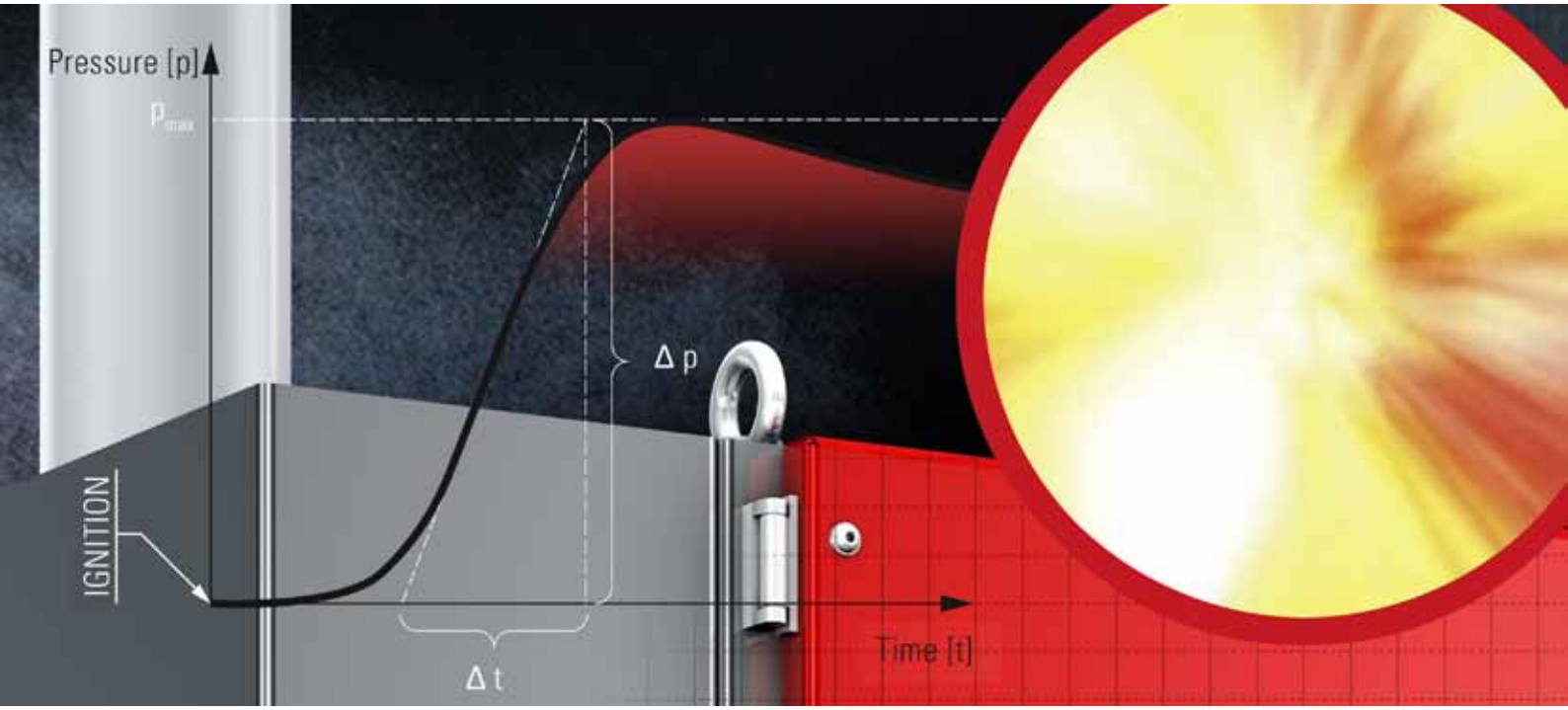
Explosion prevention and explosion protection according to ATEX guidelines



Safe extraction and separation of explosive dust

- Metallic dust
- Organic dust
- Paint and spray dust

Comprehensive information concerning "Explosion prevention and explosion protection according to ATEX guidelines" can be found on our website **www.exschutz.net**

