

DUST HAZARDOUS AREAS BACKGROUND TO THE IGNITION RISKS OF ELECTROSTATIC CHARGE

What dangers are caused by static charge when handling bulk materials?
Prevent electrostatic charging in accordance with best practice.

Safety through standards and best practice

Working in dust explosive atmospheres carries the danger of causing an explosion of the dust-air mixture. Storage silos/granaries, sieves, mills or filters are typical places where hazardous dust atmospheres occur. Therefore, there are a variety of standards and best practice recommendations to ensure safety for man, machine and environment while working in these zones. The most important are TRGS 727, CLC / TR 60079-32-1:2015, TRBS 2152 and IEC TS 60079-32-1:2013.

Which dust carry a high risk?

First of all, it is important to identify whether there is a potentially dangerous working environment due to explosive dust atmospheres. In order to investigate the explosiveness of a substance in dust / particle form, the IFA (Institute for Occupational Safety and Health of the German Social Accident Insurance) uses a standardized procedure, stated in ISO 6184/-1. Using this method, the examined dusts were classified into dust explosion classes, based on the determined K_{st} value.

This value describes the maximum increase in pressure caused by ignition of the dust-air mixture in a 1 m³ container. The higher the K_{st} value, the more explosive and faster the explosion expands. This also means: If one of the examined dust is classified, it is proven as generally explosive when mixed with air.

Dust explosion class	K_{st} value
St 1	> 0 to 200
St 2	> 200 to 300
St 3	> 300

Table 1: Dust explosion classes¹

In the following you will find an excerpt from the materials of the test series that were classified as explosive. Please note that the explosion capability depends on external influencing factors (such as humidity, particle size, mixing ratio with oxygen).

¹ Cf.: <http://staubex.ifa.dguv.de/html-dokumente/erlt61.htm>

Wood, wood products, fiber:

Cotton, wood, jute, coconut fiber, peat, pulp

Food and feed:

Flour, starch, rice, fruits in powder form

Coal, coal products:

Activated carbon, coke, pitch, soot

Other natural products:

Hops, leather, herbs, straw

Plastics, resins, rubber:

ABS, coating powder, rubber, wax, cell flour

Pharmaceuticals, cosmetics and

Pesticides:

Ascorbic acid, bath powder, herbicide, soap base

Intermediates, excipients:

Anthraquinone, flavor, lead, calcium, casein

Technical-chemical products:

Paints, light stabilizers, putty, washing powder

Metals, alloys:

Aluminum, bronze, iron, brass, magnesium

Other products:

Amongst others ash, binder, PVC powder, abrasive, toner, release agent

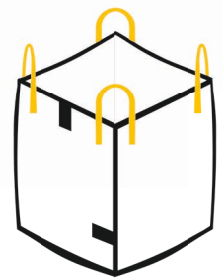
If your material is not on this list, you can use the IFA database to check its explosive potential. The list above is for guidance only and should not be considered as a complete summary.

Which actions must be taken?

Should one or more of your materials in the production process be classified as explosive, further steps are required. Therefore, the TRBS 2152-1 offers a guideline for risk assessment.

Recommended procedure for risk assessment:

First, it should be checked whether there is the possibility of an explosive atmosphere due to dust-air-mixtures in the workplace. These can occur in a variety of work processes, such as grinding, sieving, filling and emptying of products and containers. Subsequently, the maximum amount of



the mixture should be determined in order to assess the explosion hazard. Especially one value stands out in this manual: more than **10 l** of explosive atmospheres are considered dangerous regardless of the size of the room and appropriate protective measures should be taken.² The first step here is to check whether the spread of explosive atmospheres can be prevented completely. If this is not possible, further explosion protection measures are required in order to effectively avoid potential ignition sources.

In order to assess the extent to which your work environment is at risk of explosion, various providers offer risk assessment services with recommendations for action and an ex-zone classification.

Which ignition sources are to be considered for explosive atmospheres?

The TRBS 2152 section 3 lists potential ignition sources that should be prohibited by operational safety standards in explosion protection zones.

These includes, among others:

- Flames and hot gases
- Hot surfaces
- Mechanically generated sparks
- Electrical systems
- Electrical equalizing currents, cathodic corrosion protection
- Static electricity
- Lightning strikes

Static electricity and the related potential energy discharges are a dangerous source of ignition requiring special attention. Both, the material and the equipment can become charged, which can lead to spark discharges of which the energy is well above the minimum ignition energy of the surrounding atmosphere. As a result of induction, objects in the immediate surroundings may be charged and thus also constitute an ignition source.

