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Explosion protection in pressure measurement technology

Explosions can be violent and tend to leave behind a great deal of damage. With this in mind, the ultimate aim when building electronic devices for use in potentially explosive environments is to completely prevent explosions. KELLER Druckmesstechnik AG has been producing products for use in explosive environments since 1988. These certified products ensure safe operation in the most diverse range of use cases.

The effects of explosions

Explosion at TotalFinaElf in Toulouse*
On 21 September 2001, 300 tonnes of artificial fertiliser exploded at a factory belonging to the company TotalFinaElf. 22 employees and 7 residents died in the explosion and 2500 people were injured. As has been the case in previous industrial disasters, the risks were known about beforehand and yet the precise causes remained unclear after the accident.

Explosion at Bayer in Wuppertal*

On 8 June 1999, there was an explosion and then a fire at the factory premises of Bayer AG in Wuppertal. This disaster led to over 100 injuries and damages payouts in the millions, as well as leaving behind a landscape of rubble around the boiler house. Luckily, no lives were lost in the accident but the chemicals and soot released caused long-term breathing difficulties, headaches, nausea and eye and skin irritation in countless people.

*Source: Bureau Veritas, former training representative

What causes explosions?

An explosion is a sudden chemical reaction involving an inflammable substance in the form of gas, dust, vapour or mist combining with oxygen and releasing large amounts of energy. This leads to an explosive atmosphere if the mixture achieves a very specific concentration ratio. If the concentration is too high (rich mixture) or too low (lean mixture), then a steady combustion reaction will occur, but no explosion. The mixture will only behave explosively on ignition if it is between the upper and lower explosive limit. The environmental pressure and the proportion of oxygen in the air influence the limits of the explosive atmosphere.

Protection from ignition

As much as a century ago, the necessity and importance of all-encompassing provisions for explosion protection had been demonstrated by the many devastating accidents of the past. It was then that the first national regulations and laws were enacted, and these remained in force until 1994. Since 1994, explosion protection has been regulated in European Directives:

- ATEX 95 or 94/9/EC (Equipment Directive)
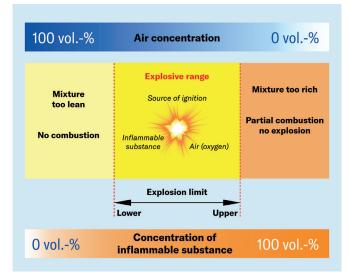- ATEX 137 or 1999/92/EC (Workplace Directive)

Businesses operating in potentially explosive environments are required to ensure that at least two measures are in place to prevent explosions. The primary measure requires the operating company to prevent an explosive

atmosphere from coming about to begin with. The concentration ratio can be changed and rendered non-hazardous using the following measures:

- replacing inflammable substances with non-hazardous alternatives.
- adding nitrogen, carbon dioxide, etc., which neutralises inflammable substances.
- using natural or mechanical ventilation so as to limit the concentration.

If it is not possible to create an explosion-proof environment, then as a secondary measure the risk potential needs to be divided into three danger zones according to the probability of a source of ignition occurring. These three zones state whether an explosive atmosphere could occur at all times, intermittently or for brief moments. This way, devices designed to be used in these zones can be chosen accordingly.

Explosion-proof products

Products used in a potentially explosive environment need to be designed to offer the protection necessary for the class of hazard present. Explosion-proof products are subject to various directives and standards such that the

100 vol.-%	Air concentration	0 vol.-%
Mixture too lean	Explosive range	Mixture too rich
	Source of ignition	Partial combustion no explosion
No combustion	Inflammable substance Air (oxygen)	
	Explosion limit	
	Lower Upper	

| 0 vol.-% | Concentration of inflammable substance | 100 vol.-% |

Concentration range for an explosive atmosphere containing an inflammable substance ©KELLER Pressure

necessary protection is ensured at all times. There are different licensing bodies and sets of standards depending on geographical location.

Explosion-proof products for the European market are tested and certified according to the European Directive 2014/34/EU (which supersedes the original Directive 94/9/EC). All products for this market must be designed according to the EN 60079 set of standards. These standards cover areas at risk of gas and dust explosions, and classify the products according to types of ignition. These define how operating equipment needs to be built so that it cannot trigger any kind of ignition in a potentially explosive environment.

Intrinsically safe pressure measurement technology by KELLER

In addition to type d (flameproof enclosure) and type ec (increased safety) ignition protection products, KELLER mainly produces pressure transmitters, level probes and digital gauges of the ignition protection type i (intrinsic safety). Products certified to be intrinsically safe limit the energy so that ignition of an explosive atmosphere cannot be triggered either by sparks or thermal effects.

