethylene (ethene), ethyl acetate, ethylene oxide, n-hexane, methanol, methyl ethyl ketone (MEK), n-nonane, n-octane, n-pentane, i-propanol, propylene (propene), propylene oxide, toluene and hydrogen.

In all, more than 200 different flammable gases and vapors can be reliably detected using catalytic bead sensors.

The infrared sensor principle

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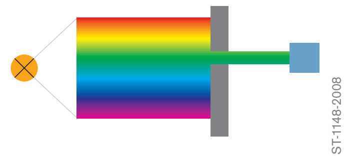
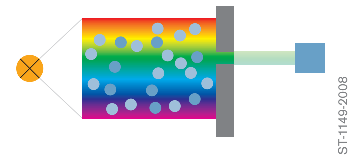
Principle of operation of infrared absorption (measurement cuvette)



Only the green part of the light radiation is filtered out and its intensity measured.



If a gas absorbs the green part of the light radiation, its intensity is measurably reduced.

INFRARED ABSORPTION

Whenever substances contain both carbon (C) and hydrogen atoms (H), i.e. hydrocarbons, their C-H bonds can briefly absorb part of the infrared light radiation. This slightly weakens the intensity of the emitted light.

Light-sensitive pyrodetectors are able to register this weakening, while downstream electronics can calculate a signal on this basis which serves as a reliable indicator if a gas concentration is present.

The concentrations that can be measured by means of infrared absorption range – depending on the substance in question – from a few hundred ppm (parts per million) up to 100 % by volume.

This method is often used to detect flammable gases and vapors within their 0 to 100 %LEL ranges, though it can also be used for the early detection of even small leaks (in coolant circuits, for example) so that more serious damage can be avoided.

FAIL-SAFE OPERATION

All the components needed to perform the measurement – light sources, detectors, signal amplifiers, processors, memory chips, heating elements etc. are protected against external influences.

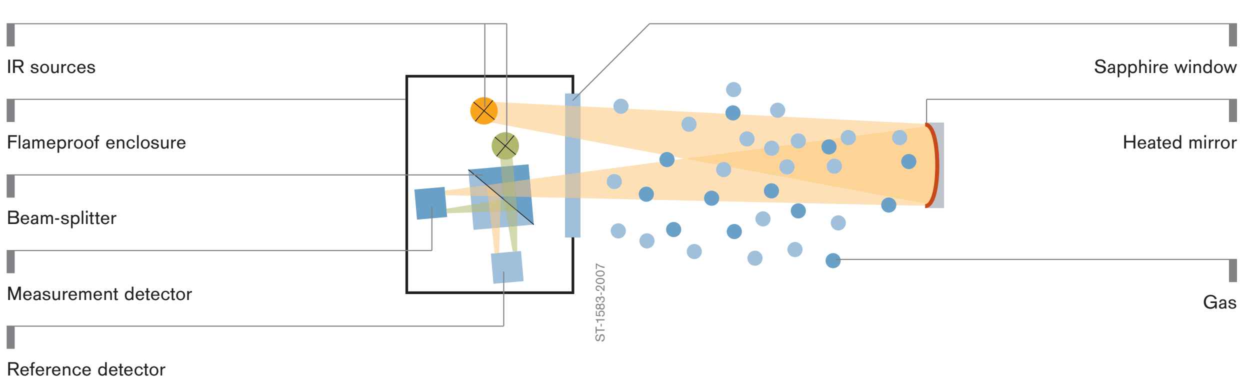
In most IR gas detectors, a solid explosion proof stainless steel housing acts as a hermetic seal, protecting the interior components from dirt, moisture, corrosive gases and other factors which might impair the measurement.

The constant readiness for use of the components is continuously monitored internally, and any component failure immediately triggers a fault alarm – ensuring true “fail-safe” operation!

Many Dräger IR transmitters feature SIL (Safety Integrity Level) certification, and have been approved by the independent testing authorities exida and TÜV. They confirm that this sensor technology is ideally suited to applications where demands for functional safety are high.

Our customers can rely on the reliable readiness for measurement.