Electrostatic charge of particles and powders

In many manufacturing processes, the contact of dust / material with the equipment and conveyor is unavoidable. Due to the rapid impact and separation speeds, inadequate conductivity of the materials can lead to static charging of the material surface. This type of charging is due to an incomplete charge exchange during contact.

If it comes to a contact of two neutral materials, an exchange of electrons as a result of the different electron-binding forces takes place. When this contact occurs at high speed, the charges do not have time to return to their starting point and remain on the surface of the contacted material. As a result, on the material with higher electron-binding force occurs an excess of electrons, which means a negative surface charge. On the surface of the second material therefore is an electron deficiency and thus a positive surface charge.

Due to the different surface charging, a high potential difference between the materials takes place. Both surfaces now strive for charge neutrality.

If a sufficiently conductive connection is established between one of the charged surfaces and the ground potential, an abrupt potential equalization takes place. If the charge exchange occurs before both materials touch, the resulting distance can be an ignition-effective spark gap. In addition, if the voltage difference is higher than the breakdown voltage of the surrounding insulator, a spark skip is highly probable.

Even smaller objects have a capacity that is large enough to cause an ignition-effective discharge. A small container up to 50 l, with a capacity of up to 100 pF, can store enough charge to cause a high-energy spark. In addition, it is assumed that the container stands on an almost insulating surface.

Alternatively, a resistance of $10^{10} \Omega$ is assumed, which equals the resistance value of a concrete floor with abrasion-reducing plastic insert.³ Moreover, an assumable charging current of 10^{-6} A which was measured during filling processes, is given.

$$U = R \cdot I$$

$$U = 10^{10} \Omega \cdot 10^{-6} \text{ A} = 10^4 \text{ V}$$

Maximum energy of the spark discharge:

$$W_{\max} = \frac{1}{2} \cdot C \cdot U^2$$

$$W_{\max} = \frac{1}{2} \cdot 0,1 \cdot 10^{-9} \text{ F} \cdot (10^4 \text{ V})^2$$

$$W_{\max} = 5 \text{ mJ}$$

Furthermore, larger containers with higher capacity can cause significantly greater discharges.

2| Cf.: TRBS 2152-1 Sec.: 3.4.1.(2)

3| Cf.: TRGS 727 att.: H

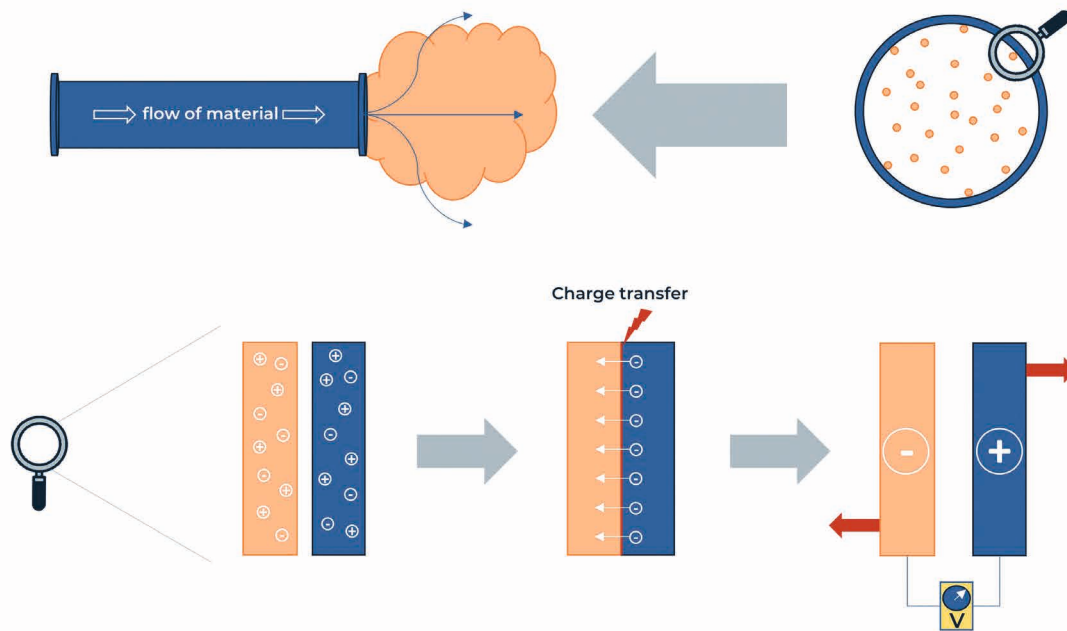


Figure 1: Static charging, dust in pipe

Minimum ignition energies of dusts

The classification of dusts regarding their minimum ignition energy, as determined by the employer’s liability insurance association for raw materials and chemical industry (BGRCI), confirms the ignition efficiency of the calculated discharge energy. It becomes clear that electrostatic charging must be prevented in order to ensure operational safety.

