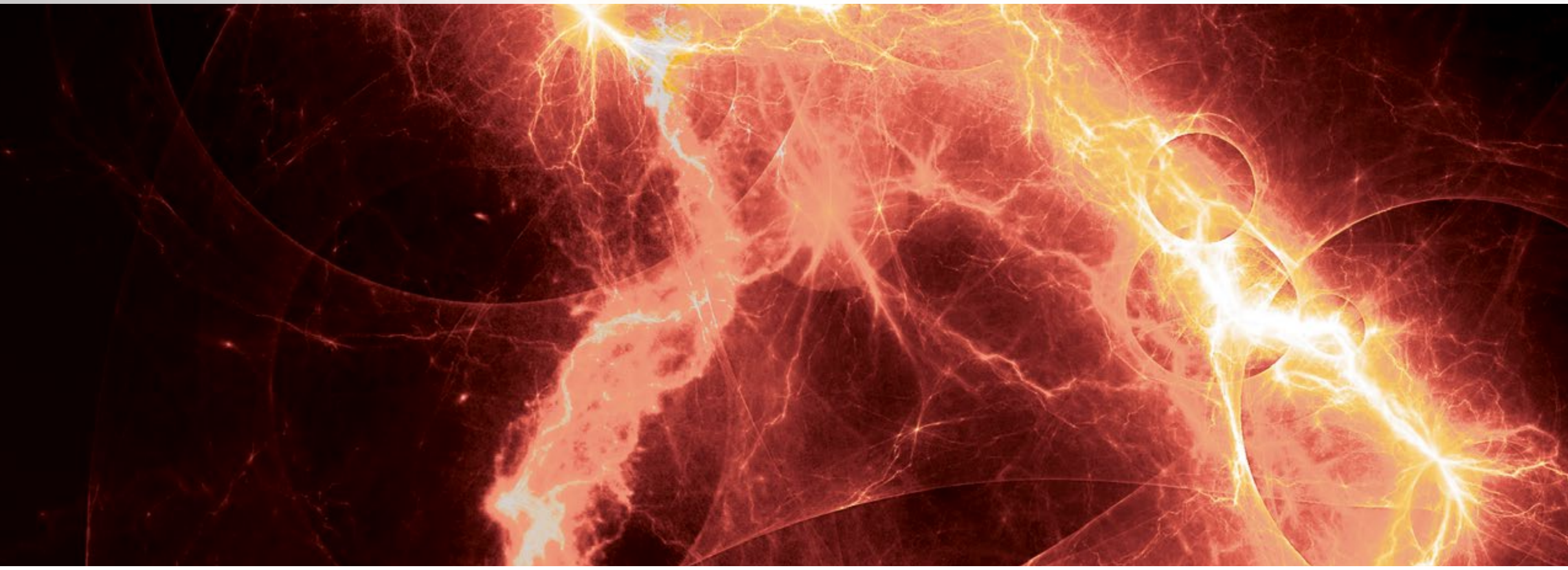

FOCUS ARTICLE

Electrostatic Hazards Associated with Liquid and Powder Processing

Often an electrostatic ignition hazard arises when the electrostatic charge generated in a process is allowed to accumulate to levels sufficient to give rise to electrostatic discharges. Thus, the first step in an electrostatic hazard assessment is identifying where in the process electrostatic charge can be generated and accumulated. Next, if the generation and accumulation of charge cannot be controlled, the types of electrostatic discharges that can arise must be identified. Lastly, in order to verify that a hazard exists, the effective energy of these discharges must be determined and compared to the minimum ignition energy (MIE) of the prevailing flammable atmosphere or the dielectric strength of lining (the natural limitation of charge accumulation) in vessels, containers and piping.

A systematic approach for **identifying electrostatic hazards** is outlined in the National Fire Protection Association (NFPA) Recommended Practice # 77. This document states that an assessment of each process should be conducted to identify electrostatic hazards, including ungrounded conductors, such as metal devices and equipment, personnel, as well as items made from electrically insulating materials. The assessment should:

1. Be conducted under actual operating conditions, to the extent practicable;
2. Be based on actual measurements of resistance-to-ground, electrical continuity, electric field strength, streaming current, and accumulated charge; and
3. Consider prevailing environmental conditions that may affect charge generation and accumulation.

This paper discussed some of the measures that could be considered for controlling potential electrostatic hazards during liquid and powder handling operations.

Liquid Handling / Processing

Electrostatic charge is most commonly generated on liquids when they flow through pipes, hoses, and filters and when they are stirred. Liquids can also become charged if they are transferred into a container that is either already charged (e.g. an electrostatically charged plastic container) or becomes charged while containing the liquid (e.g. when the outside surface of a plastic container containing a liquid is rubbed). Charge can accumulate within the liquid if it is insulating in electrostatic terms or electrostatically isolated from ground. The accumulation of electrostatic charge on the liquid's surface can give rise to electrostatic discharges from the surface. These discharges can be sufficiently energetic to ignite flammable vapor, such as that which may be evolved in the vessel headspace from a flammable liquid, or a liquid processed above its flash point.

The flow and agitation of liquids can also cause insulating (plastic or rubber) and ungrounded conductive (metal) vessels, piping, and fittings to become electrostatically charged. Charge accumulated on insulating (plastic or rubber) and ungrounded metal devices and equipment can give rise to electrostatic discharges sufficiently energetic to ignite flammable atmospheres. Electrostatic charge accumulation on the insulating linings (glass or plastic) of vessels and pipes could also result in the creation of pinholes in the lining, causing leaks, corrosion of the piping or vessel, and contamination of the liquid. It should be noted that pinholes could even occur under inert atmospheres. Consequently, it is essential to identify and eliminate or control electrostatic charge generation, accumulation, and/or discharges.

