Safety & Security

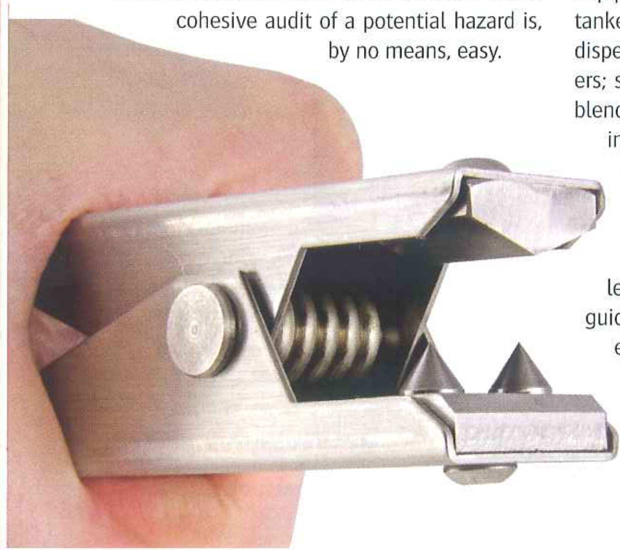
Safeguarding against the hazards of static electricity

Any person responsible for the safety of employees, colleagues, plant equipment and plant property, needs to determine if their processes have the potential to discharge static sparks into flammable or combustible atmospheres.

Static ignition hazards occur at the nuclear level which makes it difficult to visualise how, and why, static electricity is a hazard in industries where flammable and combustible products are regularly processed. If you consider that a walking a cross a carpet can generate up to 35,000 volts on a person wearing insulating footwear, it is easy to see how normal, everyday processes can generate potentials well in excess of 10,000 volts.

For a small object like a bucket, which has a typical capacitance of 20 pico-farads, the total energy available for discharge at 10 KV is 1mJ. This is higher than most flammable vapour minimum ignition energies (MIE's). Scaling up, the MIE available on a human, at 10 KV, would be 10mJ. In powder conveying operations voltages of the order of 1000 KV can easily be generated on parts of the conveying system. Road tankers undergoing loading can reach MIE levels of 2250 mJ.

Complicating matters further, ignitable electrostatic discharges can occur in many forms ranging from spark discharges, propagating brush discharges, bulking brush discharges, to corona discharges. The effort required to assess, determine and combine these variables into a cohesive audit of a potential hazard is, by no means, easy.



STANDARDS FOR STATIC GROUNDING CONTROL:

Fortunately, there are several internationally recognised standards that provide guidance on ways to limit electrostatic hazards enabling those of us responsible for worker health and safety minimise the risk of incendive static discharges. Hazardous area operators who can demonstrate compliance with these standards will go a long way to providing a safe working environment and preventing the ignition of ignitable atmospheres. The most comprehensive standards are:

NFPA 77: Recommended Practice on Static Electricity (2007).
Cenelec CLC/TR 50404: Code of practice for the avoidance of hazards due to static electricity (2003).
American Petroleum Institute API RP 2003: Protection against Ignitions Arising out of Static, Lightning and Stray Currents (2008).
API RP 2219: Safe Operation of Vacuum Trucks in Petroleum Service (2005).

The standards, particularly NFPA 77 and CLC/TR: 50404, describe a range of processes where static charges can be generated including flow in pipes and hoses; loading & unloading of road tankers; railcar loading & unloading; filling and dispensing portable tanks, drums and containers; storage tank filling and cleaning; mixing, blending and agitation operations; the conveying of powders and other operations. The API RP 2003 standard focuses on road tanker (tank-truck) loading and railcar filling operations, storage tank filling and general operations involving petroleum products. API 2219 provides detailed guidance on protecting vacuum trucks from electrostatic hazards.

The standards outline what factors can be identified and controlled to limit electrostatic hazards and these controls typically depend on:

- Preventing the accumulation of static charges on material, people and equipment.
- Finding ways to limit the generation of static charges.

Controlling the generation of static charges is linked to finding ways of minimising the relative velocity of materials, be that flow velocities of liquids in a pipe or the RPM of a mixing process. Still, even lower velocities can separate enough charges to set up the right conditions for an electrostatic discharge. NFPA 77 (5.1.10) states that the transfer of just one electron in 500,000 atoms is required to generate voltages with enough energy to ignite flammable atmospheres.