Extracted dust may create dust explosions

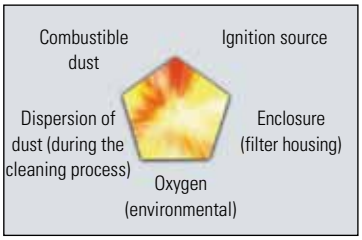
A precondition for a dust explosion is an explosive environment

A dust explosion does not occur by chance. Reactive substances with suitable mixing ratios will create a potentially explosive situation.

Metallic, organic or paint and spray dusts can create an explosive combination in the presence of oxygen.

A criterion for a dust explosion is dispersed dust consisting of a mix of dust particles of various sizes plus gas molecules. The differences in density generate a continuous circulation that creates a homogeneous mixture. As soon as a specific dust density is attained below certain particulate dimensions, an explosive environment is produced. However, in general, explosion limits are not limited just to a certain particle size of combustible dusts.

Explosion limits (LEL, lower explosion limit) can only be detected by performing specific tests.



Dust explosions only occur under certain conditions.

Organic and metallic dusts are prone to explosion

Organic dusts

Such as CFC, GRP, GMPU, including carbon, powder, cocoa, starches, lumber, fibers, feedstuff, as well as paint and spray dusts. Dusts from the treatment and processing of these products and substances are flammable and are assigned to dust explosion class St 1.

Metallic dusts

Typically, metallic dusts are minerals such as magnesium, aluminum and fine blasting dust such as steel.

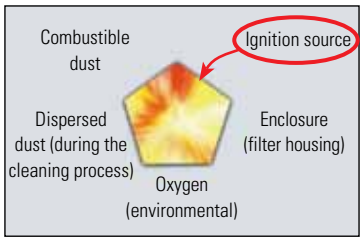
With a particularly small particle size (e.g., dust) even substances that are not normally combustible in solid form, can suddenly ignite.

The very large surface area of metallic dust particles generates heat quickly and presents an explosion hazard.

No ignition source – no dust explosion

A potentially explosive situation does not necessarily produce a reaction!

To initiate an explosion, there must be an ignition source. This also includes the ability to self-ignite (automatic combustion).



The Filter cleaning can lead to an explosive environment

The risk of an explosion exists particularly during filter cleaning in a dry dust separator. An explosion can occur upon the precisely timed entry of an ignition source into the filter area. However, dry separation systems are obviously still a superior economic solution for many processes in the separation of emissions.

To benefit from this advantage safely, mechanical and procedural precautions should be taken to prevent the entry of an ignition source into the filter area – or to control the effects of a potential explosion.

ATEX 137 (operator guideline) defines the operator's responsibility

Explosion protection guideline 1999/92/EC (ATEX 137) contains basic safety requirements concerning hazards from "explosive atmospheres". Occupational safety is an important subject. However, the operator cannot always recognize potential explosion hazards and the corresponding need for action. Keller offers detailed recommendations. Although this topic does not always raise the necessary awareness, in the event of damage, the operator must provide a corresponding explosion protection document as proof.