Approaches for **controlling electrostatic hazards** associated with liquid processing include:

> **Raising the Liquid's Conductivity**
The potential electrostatic hazard posed by a liquid can be reduced by increasing its electrical conductivity. Specifically, it is desirable to increase the conductivity of single-phase liquids above 100 pS/m (picosiemens per meter), and liquids containing solids and immiscibles above 1,000 pS/m. This can be accomplished through the addition of conductive liquids or antistatic additives.

> **Grounding of the Liquid**
Efforts should be made to keep liquids in continuous contact with electrical ground, even in insulating vessels and plastic-lined piping, in order to minimize the accumulation of electrostatic charge on the liquid. In insulating vessels, a suitable pathway may be provided by a grounded metal bottom runoff valve, a grounded tantalum patch below the liquid surface, or a grounded metal dip pipe. The incidence of pinholing can be eliminated by using an static dissipative or conductive lining.

> **Limiting the Liquid Velocity**
Limiting the liquid velocity during filling operations helps to reduce electrostatic charge generation during pipeline flow, as well as minimizing splashing and spraying in the receiving vessel or container. If flow velocity limitations cannot be observed or if a grounded metal dip pipe cannot be used, it may not be possible to dissipate electrostatic charge from the liquid at a rate sufficient to reduce the probability of ignition from an electrostatic discharge from the liquid to a suitably low level. Therefore, in such cases, inerting of the vessel or container before and during filling should be considered in order to minimize the fire and explosion risk.

> **Managing Electrostatic Hazards During Filtration**
Liquids are often passed through a filter before they are introduced to a receiving vessel or container. The flow of liquids through filters is often characterized by the generation of relatively high levels of electrostatic charge due to the relatively large amount of surface area available for contact. It is desirable to dissipate the electrostatic charge from a flammable liquid before it enters a receiving vessel in order to reduce the potential electrostatic ignition hazard. This is typically accomplished by locating filters as far upstream of receiving vessels as possible, so that charge can be dissipated from the liquid in the grounded metal piping downstream of the filter before the liquid is introduced to the vessel.

> **Managing Electrostatic Hazards During Agitation**
Because electrostatic discharges from the liquid surface are inherent to the operation, it is generally recommended that agitation of electrically insulating liquids be conducted under an inert atmosphere.

Powder Handling / Processing

In this section it is assumed that the powder DOES NOT contain any flammable solvent and it is handled and processed in an atmosphere free from flammable gases and vapors.

> **Charge Generation**
Although the magnitude and polarity of charge is usually difficult to predict, charge generation should almost always be expected whenever powder particles come into contact with another surface, or each other. It occurs, for example, during mixing, grinding, sieving, pouring and pneumatic transfer. The chemical composition and the condition of the contacting surfaces can often influence the charging characteristics.

> **Charge Accumulation**
Generally powders are divided into 3 groups depending on their ability to retain static charge even if the powder is in contact with an electrically grounded conductive object.

This ability is known as Volume Resistivity:

- Powders with Volume Resistivity up to about 106 Ω.m are considered conductive,
- Powders with Volume Resistivity in the range 106 Ω.m to 109 Ω.m, are medium resistivity powders,
- Powders with Volume Resistivity above 109 Ω.m are high resistivity powders.

Charge will accumulate on a powder if the charge generation rate exceeds the rate at which the charge dissipates to containment or the atmosphere.

> **Electrostatic Discharges**
The accumulation and retention of charge on powder or equipment creates a dust explosion hazard only if the charge is suddenly released in the form of a discharge with sufficient energy to ignite the dust cloud. Potentially incendive discharges resulting from charged powder and equipment include: spark discharges, brush discharges, propagating brush discharges and cone (bulking) discharges.

General Precautions

> **Bonding and Grounding**
Spark discharges can be avoided by electrically grounding conductive items such as metal devices and equipment, fiberboard drums, low resistivity powders and people.

> **Use of Insulating Materials**
Where there could be high surface charging processes, non-conductive materials should not be used, unless the breakdown voltage across the material is less than 4 kV. Examples of non-conductive objects include flexible connectors, hoses, plastic pipes, containers, bags, coatings, liners, and filter elements.

> **Charge Reduction by Humidification**
High relative humidity can reduce the resistivity of some powders and increase the rate of charge decay from bulked powder in grounded metal containers. However, in most cases this will only be effective if a relative humidity in excess of 65 % is maintained. This is often impracticable due to agglomeration issues.

> **Charge Reduction by Ionization**
Localized ionization (corona discharges), from sharp, grounded, conducting probes or wires can, on occasion, be used to reduce the level of electrostatic charge from powder particles entering a vessel. Electrostatic ionization devices are not, however, without problems, and should only be used after consulting expert advice.

> **Explosion Protection**
In some powder handling processes it is not possible to avoid having both an explosible dust cloud and hazardous build up of charge. In those situations additional measures should be taken to prevent or protect against the consequences of dust explosions. These include inerting, use of explosion resistant equipment, explosion venting or explosion suppression.

It should be noted that the above precautions are not intended to be exhaustive or all-inclusive. Rather, they are the precautions most commonly employed, and address some of the more common liquid and solid processing operations. These precautions are necessarily general in nature and therefore may not be appropriate for all applications. Additional or different precautions may be required depending upon the specific application or conditions that could not have been reasonably foreseen. Additional precautions concerning the operations covered in this document and other operations should be reviewed. Expert advice should be sought as necessary.

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- Regulatory testing: REACH, UN, CLP, ADR, OSHA, DOT
- Electrostatic testing for powders, liquids, process equipment, liners, shoes, FIBCs

Specialist Consulting (Technical/Engineering)

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- Electrostatic hazards, problems, and applications
- Reactive chemical, self-heating, and thermal instability hazards
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