ROSE

A Phoenix Mecano Company

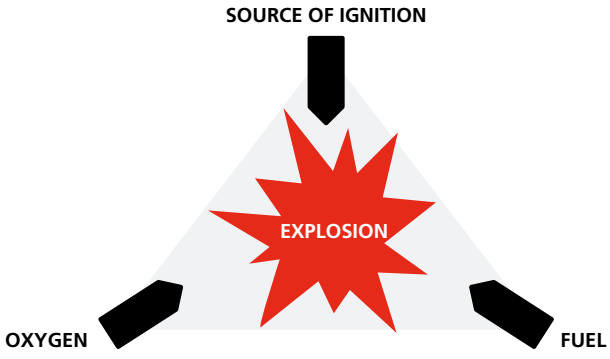
Explosion protection in the processing industry

Understanding Ex d enclosures and using them in accordance with standards

White Paper
June 2018

EXPLOSIVE ATMOSPHERES ARE FOUND IN NUMEROUS SECTORS OF THE PROCESSING INDUSTRY. THEY REQUIRE SPECIAL PRECAUTIONS AND PROTECTION CONCEPTS IN ORDER TO ENSURE THE SAFE USE OF ELECTRICAL EQUIPMENT. FOR EXAMPLE, FLAMEPROOF ENCLOSURES IN THE EX D IGNITION PROTECTION CATEGORY PROVIDE AN OPTIMAL SOLUTION. HOWEVER, THE END USER MUST USE THEM IN ACCORDANCE WITH THE STANDARDS IN ORDER TO PREVENT COMPROMISING THE CERTIFICATION OF THE ENTIRE EQUIPMENT.

In spite of Tesla, Twizy, i3 and many other electric-powered vehicles, the demand for oil – for example as used to make fuel – is constantly increasing. The chemical industry is also growing, and the volume of investment in this sector tripled between 2005 and 2015. However, these sectors also create special challenges for plant engineering, because many processes in the chemical and petrochemical industries require the processing, storage or handling of flammable substances such as gases, liquids or even dusts. This also applies to various production processes in the foodstuffs, animal feed and pharmaceutical industries, and in agriculture or mining. If flammable materials come into contact with oxygen and a source of ignition – caused for example by sparks or hot surfaces – there is a risk of explosion. This is why, when using these substances, plant manufacturers and operators must pay attention to special regulations in order to protect employees, and make use of appropriately certified components and devices. In Germany there is a wide-ranging set of rules in the Betriebssicherheitsverordnung (= Industrial Safety Regulation) and the Gefahrstoffverordnung (= Ordinance on Hazardous Substances).



Primary, secondary and tertiary explosion protection

Safety technology uses three methods in order to provide protection against explosions. **Primary explosion protection** ensures that an explosive atmosphere cannot occur. For example, this may involve thinning a flammable liquid, substituting a harmless coarser granulate for an explosive dust, or lowering the oxygen level in the air.

Secondary explosion protection ensures that no sources of ignition such as sparks, impact sparks or hot surfaces are present in an explosive atmosphere. There is also a requirement for devices which are specially designed for this sector, including devices with the widespread Ex e and Ex i ignition protection types.

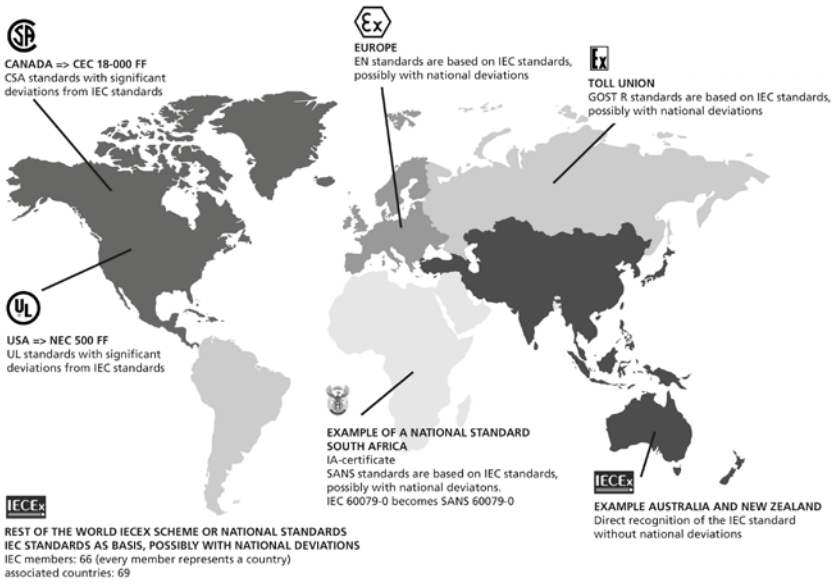
However, as the choice of components with an appropriate approval – for example in the field of automation – is limited, there is a third constructional option. This involves the use of standard industrial components in a flameproof enclosure with Ex d ignition protection type in an explosive atmosphere. In this case, **tertiary explosion protection** ensures that the effects of any explosion which occurs are damped, so the user has the opportunity to make his choice from the entire range of automation components.