Schematic diagram of the Dräger Polytron IR (explosion proof)



Precise reflection

STABLE – EVEN UNDER ADVERSE CONDITIONS

A stable measurement signal – even a “stable zero” if no hydrocarbons are present – is one of the key requirements in industrial applications. False alarms are simply unacceptable, as they can result in emergency shutdowns, production downtime and even plant evacuations.

Dräger sets global standards with its forward-looking innovations, such as double compensation of temperature and ageing effects, the 4-beam technology for high resistance to contamination, and the beam block warning for preventive maintenance.

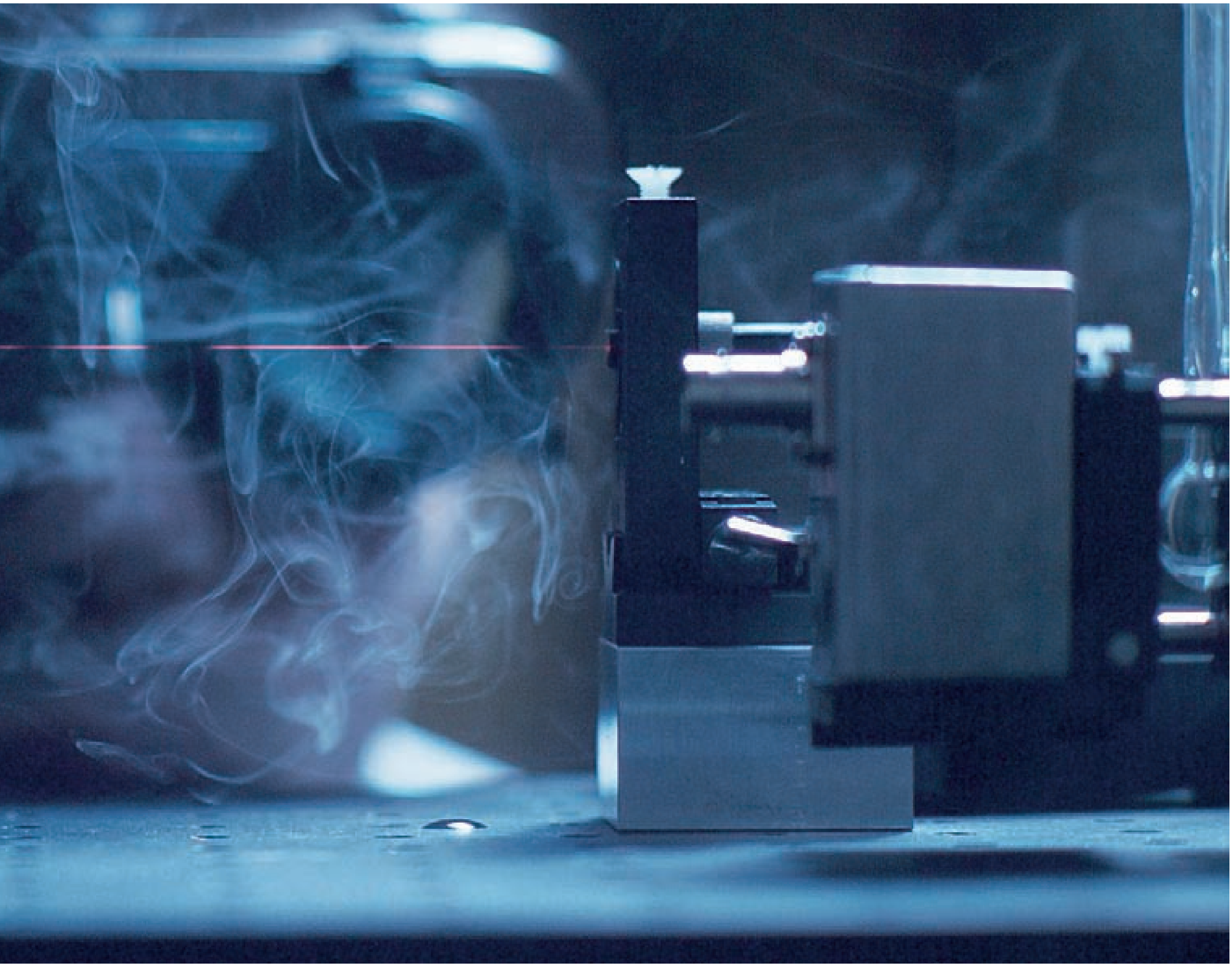
For more than 15 years, we have succeeded time after time in meeting our customer’s exacting requirements and continuously raising the bar just a little bit higher each time: one typical challenge when it comes to IR gas detectors, for example, is to prevent contamination in the measurement cuvette from negatively affecting the measurement signal.