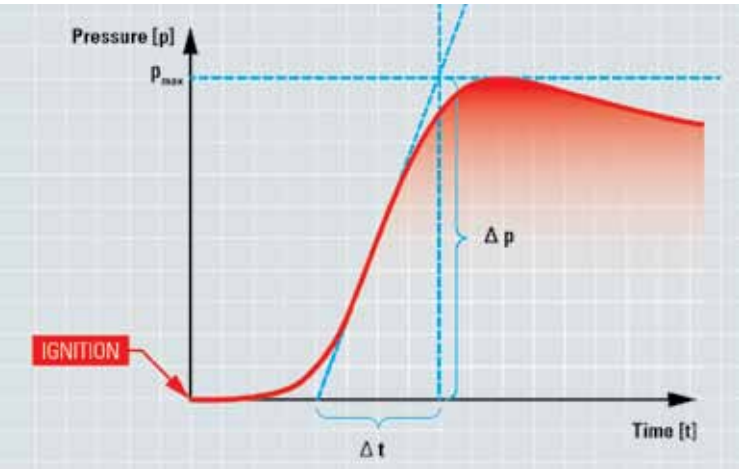
Dust sample provides confirming data

A dust sample can provide verification of explosive potential and detect the existence of explosive parameters. If necessary, Keller offers to perform such tests as part of a service package at a fixed cost. (www.exschutz.net)

Examples of explosion parameters: Explosion pressure and explosion severity

The maximum explosion pressure p_{max} is influenced by the housing.

The rapid pressure increase dp/dt reflects the potential severity of an explosion. It is defined as the primary origin in the deviation point of the pressure/time curve and used as parameter K_{St}-value for classification into dust explosion classes St 1, St 2 and St 3.



Pressure curve of a dust explosion in 1 m² ball pressure tank.

Dust explosion classifications

The dust explosion classes are the basis for designing constructive protection measures in addition to the maximum explosion pressure p_{max}.

Dust explosion class	K_{St} [bar m/s]
St 1	0 – 200
St 2	201 – 300
St 3	> 300

Testing parameters to determine the K_{St}-value and p_{max} are defined in directives VDI 2263 sheet 1 guidelines, and EN 14034.

Explosion parameters for evaluating risk of explosion

Explosion parameters

The opposite explosion parameters are examples from previously completed projects. An in-depth overview is provided in the GESTIS-DUST-EX database.

The tolerances are basically relatively high (+/- 20 %). A distinction between KSt 180 and KSt 200, for example, is generally not useful.

Type of dust	p_{max} [bar]	K_{St} [bar m/s]
PVC	8,5	98
Polyethylene	8,8	131
Coal dust	8,2	135
Tin-Copperdust	4,5	80
Polyethylene dust	< 8	< 100
Stitching and milling dust Plastics	7	113
Rubber milling dust	8,4	160
Aluminum milling dust	8,5	160
Paint overspray	8,2	162
Aluminum dust with aerosols from MQL	9	165
Fabric fibers (laminate residues)	< 10	< 200
Zinc dust	9,5	250

Explosion protection document

The operator is obligated to create an explosion protection document to determine suitable protective measures.

The explosion protection document must be recorded and must include at least the following points:

- Probability and duration of the presence of explosive conditions. The explosion endangered areas will be classified into zones
- Probability of the existence, initiation and prevalence of ignition sources (including electrostatic discharges)
- Extent and effect of an explosion (explosion parameters)

Mandatory actions to be taken for a potential explosion hazard

Following clarification of the explosion risk, detection of explosive dust parameters such as ignition temperature, minimum ignition energy (MIE), lower explosion limit (LEL), Kst value ... the company is required to take steps according to ATEX 137.

Critical safety measures:

- Zone division depending on the explosion risk
- Labelling hazardous areas
- Determine which protective actions to implement
- Operating instructions for employees
- Creating an explosion prevention document containing all available data and effective procedures

The ATEX guideline is implemented nationally by Industrial Safety Regulation BetrSichV.

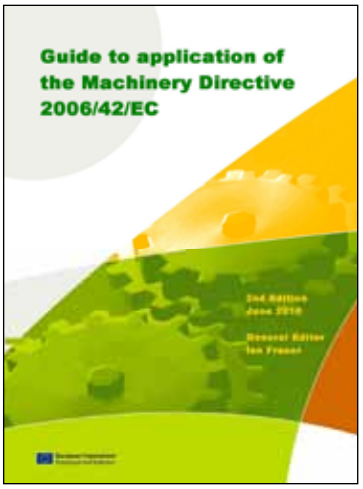
The following regulations are mandatory:

- DGUV standard 113-001 (former BGR 104)
- TRBS 2152 / TRGS 720
- TRBS 2152-1 / TRGS 721
- TRBS 2152-2 / TRGS 722
- TRBS 2153 / TRGS 727

Machinery Guideline 2006/42/EC

Appendix 1, point 1.5.7. of the general machinery guideline:

"Machinery must be designed and constructed in such a manner as to avoid any risk of explosion posed by the machinery itself or by gases, liquids, dust, fumes or other substances produced or used by the machinery."



