Electrostatics

Charging

Triboelectric charging is the main cause of electrostatic charging.
A typical example is shown in fig. 1.

A non-conductive powder or liquid is moved through a conductive pipe. During the movement, there is intense contact between the product and the pipe and, since electrons will be attracted more to one material than another, there will be an exchange of charge in the contact area. That will result in the product leaving the pipe having a negative charge and the pipe having a positive charge (or vice versa). The main conditions for creating a triboelectric charge are:

- initial close contact between two different materials,
- rapid separation of the two materials,
- at least one of the two materials being non-conductive.

In addition to the movement of non-conductive powders or liquids through metal pipes, other typical examples where charging may arise include:

- movement of powders or liquids through non-conductive (plastic) pipes,
- intense friction between objects,
- rapid emptying of bags or bins,
- belts running over rollers.

Electrostatic charging can also be caused by influention or induction. A (conductive) object is placed within a strong electrostatic field. The field causes the electrons in the object to move, resulting in a charge.

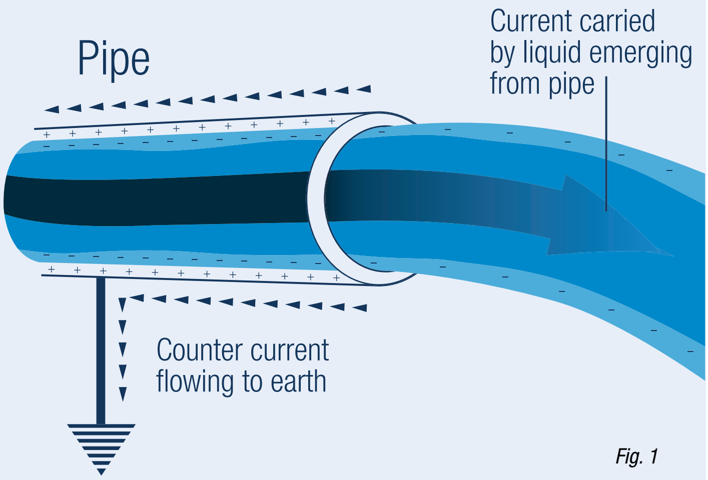


Fig. 1

Discharges

An overview of the various types of discharges is shown in fig. 2.

- A spark discharge occurs when a charged conductor approaches another conductor. For example: in fig. 1, a spark discharge could occur when the earthing contact of the pipe is lost. Such spark discharges can be very powerful when conductors with a large capacity are involved.

- Brush discharges are well-known. They are commonly seen in the crackling that may occur on plastic foils or nylon clothing, which is the result of a (partial) discharge from a non-conductive material to a conductor. Brush discharges may also occur on the charged surface of non-conductive liquid in a tank when, for example, a level gauge or a sampling device is brought close to the surface. The energy content is limited, however. Brush discharges may ignite most gases, but cannot ignite most dusts.

- Corona discharges have been known for a long time. In the Middle Ages, they were viewed with religious awe, especially by sailors, and were known as Saint Elmo's fire, after St. Elmo, the patron saint of sailors. They arise around highly charged pointed objects or around earthed objects extending into a strong electrostatic field. The electrical field at the point causes ionisation of the air around it. The energy content of corona discharges is very limited. It is not even dangerous for most gases.

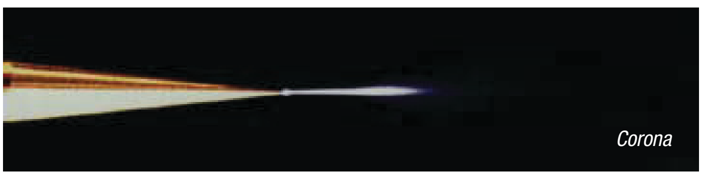
- Lightning discharges are extremely powerful, but are not usually relevant to industrial processes.

- Cone (or Maurer) discharges or a type of brush discharge that can occur along the conical surface of charged, non-conductive products stored in silos. Studies have shown that cone discharges can cause dust explosions in a silo if conditions are right.

- Propagating brush discharges are very powerful and can ignite almost all explosive atmospheres. These typically occur in layered structures, such as metal vessels with a non-conductive liner, or non-conductive flexibles with a conductive (metal) reinforcement. Earthing the metal will not prevent propagating brush discharges!

The following table summarises the various discharges and the corresponding hazards:

discharge type	*energy content mJ*	*hazardous for most vapour/ gas-air mixtures*	*hazardous for dust-air mixtures*
spark	*< 10.000*	*++*	*+*
corona	*< 0.1*	*-*	*-*
brush	*< 3-4*	*+*	*?*
propagating brush	*< 3.000*	*++*	*++*
cone (Maurer)	*< 10-25*	*++*	*+*



Corona

Prevention

Even though an electrostatic discharge may not cause an explosion in every situation, it is often advisable to take steps to prevent them. At the least, discharges are a nuisance for operators; they may also damage electronics, however. Electrostatic charging and discharging can be prevented in several ways:

- Maintain a high moisture content. This will create a thin layer of water on surfaces, making them conductive to varying degrees (depending on the material) and prevent charging.
- Reduce speeds. Separating materials rapidly is an important condition for generating charges. Charging levels therefore can be reduced by reducing speeds. Conversely, processes that do not have any problems related to electrostatics may develop them if the speed is increased.
- Only use conductive materials. When all materials in a process (equipment, including flexibles and gaskets), as well as the products used (liquids, powders) are conductive, no charging – and therefore no discharging – will occur. In practice, however, it is very difficult to achieve this situation.
- Earth all conductive items (see fig. 1). This does not prevent the charging mechanism, but will prevent high charge levels on these conductive items (e.g. the pipe in fig. 1).
- Ionise the air. This constitutes making the air conductive. With ionisation systems, the charge can be removed from non-conductive materials, such as plastic foils, and discharging can be prevented.