The history of the Ex d enclosure started in the mining industry

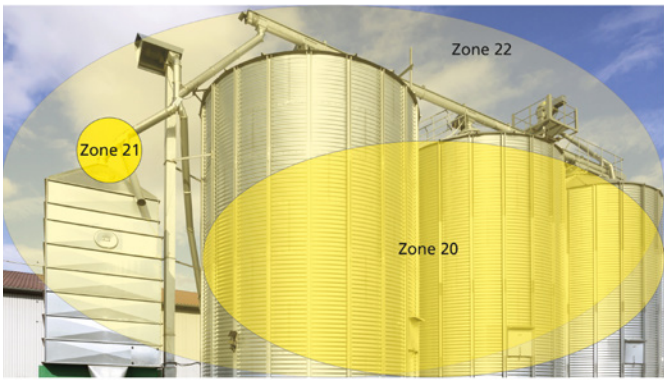
The development of the ignition protection concept started in the early years of the 19th century with the invention of the first miner's lamp. The safe use of electrical energy in mining was revolutionised by the use of type Ex d ignition protection. The number of accidents resulting from explosions in mines sank impressively. Today, Ex d enclosures are used in a wide range of industrial applications; they withstand the pressure from an internal explosion, the ignition energy is depleted via the gap and does not escape to the outside.

Preventing explosions by using ignition protection concepts

As part of the framework of explosion protection, and with the help of defined ignition protection types, precautions are taken using a wide range of constructional principles in order to prevent explosions. The basic idea behind every type of ignition protection is to prevent the simultaneous presence of an explosive atmosphere and a potential source of ignition. Ignition protection types are defined in various international and European norms IEC/EN 60079 ff. The manufacturer must comply with the appropriate specifications and guidelines during the design, manufacture and testing of devices or protection systems, and must mark them accordingly.



The **relevant European (EN 60079-1) and international (IEC 60079-1) standards** apply in explosive atmospheres. In addition to the "General requirements" in EN / IEC 60079-0, manufacturers and end-users in Europe must also comply with the requirements of EU directive 2014/34/EU (ATEX) and 1999/92/EC. Directive 2014/34/EU regulates the use as intended of equipment and protective systems in explosive areas. Directive 1999/92/EC contains minimum requirements to improve health protection and the safety of employees who may be exposed to the risk of an explosive atmosphere. In particular, this applies to plant operators. Explosive atmospheres are divided into so-called zones in EN / IEC 60079-0. Classification as a zone does not evaluate the effects of an explosion – instead, it describes the probability of the occurrence and the quantity, duration and characteristics of explosive gases or dust mixtures.



Categorisation into groups of equipment and substances

Depending on their potential for danger, explosive gases are divided into gas groups IIA, IIB, IIC, and explosive dusts into dust groups IIIA, IIIB, IIIC. In each case, groups IIC and IIIC represent the most dangerous groups of substances.

As part of risk assessment carried out by the manufacturer, explosion protection measures must be taken for all equipment which contains a potential ignition source. Categorisation of the operating equipment takes place in the equipment groups. Group I stands for equipment used in mines which are susceptible to firedamp. Group II stands for equipment used in explosive gas atmospheres, and Group III stands for use in explosive dust atmospheres.

The Equipment Protection Level (EPL) designates the level of equipment protection according to IEC 60079-0: 2011. Equipment and protection systems used in explosive atmospheres must be classified, marked and tested accordingly, with the letter "G" standing for gas explosion-proof equipment, and "D" for dust explosion-proof equipment.

Appliance category	Level of protection EPL	Dimensions in safety	Applicable in zones
Gases, vapours, mist			
1G	Ga	very high	0, 1, 2
2G	Gb	high	1, 2
3G	Gc	normal	2
Dusts			
1D	Da	very high	20, 21, 22
2D	Db	high	21, 22
3D	Dc	normal	22
Mine workings endangered by firedamp			
M1	Ma	very high	Continued operation in Ex-atmosphere
M2	Mb	high	Shutdown in Ex-atmosphere

Source: Physikalisch-Technische Bundesanstalt (PTB)

What is important when using Ex d enclosures?

Even when an appropriate test and marking have been carried out, when using Ex d enclosures for the flameproof of electrical equipment in explosive atmospheres, the operator must understand exactly the effects of the encapsulation and the function of the overall device. Plant operators above all must be certain that fitters and the maintenance personnel are qualified to commission and maintain flameproof enclosures so that the certification of the entire equipment is not at risk.

