Flammable Liquids and the Fundamentals of Static Electricity

Process Safety Congres, Dordrecht The Netherlands, 15 May 2024

ATHEX INDUSTRIAL SUPPLIERS

Static Electricity: Mitigation and Control from Newson Gale

We empower people to understand and control electrostatic ignition hazards

Newson Gale HOERBIGER Safety Solutions

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Objectives:

To provide an introduction to:

Basic concepts of static electricity as an ignition hazard:

- Electrostatic charge generation.
- How electrostatic charge is stored (capacitance).
- Primary factors behind an electrostatic incident.
- True Earth Ground.
- Example application.

Introduction to Regulatory Requirements, Standards & Recommended Practice:

- ATEX 137 directive.
- IEC TS 60079-32-1

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Problem with Static Electricity

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Electrostatic Fundamentals

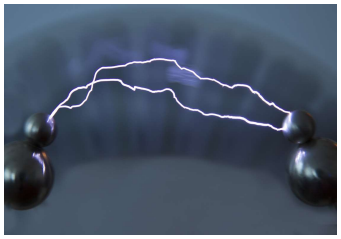
Charge Generation

Processing operations can **generate vast quantities of electrostatic charge** via the movement of non-conductive product.

Charging generally occurs during processing operations due to **triboelectrification**.

Triboelectric effect *(also known as triboelectric charging)* is a type of contact electrification on which certain materials become **electrically charged after they are separated** from a different material with which they were in contact.

Rubbing the two materials against each other increases the contact between their surfaces, and hence the triboelectric effect. The **polarity and strength** of the charges produced **differ according to the materials**, surface roughness, temperature and other properties.



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Electrostatic Fundamentals

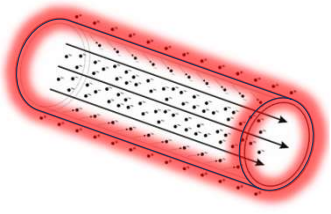
What is static electricity?

Static electricity or an **electrostatic charge** is actually **trapped electric charge**, positive or negative, on the **surface of a material** that has accumulated over time.

When an **imbalance of static electric charge** is present on an object, the object is said to be electrified.

If the process is **not earthed**, charge generation leads to an imbalance of charge being accumulated on both the product, and process equipment resulting in **electrification**.

Electrified objects can discharge electrostatic sparks onto objects held at a different potential, such as operators, tooling or near objects.



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Electrostatic Fundamentals

Charge Generation on an **Isolated Metal** Drum

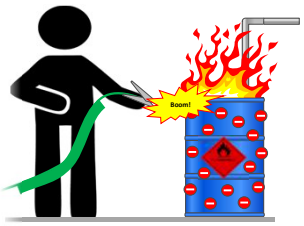
Non-conductive product is now carrying a **negative (or positive...) charge**.

As the product is being deposited into drums, totes and other containers, charge will build on metal/conductive and non-conductive components. On metal (or conductive) surfaces the charge will **evenly distribute as the 'like' charges repelling each other, spread over the surface.**

Unable to find a path to ground, **charges will build** until it reaches the **breakdown voltage** of the air gap and discharge/spark to a near object at a lower potential.

The object **does not need to be grounded;** it only needs to be at a different potential.

This can be an object close to the charged drum, e.g., another drum, small vessel, pipework. Or approaching the charged drum with an object e.g., **a forgotten ground clamp**, or drum clamp, or even the operator.



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Electrostatic Fundamentals

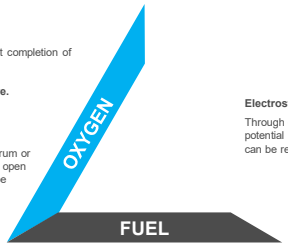
Fire Triangle

No ignition can take place without completion of the fire triangle.

Remove one component = **no fire.**

Non-purged Activity

If a process is manual, e.g., drum or tanker transfer, the process is open air, therefore oxygen cannot be removed.



Electrostatic Spark Energy

Through electrostatic earthing, the potential for electrostatic discharges can be removed.

Flammable Vapour/Gas or Combustible Dust Atmosphere

As the product being transferred is the Fuel this cannot be removed.

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Electrostatic Fundamentals

Charge Generation on a **Grounded Metal** Drum

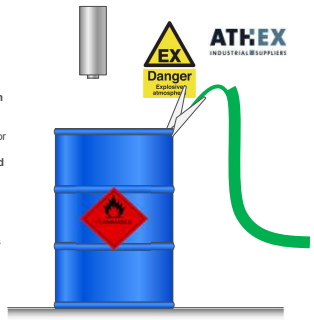
To solve the 'problem' CLAMP ON FIRST, before the operation starts and there is no charge on the drum.

To dissipate the charge, the container must be metal, conductive or dissipative and have a **path to ground**. As the product is being deposited into the drum, **charge on the drum will flow to ground** to naturally balance the potential.

*As long as the path to ground has **low enough resistance**, the charge will dissipate quicker than it can build.*

Therefore, **no charge will be stored on the drum surface** that is high enough to create an electrostatic discharge.

Just remember to CLAMP ON FIRST!!!



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Electrostatic Fundamentals

Why do we need HAZLOC footwear?

When a person is at rest and not carrying any charge, the charge is **equalized** between the person and the floor.

When walking across a floor, the friction between the soles of their shoes and the surface of the floor **generates a triboelectric electrostatic charge**.

This is especially true if the **floor is also insulating**. Most modern shoes also have highly insulating plastic soles which helps to increase charge generation.

Where there is **no path to ground** or limiting resistance due to insulating soles and/or insulating flooring, the **stored charge** builds on the body due to its **capacitance**.

Triboelectric static charging will still generate charge irreverent of the conductivity of the shoe and floor.