Download link for the application:
http://www.exschutz.net/images/machinery_guide.pdf

ATEX 114 (product guideline) for products in explosion risk areas and applications

The 2014/34/EU directive of the European Parliament and Council (generally known as ATEX 114) primarily applies to manufacturers.

The guideline encompasses protective systems and all machinery and systems located in potentially explosive areas. Electrical and non-electrical systems are also relevant since they possess their own potential ignition source.

ATEX-Logo

ATEX derives its name from French **At**mosphère **Ex**plosive

Manufacturer's obligation according to ATEX 114

- Performing a risk evaluation of the product
- Clarification of intended use and operating conditions
- Classification into system categories
- Labelling on a printed plate
- EC-type evaluation by an authorized agency if an electrical system belongs to categories 1 or 2, a non-electrical system to category 1, or if it is a matter of a protective measure.

Category	**1**		**2**		**3**	
Level of safety	very high		high		normal	
Application in zone	0/1/2	20/21/22	1/2	21/22	2	22
Environment		D	G	D	G	D

Classification into system category

Coordinating between ATEX 114 and ATEX 137

Keller Lufttechnik offers experienced advice regarding this subject

There is a mutual reliance between an operator's guideline and the manufacturer's guideline.

It therefore necessitates the coordination of scheduled projects with essential clarifications between the operator and the system manufacturer.

Keller Lufttechnik provides experienced advice ranging from the initial conception of emissions extraction while taking into consideration ATEX guidelines 114/137, to the coordination of fire protection measures, and to the possible inclusion of heat exchange facilities.

We will be pleased to assist you in fulfilling all the mandatory requirements.

Basic requirements for	
Operator (ATEX 137)	**Manufacturer (ATEX 114)**
Designating zones for a single system; selection of corresponding devices	Location selection, specification of the system category/category
Zone 0 / 20 Zone 1 / 21 Zone 2 / 22	Category 1: Category 2: Category 3:
Compliance with applicable requirements for installation, commissioning and maintenance	The systems must meet all requirements for occupation health and safety
Performance of a risk analysis, requiring coordination	Performance of a ignition source analysis for the systems
Completion of an explosion protection document	Completion of a declaration of conformity
Continuous updating	Adequate quality assurance

Zone division according to ATEX

The areas of operation must be divided into zones (ATEX 137/VDI 2263-6/ DGUV standard 113-001 (former BGR 104):

Environment: **Gas/mist/ fumes**

Concentration > = 100 % of LEL
Zone 0

Concentration 50 – 99 % of LEL
Zone 1

Concentration 20 – 49 % of LEL
Zone 2

Environment: **Dust**

Hazard if content is more than 50 % of the operation or continuous Zone 20

Occasional hazard if less than 50 % of the process Zone 21

No hazard during normal operation or rare and short-lived Zone 22

Classification into device categories according to ATEX 114

Device group I

Includes systems for underground and surface mining

Device group II

Classification of all systems in remaining explosion prone areas. All the following information pertains to device group 2.