The Dräger PIR 7000 achieves a new quality and perfect balance between signal strength and contamination resistance in this respect: thanks to its perfectly harmonized multi-mirror optics, the instrument maximizes its use of the available light, meaning that even a significant build-up of dust or dirt particles has no effect on its measurement properties.

BEST POSSIBLE LINEARITY AND CONVENIENT OPERATION

Due to the non-linear absorption behaviour of the great majority of hydrocarbons, individual linearized characteristics would theoretically need to be described for every single substance. The goal must be to enable the IR transmitter to calculate a signal which, as far as possible, increases proportionally to the rise in gas concentration.

To this end, the Dräger Polytron IR type 334 features a “gas library” containing 38 substances, which offers the world's biggest choice of linearizations (27 substances have additionally been tested and certified for measurement performance according to ATEX).



And even if the substance to be monitored has not yet been included in the gas library, there is at least a very good chance of finding among the 38 different linearizations one which comes very close to the required absorption behaviour.

And best of all, calibration of sensitivity can still be performed conveniently with standard test gases (e.g. methane, propane or ethylene). The Dräger Polytron IR automatically converts the different gas parameters of the desired target gas and the standard test gas accordingly – approved according to ATEX.

INFRARED – THE FIRST CHOICE

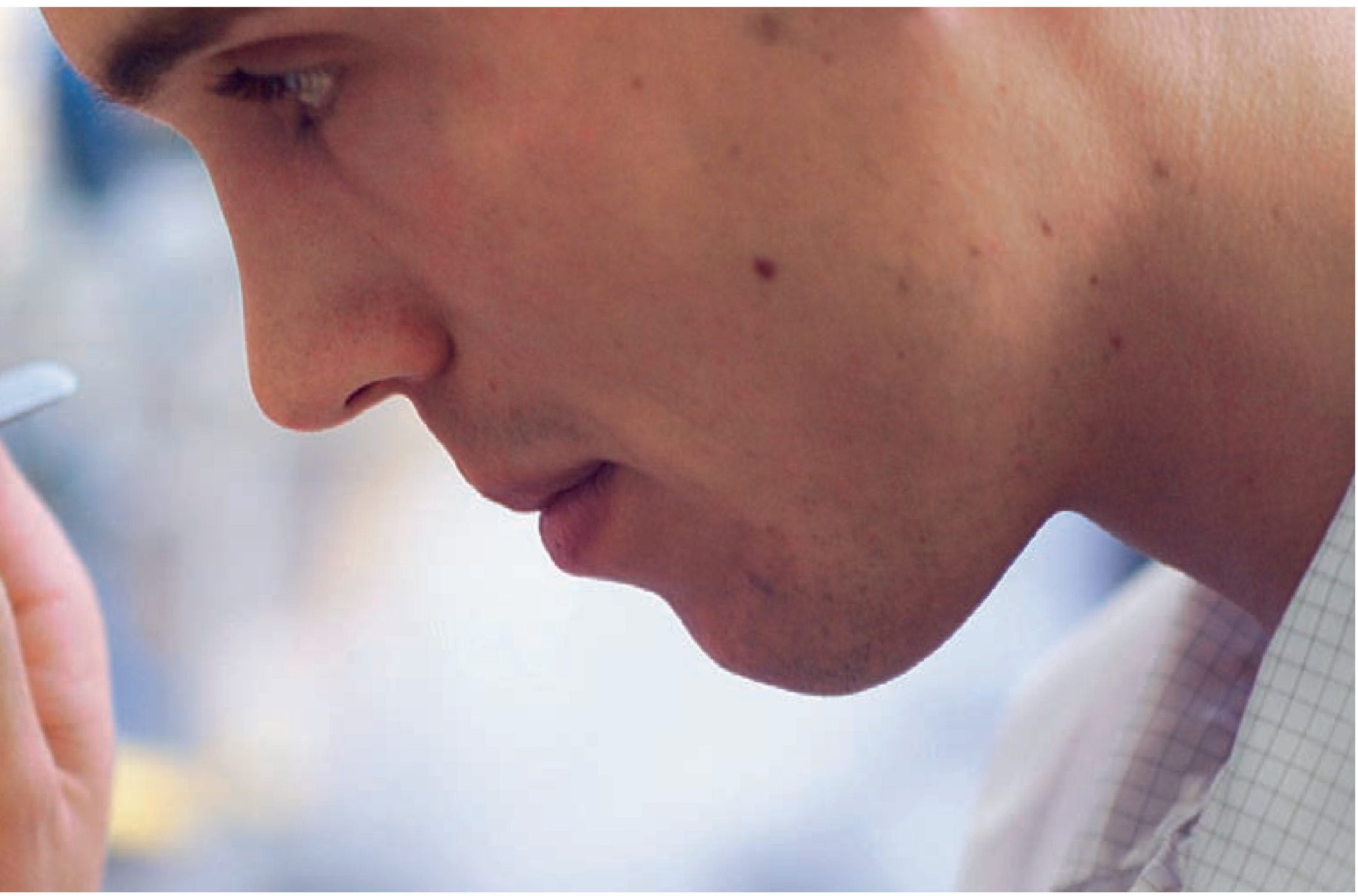
Infrared gas detectors are therefore the first choice nowadays for stringent industrial requirements (e.g. in chemical plants or in the automotive industry) and for applications with adverse ambient conditions (e.g. on offshore oil rigs).