- The primary function of an Ex d enclosure is to prevent an internal explosion from spreading.
- In addition, the enclosure protects the fitted equipment against environmental influences such as moisture, dirt, dust or water.
- Mechanically, an Ex d enclosure is designed to withstand an internal explosion.
- The design of the enclosure – and in particular of the flamepath – prevents the spread of sparks, flames and hot gases so that any explosive atmosphere surrounding the device is not ignited.
- It is important that the so-called ignition protection gap in Ex d enclosures is not damaged.

Use of Ex d enclosures in accordance with the standard

The user and operator should always know and understand the effects of modifications to Ex d enclosures whether these are used on an offshore oil platform or in a land-based petrochemical plant. This is because as soon as Ex d devices have left the manufacturer and its quality system, the entire responsibility for safe use is transferred to the end user. However, this is the challenge which faces the plant operator. For example, if modifications to the enclosure are necessary, such as subsequent lacquering, additional wiring, etc., there are no guidelines for the manufacturer or operator to follow.

Risks caused by subsequent lacquering

Any subsequent lacquering of an Ex d enclosure, and in particular if paint penetrates the flamepath, can have a negative effect on the certification. In addition, if paint covers the screws, this can prevent access to the enclosure.
As lacquers are not normally conductive, this can also lead to electrostatic hazards and the occurrence of an additional potential source of ignition. EN / IEC 60079-0 states that electrical equipment must be designed in such a way that under normal conditions of use, maintenance and cleaning, ignition caused by an electrostatic charge is prevented. The standard states precisely which layer thicknesses (e.g. for lacquers) and surfaces (e.g. for plastic inscription labels) must be complied with as maximum values.

Limits for non-metallic layer thicknesses

Appliances of Group II			
EPL	**Group IIA**	**Group IIB**	**Group IIC**
Ga	2 mm	2 mm	0,2 mm
Gb	2 mm	2 mm	0,2 mm
Gc	2 mm	2 mm	0,2 mm

Limits for non-metallic surfaces

Appliances of Group II			
EPL	**Group IIA**	**Group IIB**	**Group IIC**
Ga	5000 mm²	2500 mm²	400 mm²
Gb	10000 mm²	10000 mm²	2000 mm²
Gc	10000 mm²	10000 mm²	2000 mm²

Source: EN 60079-0:2014-06

It depends on the right torque

One frequent mistake when using an Ex d enclosure involves using the incorrect torque to fasten the lid, or forgetting the screws altogether. This is especially dangerous in the case of Ex d enclosures in gas group IIC, where the tolerances for the flamepath are extremely low. This is why it is important that all the screws are tightened with the correct torque. The manufacturer is responsible for supplying the information. Of course, the same – but with different tolerances – applies to IIB and IIA enclosures.

Suitably greased, optimally protected

The application of a suitable grease is absolutely necessary in order to protect against corrosion on flat gaps and also in thread gaps. The grease provides protection and ensures that the screws and screwed enclosure parts can still be operated even after a long period of time. The standard specifies that this grease must not harden, contain any vaporising solvents, and must be anti-corrosive (cf. DIN EN 60079-14:2014-10). In order to ensure that the correct choice is made, users should strictly follow the manufacturer's instructions by taking the named requirements into consideration, because this ensures suitability for the area of application.

Extensively tested

Purchasers of Ex d enclosures should also know the relevant tests. The tests to be carried out are defined in EN / IEC 60079-0 (general requirements) and in EN / IEC 60079-1 for the flameproof type of ignition protection.

- Self-heating tests or calculations are carried out for all Ex d enclosures for the purpose of determining the maximum surface temperature of the entire unit (enclosure + installations) under maximum operating conditions (including safety buffer).

- Thermal resistance against heat and cold (non-metallic enclosures or enclosure parts) is tested.
- Impact tests are carried out on critical parts.
- Tests are also carried out to prevent an electrostatic source of ignition.
- Additional comprehensive tests which result from the standard (EN / IEC 60079-1) are normally reference pressure, over-pressure and spark transmittance tests.
- More tests include those carried out on translucent parts made of glass, cable glands and vent plugs.

The enclosures are tested in the laboratory

For the reference pressure tests, the enclosure is filled with an explosive gas mixture which is then ignited. The reference pressure is dependent on the ambient temperature (the lower the temperature, the higher the reference pressure) of the enclosure, and on the geometry inside the enclosure. These tests are followed by a hydrostatic over-pressure test which checks the mechanical rigidity of the enclosure.