Device category 1

Hazard potential: continuous, frequent or over an extended period of time
Requirement: very strict safety procedures

Device category 2

Hazard potential: occasional
Requirement: strict safety measures

Device category 3

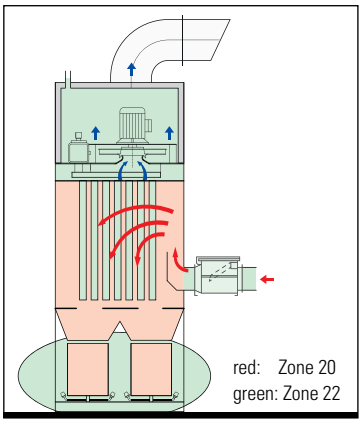
Hazard potential: rare or short-lived
Requirement: normal safety measures

Range of applications according to product guidelines ATEX 114

In zone 20 use only device category 1D

In zone 21, systems in device category 2D (+1D) are permissible.

For zone 22, suitable device category 3D (+2D and 1D).



Zone division VARIO

Preventing an explosive environment

Avoiding a potential explosion prevention seems to be an obvious safety measure – however, it may not be suitable for all processes.

Wet separation

For this process, possible ignition sources are flushed with water, preventing the creation of an explosive atmosphere in the dust separator. Depending on the variety of processes, this technology is not universally applicable.

Inertisation

When using inertisation, the separator is supplied with inert material such as limestone powder to avoid the creation of an explosive atmosphere. The mixture ratio must ensure that the combination of inert material and explosive dust/air cannot set off an explosion in itself. The economic feasibility depends on the volume of dust created and the need for inert material.

Ignition source free operation

An explosion can only be set off in the presence of an ignition source (secondary explosion protection)

Procedural measures

This is to avoid common ignition sources such as welding, smoke and other sources of open flames.

Eliminating ignition sources in the separation system

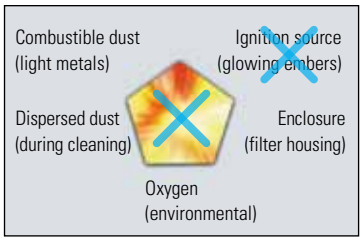
Inadequate for especially ignition-sensitive dusts with MIE < 10 mJ and hybrid mixtures.

All components inside EX zones must be approved according to ATEX in order to be ruled out as an ignition source.

If the entry of an ignition source from outside of the separation system can be prevented safely, grounding the system components is sufficient.

Grounding prevents electrostatic spark discharge.

Additional conductive and grounded filter elements can be installed.



Explosion pentagon
Despite an explosive environment, an explosion is impossible without an ignition source.

Protection concept ProSens

patented

FSA-tested

Forschungsgesellschaft für angewandte Systemsicherheit und Arbeitsmedizin

For dusts with MIE > 10 mJ with rare ignition sources and low dust concentrations.

Cleaning during system downtimes

If the separation process is interrupted to clean the filter elements, no ignition sources exist.

Ignition source monitoring

The suction ductwork is monitored by a spark sensor.

During the next scheduled filter element cleaning, the potential of an explosive situation can be thwarted by the control in case the entry of an ignition source has been detected.

ProSens ignition source monitoring

Explosion protection

Explosion protection

If the above mentioned measures are inadequate to prevent an explosion and its effects, additional explosion protection methods can be installed.

The standards describe the following protective measures:

- Explosion-proof construction
- Explosion pressure relief
- Explosion suppression
- Prevention of flame and explosion transfer

Containment design

Explosion pressure resistant

Designed for a maximum explosion pressure or a reduced maximum explosion pressure, the filter housing should withstand an explosion without any distortion.

Explosion pressure-surge resistant

Explosion potential is rare if the system is designed according to this category, or to the maximum or reduced explosion pressure. As a general rule, basic safety measures are applied here. The housing might deform as a consequence of an explosion.

Determining the pressure shock resistance to explosion

Keller Lufttechnik performed explosion tests for its filter housings at the German FSA (Research Centre for Applied System Safety and Industrial Medicine) to determine the pressure surge resistance. Depending on the application it is possible to design the housings with a pressure surge resistance of 0.2 bar or 0.4 bar excess pressure (in individual cases up to 2 bar).

