

STATIC ELECTRICITY AND POWDERS

Static electricity continues to cause problems when handling and processing powders. Although costly in terms of production figures many problems, such as powders sticking to surfaces, are often simply lived with in the mistaken belief that nothing can be done. However, if the risk is one of fire and explosion, as is often the case, doing nothing is not an acceptable option. This document provides some basic background information on the issues and offers a structured approach to assessing the likely problems and hazards for a particular process. Clearly in such a short article we cannot cover all eventualities and in many situations it will be crucial to seek expert advice.

ELECTROSTATIC CHARGING OF POWDERS

A powder will exchange charge with anything it contacts, including process plant. The result will always be a tendency for a moving powder to carry away one polarity of charge (positive or negative) and leave behind the opposite polarity. Whether charged plant or powder is problematic or create a hazard, depends on the rates of charge gain and charge loss, both of which occur simultaneously. When it comes to assessing the likelihood of developing problematic charge levels we need to look closely at the electrostatic properties of powder:

Resistivity is measured in Ohm-metres ($\Omega.m$) and represents a powder's ability to transfer charge through its bulk. Values to remember* are:

- Less than $10^6 \Omega.m$ indicates that the material is conductive where static electricity is concerned.
- More than $10^9 \Omega.m$ and the material is considered insulating.

Charge relaxation time is measured in seconds (s) and is a very practical way of showing how quickly a powder can lose charge. It is complementary to, but not the same as, resistivity. Values to remember* are:

- Less than 0.1 s is considered a fast charge relaxation time in most situations.
- More than 100 s is considered slow.

Chargeability is measured in Coulombs per kilogram ($C.kg^{-1}$) and indicates the likely worst-case charge level for the powder. Chargeability values to remember* are:

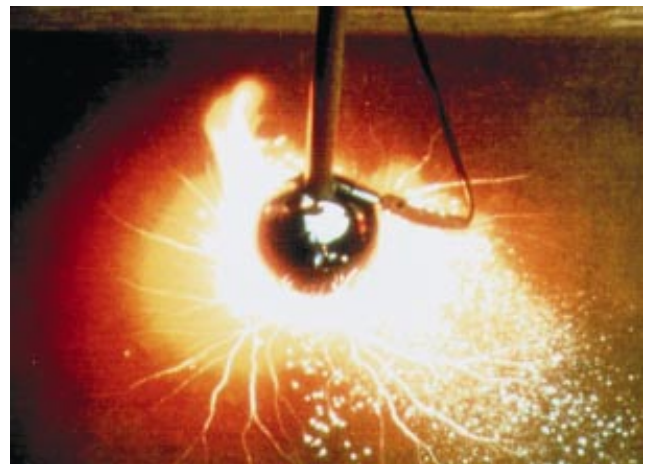
- Less than $10^{-9} C.kg^{-1}$ is a low chargeability powder.
- More than $10^{-6} C.kg^{-1}$ is a high chargeability powder.

Each one of these properties is important in its own right but only by obtaining all three can the full picture be seen. Furthermore, the importance of humidity in static problems means that each must be measured at no less than two relative humidities.

The plant is equally important, for it is here that the opposite charge is left behind. If it is a good conductor (such as a metal) and properly earthed the charge will be lost as quickly as it is produced and there will be no evidence on the plant of powder charging having taken place. However, insulating plant components (even linings or coatings), or poorly earthed metal components can lead to charge accumulation on the plant.

Charge accumulation on either the plant or the powder can lead to a problematic attractive force between them or, sooner or later, an electrostatic discharge (spark-type event).

* These are typical values only and can only be properly considered in the context of a full assessment.



ELECTROSTATIC DISCHARGES

There are a number of different types of electrostatic discharge, each with different characteristic energy levels. These are itemised below.

Spark discharges occur from conductors, which includes plant items, portable metal objects, people, or even the bulked powder itself. The energy available from such a discharge depends on the size and position of the object, but in practice will rarely exceed 250 mJ, and can be avoided by effective earthing.

Brush discharges occur from the surface of insulators, and may have an energy up to about 4mJ. Measures can be taken to prevent charging but the only sure way of avoiding brush discharges is to avoid insulators.

Propagating brush discharges occur from thin insulating materials usually when in contact with a conductor. A typical scenario is a plastic liner inside a fibreboard keg (fibreboard is a good conductor in the context of static electricity). This combination allows unusually high charge levels to accumulate, and the discharge energy can then exceed 1000mJ. In this case avoidance is by careful selection of the liner.

Cone (or bulking) discharges occur across the surface of an insulating powder being delivered to a heap or container. This type of discharge occurs because highly charged powder particles, which naturally repel one another, are forced together under gravity. The energy available from this type of discharge depends on particle size and container size and the maximum is currently believed to exceed 500mJ. Avoidance can be achieved by reducing the powder charge before it settles, or by reducing the heap/container diameter.

Corona discharge is a benign form of electrostatic discharge. It produces a steady current by ionisation of local gas around a sharp feature. It is not capable of igniting common materials, although there

Safety advice from the experts in process safety.

is some uncertainty when it comes to unusually sensitive gases, such as hydrogen.

Lightning-like discharges are associated with extremely large volumes of dispersed charged particles, such as storm clouds. It is generally agreed that this type of discharge is very unlikely to occur even in large-scale industrial plant.

Once the energy that might be available in the form of electrostatic discharge from plant or product is known it is important to know the sensitivity to ignition of the materials being used.

EXPLOSION SENSITIVITY

It is worth noting here that a discharge at the limit of human perception is more than enough to ignite many common vapours and gases, and may even ignite sensitive powder clouds.

Knowing the energy of discharges that could occur from plant or product is only helpful if you also know the energy that could ignite flammable materials present. For many pure solvent vapours and gases this information is available in the literature. For most powders literature values should not be used and may not even be available. The tests required for this part of the assessment are:

- **A/B Classification:** a screening test to establish if the powder is flammable when dispersed as a cloud.
- **Minimum Ignition Energy (MIE):** for determining the lowest energy required to ignite the cloud.

In some situation the MIE of a layer (rather than a dispersed cloud) may be relevant. Remember, too, that failure to ignite with these tests does not automatically mean that other ignition sources, outside the scope of this article, will also be safe. (For further information on the broader issues of powder hazard profiling please ask for a copy of our

CHARP™ leaflet or talk to one of our Consultant Engineers for expert and confidential advice.)

SYSTEMATIC ASSESSMENT

Using the information described above, and knowledge of the plant and process, a systematic approach to identifying electrostatics problems and hazards requires that the following five questions are answered:

- i) Is there a flammable atmosphere, and what is its sensitivity to ignition? (MIE is the key indicator of sensitivity in the present context.)
- ii) Is there an electrostatic charge generation mechanism? (Consider movement of materials and their electrostatic properties.)
- iii) Can charge accumulate anywhere? (Look for isolated conductors or insulators and consider electrostatic properties of process materials.)
- iv) Is there a discharge mechanism? (If charge can accumulate it must almost always be assumed that a discharge could occur.)
- v) Could there be enough energy in the discharge to ignite the flammable atmosphere? (Compare the possible discharge energy with the MIE.) If there is no flammable atmosphere, could the amount and location of accumulated charge cause other processing problems?

EXPLOSION SEVERITY AND PROTECTION

If an explosion *could* occur its severity, and how to protect against it, must also be determined and our Consultant Engineers will be pleased to also provide advice in this respect.

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