VSW (Very Serious Warning): replacing non-conductive items with conductive or semi-conductive items will prevent brush discharges. If these conductive items are not earthed, however, much more powerful spark discharges could be a result. Deciding, for example, to start using anti-static bags this year and to install an earthing system for the bags next year is very dangerous and will not offer any consolation whatsoever in the event of an incident, regardless of the reason for postponing the earthing system.

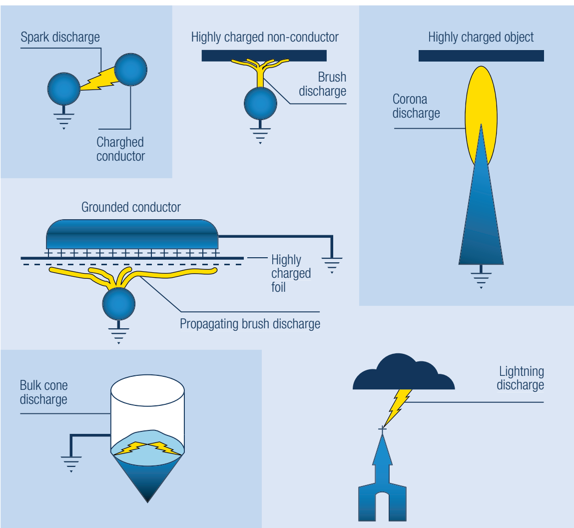


Fig. 2

Earthing

Although it should now be clear that earthing alone is not enough to prevent all types of electrostatic discharges, earthing all conductors will at least prevent hazardous spark discharges. That is why it has been common practice in the petrochemicals industry for many years – and increasingly in other industries, as well – to link up all conductive objects. From a technical perspective, there are many situations where having dedicated earthing connections is not required. This is the case, for example, when the way that the objects are mounted ensures that the resistance between them will not exceed 1 MOhm. To avoid having to carry out a detailed analysis for each connection and to making visual and other inspections easier, designers often decide to have dedicated, clearly visible, earthing connections: usually green/yellow cables or (copper) latches.

Special care is required with mobile objects, such as tanker trucks, IBCs (transportable bins) and FIBCs ("big bags"). It is impossible to create permanent earthing connections for this category of objects, but earthing is required before filling or emptying. Earthing clamps are usually used to earth such objects. A simple earthing installation consists of an earthing clamp which is connected directly to earth by a cable. There are some limitations for such systems:

- The risk analysis should take into account the possibility that earthing will have been forgotten. Are the consequences acceptable?
- If the object to be earthed is highly charged, there may be a powerful spark discharge when the earthing clamp is connected. The charge will move towards the earthing clamp. This is not acceptable in a potentially explosive atmosphere.

When more reliable earthing is required, earthing systems are usually used. Such systems include an earthing clamp that is connected to a controller. The controller will determine whether the earthing clamp is clamped to a conductor. If it is, and only then, the controller will provide a connection to earth. Such controllers usually also provide output contacts that only make it possible to start filling or emptying processes after a signal has been received from the controller to confirm that correct earthing has been established.

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Tanker trucks

Earthing systems are frequently used to earth tanker trucks. A common fault is that the operator forgets to release the earthing clamp before the truck drives off. In order to prevent damage to the control unit when this happens, it is advisable to use a break-away connection and to have spare clamps on hand.

Capacitive earthing systems can be used to confirm that the tank is earthed correctly. In addition to verifying that, there is a conductor connected to the clamp. The controller now also checks the capacity of the conductor to determine whether it is within the common range for a tanker truck. If it is not, the clamp has probably been connected improperly to an insulated part of the truck or has been connected to some other device (not a truck).

In winter, salty water (from the road salting systems) might render the tyres conductive and create a fault. The system is now measuring the capacity of the earth. To avoid such situations, these types of controllers usually have an override key switch.

FIBC

The growing awareness of the hazards of electrostatic discharges on FIBCs has led to increasing demand for anti-static FIBCs (known officially as "C" type FIBCs), which need to be earthed during filling and emptying. A double-clamp system is often used for such applications. As well as providing earthing, the controller now also checks whether FIBC is actually a C type FIBC by confirming that the resistance between the two clamps is below a critical value.

Summary

Electrostatic charging and discharging can occur during many processes. Depending on the hazards, it might be necessary to use anti-static materials. As a general rule, conductive (or anti-static) materials need to be earthed. Earthing systems are recommended for mobile systems. Intelligent earthing systems can prevent incorrect earthing. It is important to remember that earthing only prevents spark discharges. Other discharges may still occur. ISMA consultants can help to determine whether additional measures are required.

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This completely renewed, capacitive earthing monitor does not have to be calibrated any longer. Unpack, plug it in and you are ready!

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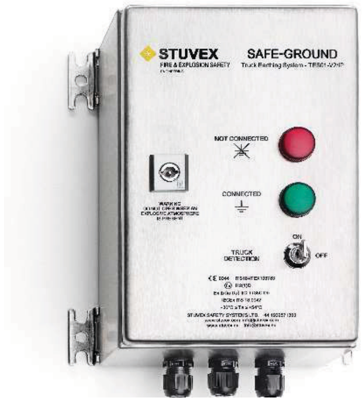
Capacitive earthing monitors often have difficulties with operating in extreme weather conditions (snow, salt, etc.) leading to a loss of performance. This new monitor is able to override the capacitive section by means of a key or interlock contact. However, good and accurate operation, even during extreme weather conditions has to be ensured.

Available in two versions: IP65 (zone 22) and EX (zone 1/2/21/22).



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