Forschungsgesellschaft für angewandte Systemsicherheit und Arbeitsmedizin

Testing the explosion potential of filter housing at the FSA facilities

Explosion protection – pressure relief outdoors or to the outside

Venting panels

Explosion pressure relief for dust extraction systems outdoors or installed adjacent to the exterior wall of the plant. Safety range depends on the system size: 10 - 25 m.

Effective relief surface: 0.5 m²

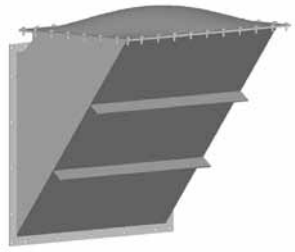
Burst disk

Filter unit with burst disks

Reduction of the safety zone

Outdoor installation: Burst channel
To reduce the safety zone when using burst disks, it is possible to install burst channels, enabling burst disks to be placed vertically instead of horizontally. The flames are deflected by 90°.

Effective relief surface: 0.4 m²



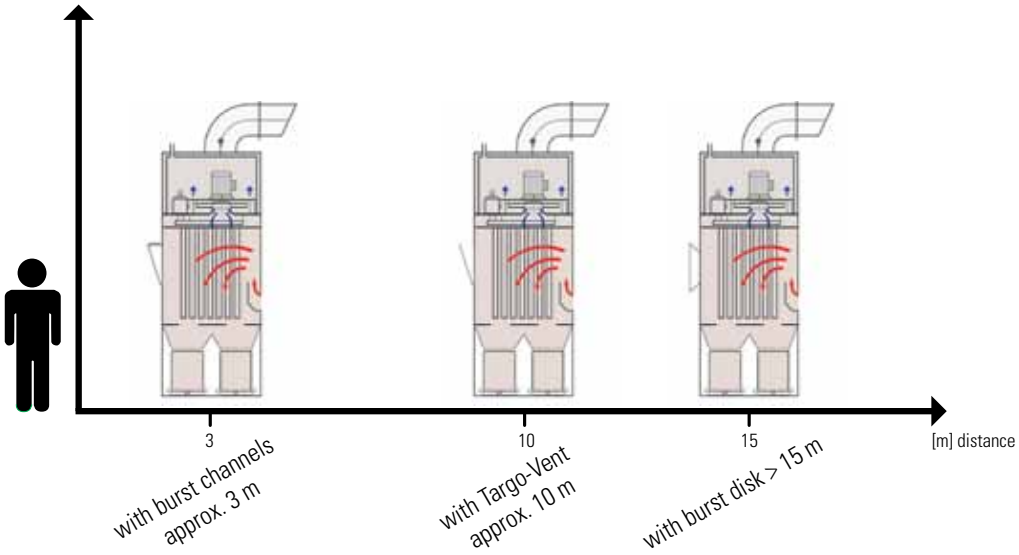
Burst channel

For indoor installation and relief through exterior wall: Targo-Vent
The safety distance can be reduced by using Targo Vent for installation indoors and relief through outer wall. The funnel-shaped enclosure deflects the flames by 45°.

Effective relief surface: 0.35 m²

Relief using Targo-Vent

Example of safety zones for a VARIO 4



Explosion protection with indoor installation

For organic dust

Flameless pressure relief through ProVent

Vario with ProVent

The protection concept ProVent ensures flameless explosion pressure relief. The safety zone is 5 m and can be reduced to 0.5 m.

Features:

- Maximum Kst-Value: 200 bar x m/s
- Dust with MIE > 3 mJ
- Safety distance: 5 m for people; 0.5 m for objects/walls

Effective explosion surface: 0.35 m²

Explosion suppression

Round filter with container for extinguishing agent

Explosion prevention by automatic application of an extinguishing agent. A safety zone is not required. Suitable for reduced maximum explosion pressure. Perfect for toxic dust.