Hydrocarbons, and indeed carbon dioxide (CO_2) and nitrous oxide (N_2O), can be reliably and accurately detected using infrared sensor technology.

The combination of monitored operational readiness, stable measurement characteristics, durable design and minimal maintenance requirements has proved persuasive for our customers, and has resulted in more than 100,000 installed infrared sensors worldwide.

Made in Germany

Gas detection technology requires a high level of precisition. Not only the integrity of systems and machines, but also human lives depend on the reliability of a gas warning system.



Dräger is one of the world's pioneers in the development and pushing ahead of sensor technology. In its own laboratories at the company's Lübeck headquarters, Dräger conducts basic research and technology studies.

Dräger strives constantly to improve all its safety technology. Whenever current technologies, new materials, changed production processes or tougher legal regulations give rise to additional requirements, Dräger has already found ways of meeting them.

Besides developing highly specialized niche products, we research ways of reducing cross-sensitivities and lowering detection limits. We are also improving economic aspects continuously, e.g. by reducing costs of ownership.

We forge lasting relationships with our customers. For over 110 years, mutual trust has been the basis for our path together into the future.

The whole is more than the sum of its parts

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Sensor technology cannot be viewed on its own. Just like in a car, it is not the engine alone which determines driving comfort. It is only when all the individual components work together in harmony that you achieve an optimal system.

At Dräger, an entire team of engineering specialists and sensor experts always works together on the design and development of gas warning systems. The team takes account of current technologies and devises new systems of hazard prevention. Solutions are planned which are tailored precisely to the relevant customer requirements.

The modular design of Dräger systems guarantees that your safety concept will meet all existing and future requirements long-term. New instruments and sensors can be added into existing systems, while systems using today's components can be expanded, changed or modernized at virtually any time.

Besides offering a uniquely wide range of sensors, measuring instruments and technical components, Dräger provides every possible kind of support.

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Experience cannot be learnt

The perfect safety system is not automatically created simply by combining good quality equipment.

Professional system engineering provided by experienced Dräger specialists, plus detailed planning, will help you identify the best solution for your particular challenge.

From commissioning to maintenance, trained service staff are at your disposal all over the world, ready to perform all the services you need.

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