KELLER is an international company and as such is not only limited to the European market. For this reason, the manufacturer of pressure measurement technology offers a wide range of certifications which can be applied to customer-specific products worldwide:

Worldwide: IECEx

International Electrotechnical Commission System for use in explosive atmospheres

Europe: ATEX:

Atmosphères Explosibles

United Kingdom: UKCA

United Kingdom Conformity Assessed

Russia: EAC

Eurasian Conformity

There are also customer-specific authorisations for:

North America: FM Approved

Certification for property damage prevention

North America: UL

Underwriters Laboratories

Canada: CSA

Canadian Standards Association

Korea: KCs

Korea Certification Safety

All explosion-proof products made by KELLER are recognisable by their specific labelling. This labelling features a key containing, among other things, the following information for gas explosion-proof products:

- Symbol Ex for ATEX
- Ignition protection type (example: ia)
- Gas group IIA, IIB or IIC
- Temperature class (example: T4-T6)
- Device protection level (example: Ga)
- Licensing office
- Licence number
- X for special conditions for safe use, described in more detail in the manuals.

Explosion-proof products in use

Products that are suitable for potentially explosive environments have a very wide field of use. KELLER has been producing explosion-proof pressure measurement technology since 1988. As a result of this invaluable experience, KELLER's certified products are recognised across many sectors. The following four examples illustrate known situations from everyday life which all share one basic task. In all applications, the level, fill level or flow rate of a container is being measured and monitored on the basis of the pressure. This common task entails a wide variety of dangers in potentially explosive environments:

Automotive industry:

Painting robots

When atomised in the spray nozzle, mists can produce ignitable mixtures.

Oil industry:

Monitoring the fill level at petrol stations

There is a risk at petrol stations that an electric spark could cause the gaseous atmosphere to explode.

Aviation industry:

Liquids logistics of de-icing machines

De-icing is performed with a liquid formed from at least 50% glycol, which is highly flammable, plus water.

Chemical industry:

Monitoring of chemical distribution

Warehouses belonging to chemical manufacturers and distributors contain numerous different chemical containers holding all manner of different explosive and harmful contents.
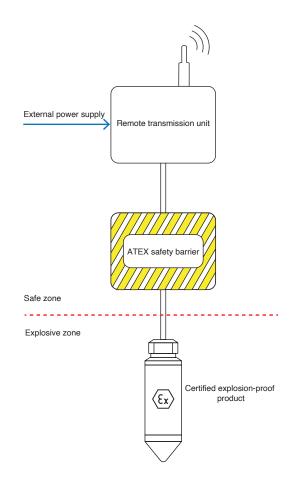
Measuring and transmitting

If the products are being used in difficult-to-reachplaces, the measured data cannot always be processed on site. In cases such as this, KELLER also offers remote transmission units which forward the measured values to a server or the cloud. The recorded and measured data is lastly retrieved and evaluated via a customer application or via KELLER's own KOLIBRI Cloud portal.
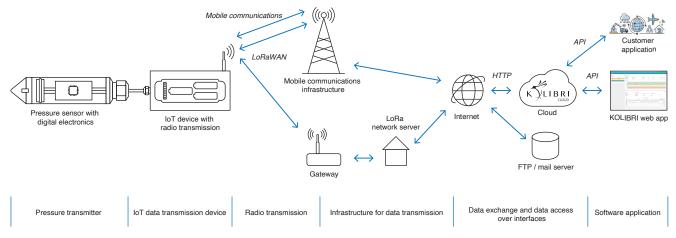
Remote transmission units, such as the Box ARC1-SB made by KELLER, are in and of themselves not explosion-proof. Modules used in potentially explosive environments must therefore, as a matter of necessity, be installed outside of the explosive atmosphere. Remote transmission units for certified explosion-proof products contain safety barriers that limit the electrical power delivered to the connected intrinsically safe product. Ignition is prevented from occurring by this barrier and the required explosion protection is achieved.

Explosion protection of the future

KELLER is currently developing a new type of radio transmission unit which communicates over LoRaWAN or NB-IoT networks (Internet of Things) and can also be installed within potentially explosive environments. This development will make explosion protection even safer, while simplifying the installation of pressure measurement technology in hazardous areas.

External power supply — Remote transmission unit

ATEX safety barrier

Safe zone

Explosive zone

Certified explosion-proof product

Remote transmission unit with data logger
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Mobile communications

LoRaWAN

Mobile communications infrastructure

Pressure sensor with digital electronics

IoT device with radio transmission

Gateway

LoRa network server

Internet

HTTP

Cloud

API

Customer application

API

KOLIBRI web app

FTP / mail server

| Pressure transmitter | IoT data transmission device | Radio transmission | Infrastructure for data transmission | Data exchange and data access over interfaces | Software application |

Remote transmission with LoRaWAN or NB-IoT networks © KELLER Pressure