Type of dust	Value of MIE	Example
very easily inflammable dusts	< 1 mJ	fine aluminum dusts
easily inflammable dusts	1 ... 10 mJ	wax dust
moderately inflammable dusts	> 10 ... 100 mJ	sugar or milk powder dusts
hardly inflammable dusts	> 100 mJ	wheat flour, coal dust

Table 2: Minimum ignition energies of dusts

How can the static charge be prevented?

Static electricity can be prevented by dissipating electrical energy to ground potential. Therefore, a sufficiently conductive connection to a designated grounding point is needed. The consensus of all standards confirms a sufficient conductivity below the maximum resistance value of $10^6 \Omega$ in the discharge connection.⁴ This value is based on calculations and

4) Cf.: IEC 60079-32-1:2013 Sec.: 13.2.2

the fact that up to a maximum charge of 100 V there is no risk of ignition from electrostatic charge. At this potential difference, the required spark gap is so short that a self-quenching effect occurs. If this value is related to the maximum charging current of 10^{-4} A , the associated resistance can easily be calculated using Ohm’s law:

$$U = R \cdot I$$

$$R_{\text{max}} = \frac{100 \text{ V}}{10^{-4} \text{ A}}$$

$$R_{\text{max}} = 10^6 \Omega$$

However, only connecting the grounding cable is not enough to ensure a safe connection.

An unnoticed break in the cable or a soiling at the contact point may be sufficient to reduce the conductivity of the compound so far that no or only insufficient charge can be discharged. As a result, static charge may occur.

Intelligent monitored grounding solution

Industry best practice consists of a monitored grounding solution. TIMM has developed tailored Grounding Control Devices for various applications.

The user only has to attach the clamp to the object to be grounded. The EKX-4 performs and indicates a secure grounding connection via the green light of the LED display to the user and transmits the release electronically via the control outputs. If there is no sufficient connection, this is indicated

by red LEDs, the control outputs are blocked and the filling is interrupted by the loading platform control system.

All Grounding Control Devices from TIMM implement our Intelligent Explosion Protection Concept (IEPC), offering the highest level of safety and user-friendliness. The types of protection “increased safety“ and “intrinsic safety“ make the devices easy to install and configure at the loading platform. Reliable detection of the object to be grounded avoids misuse by the operator and forces the grounding clamp to be clamped before each filling / emptying.



Figure 2: Grounding Control Device EKK-4 for silo trains, railway wagons, tank trucks, barrels and containers

In addition, the EKK-4 has a self-diagnostic function continuously monitoring all safety-relevant functions and to clearly identify possible faults with fault codes.

The TIMM Grounding Control Devices are all state-of-the-art and approved for use in hazardous areas of zone 21 and 22 in accordance with ATEX directive 2014/34 /EU. Only grounding systems that implement the state of the art can fully meet best practice requirements and make a decisive contribution to the safety of handling bulk materials.



Figure 3: Grounding Control Device EKK-FIBC for Big Bags / FIBC type C

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Please find further information on our website <https://www.timm-technology.de/en/>.

Sources: TRGS 727 (01/2016); „Vermeidung von Zündgefahren infolge elektrostatischer Aufladungen“; IEC 60079-32-1:2013 (2013); “Explosive atmospheres - Part 32-1: Electrostatic hazards, guidance“; CLC/TR 60079-32-1:2015 (2015); TRBS 2152-1 (2012); „Technische Regeln für Betriebssicherheit - Gefährliche explosionsfähige Atmosphäre“; Handbuch des Explosionsschutzes. (P.D.-I. Steeen, Herikus; Hrsg.) Weinheim: WILEY-VCH Verlag GmbH. (2000); <http://staubex.ifa.dguv.de/html-dokumente/erlt61.htm> (As of 16/10/2018); <https://www.bgrci.de/exinfo/ex-schutz-wissen/expertenwissen/brennbare-staeube/322-sind-elektrostatische-entladungen-fuer-staubluft-gemische-zuendfaehig/> (As of 16/10/2018); ISO 6184/1; „Explosionsschutzsysteme; Teil 1: Bestimmung der Explosionsindices von brennbaren Stäuben in der Luft“