Effective grounding and bonding is presented in the standards as the primary means of protection from electrostatic hazards and is the most straight forward, secure and cost-effective means of ensuring static hazards are managed and controlled correctly. Eliminating the accumulation of static charges will eliminate the static hazard.

Where the rate of charge generation exceeds rate of charge dissipation => Charge Accumulation => Static Hazard

GROUNDING AND BONDING

The ground (earth) has an infinite capacity to absorb charges and "grounding" (earthing) is the act of connecting a body to an electrode (or other buried structure) that has a verified contact resistance to the ground. Grounding provides a path for static charges to rapidly flow to ground, reducing the voltage of the object to zero and thereby eliminating the presence of an ignition source.

The general acceptable maximum resistance to ground is 25 ohms in the U.S and 10 ohms across Europe. "Bonding" connects objects so that they are at the same electrical potential preventing discharges when they are positioned in close proximity to each other. If bonding is carried out, it is preferable to ensure that one of the bonded objects is connected to ground, thereby ensuring all parts of the bonded system are at zero electrical potential.

Given that grounding is the primary source of static hazard prevention it is important to understand what parameters can be indentified as providing a satisfactory level of protection. The key to static hazard protection is ensuring that the path between the charged object and the static ground is of a sufficient quality to dissipate the static charges safely and rapidly to ground.

The majority of plant equipment at risk of static charge accumulation is made of metal. Metals are excellent conductors and the natural resistive properties of metals ranging from copper through to steel means that electrical resistance to the transfer of charges from the body is low, provided that the body has good contact with ground. If the metal body is not grounded, this positive characteristic can quickly become a negative as isolated metal conductors are the primary source of static spark ignition hazards.

The maximum value of resistance present in metal circuits, which includes the body at risk of static charge accumulation, should be equal to or less than 10 ohms and is the benchmark value of resistance recommended by all four standards. If a resistance of 10 ohms or more is detected then there is a likelihood that the grounding cable has been compromised and should be checked for corrosion or breakages.

Therefore it is important to ensure that the static dissipative path, the path that channels the charging current to ground, is 10 ohms or less, and stays that way for the duration of the process.

AUDIT THE PROCESSES:

NFPA 77 provides a decision tree flow chart which helps define a simple and effective way to establish whether or not objects or products should be grounded. The first step is to determine if there "is the potential to create an ignitable mixture". If there is a potential for this to occur the next step states "bond and ground all conductive equipment". There are further steps that query whether or not "electrostatic energy" can be generated and accumulate.

As stated earlier, the process of determining these factors can be time consuming and require the expertise of process safety consultants. Very often, it is more cost-effective to ground the object, particularly if it is made of conductive metal, when it is known that materials with different properties come into contact with each other (leads to the separation of charges). In order to provide a basic audit of processes NFPA 77 lists the following scenarios where charge can be generated:

Does process include?
- Flow of material?
- Agitation or atomization?
- Powders or solids?
- Interaction with personnel?
- Filtration?
- Settling?
- Bubbles rising?

If the answer to any of these questions is "Yes", the next question to be asked is, can charge accumulate?

Does process include?
- Insulated equipment?
- Insulating materials?
- Isolated conductive equipment?
- Interaction with personnel?
- Nonconductive liquids?
- Mists or clouds?

When the answer to these questions is "Yes", it states that the potential MIE should be calculated to determine if it exceeds the MIE of the atmosphere present. This will probably be the hardest thing to calculate so the best advice is to ground the equipment as there may not be an opportunity to modify the material being processed or the equipment, through which it is pumped, conveyed or handled.

Identifying electrostatic hazards can be a daunting prospect for those of us responsible for ensuring our colleagues, employees, equipment and property are fully protected from electrostatic ignition hazards. There are many factors that can contribute to the presence of a static hazard but if the examples of grounding and bonding protection outlined above can be followed, the majority of processes at risk of static discharge will be controlled and accounted for.

When an audit of a process or procedure has identified an electrostatic ignition hazard, it is important to specify grounding and bonding systems that can demonstrate compliance with the standards. Where possible, static grounding instruments that can demonstrate resistance levels recommended by the standards will ensure companies are protected from this ever-present and hazardous source of ignition.

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