Features:

- Approved for Kst-Values up to 500 bar x m/s
- Ideally suited for installation in the workplace where toxic dust or gas explosion hazards may exist
- Explosion decoupling with extinguishing agent achieved with small additional step, since detection and control are already available

For metal dust

Tested according to DIN EN 14460

patented

Flameless pressure relief by means of TR-1 ProVentPlus

TR-1 ProVentPlus

TR-1-ProVentPlus single separator ensures flameless pressure relief without a designated protective zone.

Flameless pressure relief by means of ProPipePlus

ProPipePlus

Patented ProPipePlus flame trap ensures safe explosion suppression inside closed rooms. The special stainless steel construction is approved for metal dusts, and since 2013 there is an additional design available in aluminum.

Explosion suppressed by ProPipePlus

It has been demonstrated that a safety zone is not required with this particular design.

Decoupling of dirty air ductwork

Tested according to DIN EN 16447

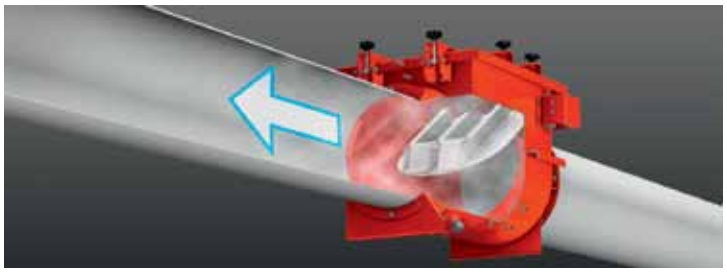
patented

Additional means with a ProFlap back pressure flap

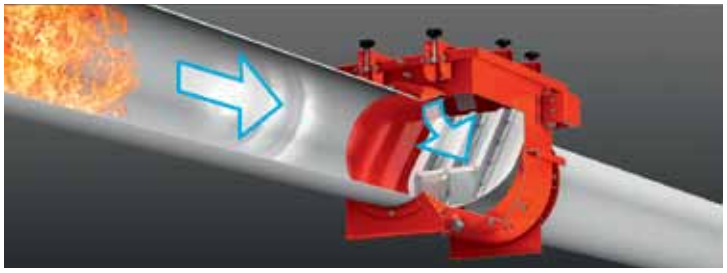
Dust extraction systems with explosion-proof design and e. g., explosion pressure relief, must be decoupled from connected dirty air ductwork.

ProFlap back pressure flap prevents the spread of explosion pressure and flames into other areas.

Staff working at the collection points or suction-equipped components are thereby protected from the effects of an explosion.



The downstream mounted back pressure flap is kept open by means of the air flow



During an explosion inside the protected system, the flap is closed by the advancing pressure inside the ductwork

Decoupling of clean air ductwork

An example using filter elements

With filter elements we assume adequate flame decoupling (not unusable as a protection system). Additional pressure decoupling may be required.

Keller Lufttechnik demonstrated the isolation of filters elements from the effects of an explosion.

VARIO with KLR-Filter

Decoupling of dust disposal

An additional method is with rotary valves.

The blocking function of a rotary valve can be used to stop an explosion from spreading. A modified design prevents ignition from materializing.

A lock achieves the same result. As an alternative, pressure shock-proof design of the dust collection container is possible.

Rotary valve

Explosion prevention and explosion protection according to ATEX guidelines

Additional information

Is my dust explosive? What types of measures can be taken? Answers and a quick solution can be located on our special website **www.exschutz.net**

Project recommendations

Our expert staff is pleased to be at your disposal for additional information. Feel free to benefit from our experience.

Intercontinental Association of Experts for Industrial Explosion Protection e.V. (IND EX e.V.)

Full member

We are full member of IND EX and participate in research work in the field of explosion protection. For this reason we always stay current with the technology.

Explosion demonstrations

Our filtration systems are also used for explosion demonstrations during IND EX special events.

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