Subsequently the enclosure is also put through a series of ignition permeability tests in which an explosive gas mixture similar to that described above is used. The enclosure is in an explosive environment; when the internal explosive mixture is ignited, transmittance of the ignition to the external atmosphere is not permitted. The spread of the ignition spark is dependent on the geometry, ambient temperature and the components inside the enclosure.

If the manufacturer's listed temperature range for use is exceeded or not reached, then as a rule the device is no longer safe. All tests must be carried out using the lowest and/or highest approved temperatures for enclosures with a deviating standard ambient temperature range (-20 °C to +40 °C).

For approval, differentiation is made between component approval and equipment approval. Component approval certifies the suitability of a component for installation in an approved complete system, for example an empty enclosure without electrical fittings. Direct use of components which only have component approval does not conform to the guidelines – in all cases, approval must be for the entire system.

Ex d enclosures for a wide range of opportunities

ROSE Systemtechnik manufactures flameproof enclosures in various sizes and designs for use in a range of gas groups and operating temperature ranges. In this way, the company provides industry with a large number of solutions for the secure and safe encapsulation of electrical equipment.

Whether as simple distribution boxes for energy, sensor signals or complex control systems – ROSE's Ex d enclosures cover an extremely large and diverse range of requirements in industrial environments. The TBE, EJB, GUB and IJB enclosures conform to Degree of Protection IP 66 in acc. with DIN EN 60529 and are thus dust-tight and protected against the ingress of water.
Consequently, ROSE's Ex d enclosures are ideal for use in the processing industry. However, they are also used in control and instrumentation applications. The company's Ex d range includes both stainless steel and aluminium enclosures.

Fact checking for the safe use of Ex d enclosures:

- Before modifying an Ex d enclosure, end users and fitters should ensure that they understand and comply with all the relevant standards.
- Always follow the information in the manufacturer's operating instructions.
- If you are uncertain about any aspects of using Ex d enclosures, please contact the manufacturer or acquire a complete solution.

ROSE Systemtechnik offers a wide range of Ex d enclosures with options for individual modifications, fitting, mechanical processing or surface improvement.

About ROSE Systemtechnik GmbH

ROSE Systemtechnik GmbH was founded in Porta Westfalica / Germany, in 1969 and, with its 350 employees there, is one of the worldwide leading innovative suppliers of industrial enclosures.

As part of the Phoenix Mecano AG / Switzerland group, we develop and manufacture high-quality industrial enclosures and system solutions for the following sectors: railway and transport technology, mechanical and plant engineering, automation technology, explosive areas, measurement and control technology and the food and beverage industries.

Source: Rose Systemtechnik

Our product range comprises:

- Industrial enclosures made of aluminium, stainless steel and plastic for individual installations used in electrical connection technology and electronic modules.
- Operating and display enclosures based on aluminium profile systems and stainless steel materials for HMI applications with industrial PCs, PLC control systems or visualisation units including supporting-arm systems.
- Components for explosion protection with junction boxes and control stations for use worldwide in explosive areas, the petrochemical and chemical industries and the chemicals industry in onshore and offshore sectors.

Service hint:

Depending on the specified requirements, customer-specific modifications or surface improvements, for example lacquering or the fitting of sight glasses, are carried out in ROSE's in-house production department. If requested by the customer, ROSE also manufactures special enclosures and carries out the complete mechanical processing, equipping and installation of the products. ROSE ensures the quality of all enclosures by means of regular on-site tests such as IP protection class and environmental tests.

In addition to our wide range of products, high quality standards and constant innovation, it is our excellent level of service which forms the basis for our success in business.

You take the decisions about the delivery condition of the products – we offer a range of options, from the unprocessed enclosure to partial finishing up to a completely assembled and tested customer-specific system solution.

Detailed information on our Ex d range of products is available on:

https://www.rose-systemtechnik.com/en/products/ex-equipment/ex-enclosure-systems/ex-d-enclosure-series/

If you have any questions about ROSE Systemtechnik's Ex d enclosures, you can contact us on:

ROSE Systemtechnik GmbH
Erbeweg 13–15
32457 Porta Westfalica

Fon: +49 571 50 41-0
Fax: +49 571 50 41-6
rose@rose-pw.de
www.rose-systemtechnik.com/en/

Authors:

Nurullah Palamut, Department Manager Explosion Proof Equipment
Mathias Ohsiek, Program Manager Explosion Proof Equipment

References:

1. Ex-Basics, deutsche Version, ROSE Systemtechnik GmbH, 3. Auflage August 2013
2. Ex d Enclosures: understanding the standards, Toni Ott, 2013
3. https://www.process.vogel.de/steigender-bedarf-an-chemieprodukten-laesst-chemieanlagenbau-boomen-a-699613/
4. https://www.ptb.de/cms/ptb/fachabteilungen/abt3/exschutz/ex-grundlagen/zuordnung-geraetekategorie-zone.html