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Electrostatic Fundamentals

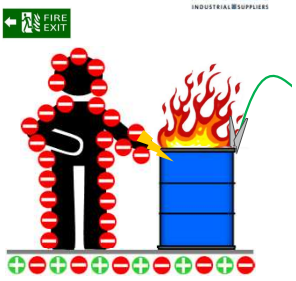
Why do we need HAZLOC footwear?

The charge stays in place until the person is **close enough to another object** where the charge voltage has a **large enough potential difference** to break down the insulation of the air gap.

The stored charge will then jump to that object in order to balance its charge with the other object as a sudden **electrostatic discharge** (ESD).

In a hazardous area environment, if the energy of the spark is higher than the minimum MIE of the vapor (if present), **an ignition can occur.**

Through their own movement people can generate large amounts of static charge if they are not grounded. Over **30,000 volts** can be carried by people who **are completely unaware that they themselves are the potential source of an electrostatic spark discharge** that could ignite a flammable atmosphere.



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Electrostatic Fundamentals

Road Tanker Transfers Risk

A typical road tanker when it is being filled with a liquid at recommended flow rates, but is **without electrostatic grounding protection**, could have its voltage raised to between **10,000 volts and 30,000 volts within 15 to 50 seconds**.

For example, a truck with a capacitance of 1000 pico-farads that is electrified to 30,000 volts has 450 milli-joules of potential spark energy. Given that most hydrocarbon vapours and gases have MIEs of less than 1 milli-joule and most combustible dusts have MIEs of less than 200 milli-joules, it's easy to see why road tankers that do not have static grounding protection in place can be a **major ignition source in a hazardous area**.

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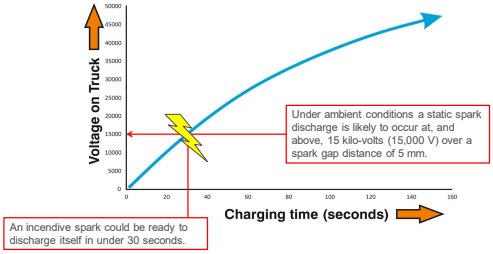
Electrostatic Fundamentals

Road Tanker Transfers Risk



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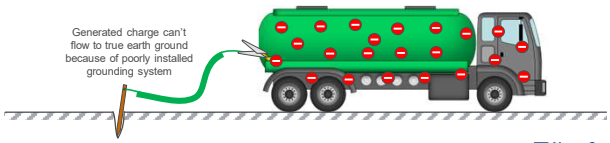
Electrostatic Fundamentals

Road Tanker Transfers Risk

- A metal object **which does not have a connection to true earth ground** will have capacitance and therefore the ability to storage dangerous levels of charge.
- **Removing this capacitance** by connecting the object to **true earth ground** will prevent charge accumulation by dissipating generated charges directly ground.
- **However, a poorly installed grounding system (not connected to true earth ground) will inhibit the flow of charge.**



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Electrostatic Fundamentals

True Earth Ground

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Assessing Electrostatic Hazards

- Could there be a flammable atmosphere?
- Can charge be generated?
- Can charge accumulate?
- Could there be a spark risk?
- Could the spark have enough energy to ignite a flammable atmosphere?

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Regulations, Standards & Recommended Practice.

- *'DIRECTIVE 1999/92/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)'*
- **(Commonly known as the ATEX 137 Directive)**

Assessment of explosion risks

1. In carrying out the obligations laid down in Articles 6(3) and 9(1) of Directive 89/391/EEC the employer shall assess the specific risks arising from explosive atmospheres, taking account at least of:
   - The likelihood that explosive atmospheres will occur and their persistence,
   - **The likelihood that ignition sources, including electrostatic discharges, will be present and become active and effective,**
   - The installations, substances used, processes, and their possible interactions,
   - The scale of the anticipated effects.

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Regulations, Standards & Recommended Practice.

IEC TS 60079-32-1
Explosive atmospheres. Electrostatic hazards, guidance

https://webstore.iec.ch/publication/60166
(Accessed 30 April 2024)

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Regulations, Standards & Recommended Practice.

IEC TS 60079-32-1 – (Not exhaustive List):

5. General
6. Static electricity in solid materials
7. Static electricity in liquids
8. Static electricity in gases
9. Static electricity in powders
11. Static electricity on people
13. Earthing and bonding.

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Regulations, Standards & Recommended Practice.

IEC TS 60079-32-1 – Relevant Sections:

13.2.2 Practical Criteria

Metallic items in good contact with earth should have a resistance to it of less than 10 Ω. Although a value of up to 1 MΩ is acceptable for static dissipation, values above 10 Ω may give an early indication of developing problems (e.g. corrosion or a loose connection) and should be investigated. It is important that all connections are reliable, permanent and not subject to deterioration.

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Regulations, Standards & Recommended Practice.

IEC TS 60079-32-1 – Relevant Sections:

13.4 The establishment and monitoring of earthing systems.

Where the bonding/earthing system is all metal, the resistance in continuous earth paths typically is less than 10 Ω. Such systems include those having multiple components. A greater resistance usually indicates that the metal path is not continuous, usually because of loose connections or corrosion. **An earthing system that is acceptable for power circuits or for lightning protection is more than adequate for a static electricity earthing system.**

Permanent bonding or earthing connections should be made in a way to provide low resistance during its lifetime, e.g. by brazing or welding. Temporary connections can be made using bolts, pressure-type earth clamps, or other special clamps. **Pressure-type clamps should have sufficient pressure to penetrate any protective coating, rust, or spilled material to ensure contact with the base metal with an interface resistance of less than 10 Ω.**

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Thank you for listening

Questions & Discussion
see you at Network Forum

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