Electrostatic fire and explosion hazard avoidance in ATEX

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In this presentation

- Why should we worry about static electricity?
- Why do fires and explosions happen?
- Understanding static electricity
- Examples of electrostatic charge build-up in industrial processes
- Key points

Why should we worry about static electricity?

Maize starch dust explosion

Vaksdal, Norway, April 1982

Photographer: A.M.Fosse

From R.K. Eckhoff (1991) Dust Explosions in the process industries

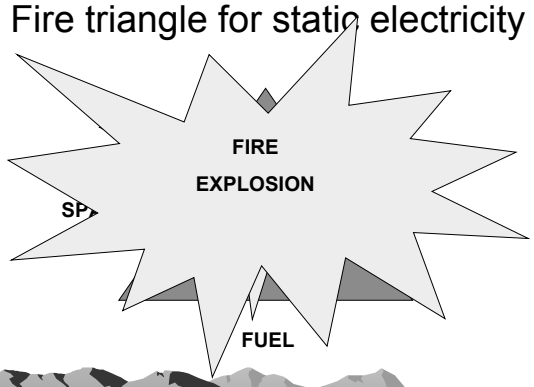
Fire when refuelling car

In the USA

Fortunately this is unlikely to happen in the UK!

Why do fires and explosions happen?

Fire triangle for static electricity



The flammable atmosphere

- The fuel could be
  - Vapours
  - Dusts
  - Droplets of liquid (mist)
  - A mixture of vapours and other materials
- The fuel is usually essential to operations
- In some cases the atmosphere may be inerted e.g. with nitrogen or CO2

Minimum Ignition Energy (MIE)

- To ignite a flammable mixtures the ESD energy must exceed the material Minimum Ignition Energy (MIE)
- Different flammable mixtures have different MIE
- MIEs of gases and hydrocarbon vapours in air are often around 0.1- 0.3 mJ
- Some vapour MIEs can be as low as 0.02 mJ
  - hydrogen-air
  - ethylene-air
  - oxygenated mixtures
- Dust clouds can have MIE from < 1mJ upwards
  - MIE varies with particle sizes and other factors

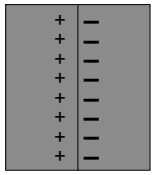
Different types of ESD have different ability to ignite materials

ESD type	Where it occurs	Will ignite
Spark	Between two conductors	Gas mixtures and dusts
Propagating brush	From insulator backed by a conductor	Gas mixtures and dusts
Brush	From insulators	Gas mixtures
Cone	Highly charged insulating powder cones in silos	Gas mixtures and low MIE dusts
Corona	Sharp edges on charged conductors	Not usually incendive

Understanding static electricity

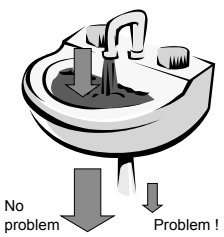
Where does electrostatic charge come from?

- Every material is made up of charge
  - Negative electrons
  - Positive atomic nuclei
- These charges are normally present in balance, and their effects cancel
  - If there is a local imbalance we may see static electricity effects
- charge transferred between materials in contact
  - electrons flow from one material to the other
- materials separate and take equal and opposite polarity (positive and negative) charge



Why don't we always get static charge build-up?

- if charge moves away faster than it is generated, then no problem
- if charge is generated faster than it can move away then build-up occurs
  - High voltages quickly arise



Conductors and grounding

- *Conducting materials* such as metal allow static electricity to move around
- We can "ground" or "earth" a conductor by connecting it to electrical earth by way of a wire
- The human body is a conductor and may need to be grounded

Insulators prevent static charge moving away

- *Insulators* cannot conduct static electricity away
- Insulators encourage static charge to build-up!
- Grounding an insulator does not work as the charge cannot move from the insulator
- Insulators can prevent charge moving from an isolated conductor
- Use of insulators in a hazard Zone is often restricted as they may be the source of ESD

Some examples of insulators

- Plastic and rubber
  - Packaging, polythene sheet and wrap, bags, boxes
  - Shoe soles
  - Floors
  - Trolley wheels
- Glass (sometimes)
- Air and gases

Demonstrations

- Charging of plastics
- Charging of metal plate without touching it
- The effect of grounding the conductor
- Voltages on people
- The effect of grounding the person

Examples of electrostatic charge build-up in industrial processes

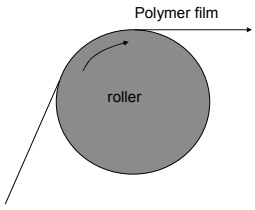
Contact charging in processes

- Charges are separated wherever two materials are in contact
  - Highly insulating liquids or solids encourage charge build-up
- In pipes, containers or process equipment
- Poured and blown powder particles can give high charge levels
- A person walking or wiping a plastic equipment surface

Rate of charge generation

- Charge generation increases with
  - Area of contact
  - Rate of "breaking contact"
  - Rubbing action

For the polymer film passing over the roller, more charge will be generated as the roller speed is increased.

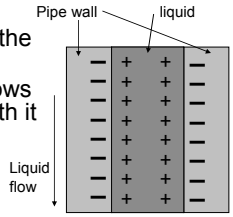


Some processes generate high charge levels

- Seiving
- Pouring
- Scroll feed transfer
- Grinding
- Micronising
- Pneumatic conveying
- Triboelectric powder coating

Charging in flowing liquids

- Charge separates between the liquid and the pipe wall
- When an insulating liquid flows away, it takes the charge with it
- Some conditions increase charge generation
  - Immiscible solid and liquid particles
  - Stirring and mixing, turbulence
  - Splashing
  - Filters



Avoiding ignition risk

- Identify and control zones of flammable atmosphere
  - Inerting can be used to eliminate flammable atmosphere if necessary
- Where flammable atmosphere is possible, eliminate ESD sources
  - In the case of dusts the Minimum Ignition Energy (MIE) will have to be assessed to determine the level of risk
- If in doubt take specialist advice

Exploding icing sugar

Courtesy Dr D K Davies

Assess use of insulators

- Avoid insulators that could charge up dangerously or cause conductors to become isolated
  - Plastic equipment and packaging
  - Rubber
  - Epoxy floors
- Charged insulators give brush discharges that could ignite flammable vapours
  - Only small areas of insulating surfaces are allowed in Zone 0 and 1

Specific guidance for many industrial situations is given in CLC/TR 50404:2003

Ground any conductors including people

- Avoid having isolated metal parts that could be charged by induction or triboelectrification
- Ground all conductors of any significant size
  - People are large conductors and must often be grounded through shoes and flooring!
- Charged conductors give sparks that may ignite vapour or dust clouds
- Charged insulators Induced voltages in isolated metal parts, causing sparks

Specific guidance for many industrial situations is given in CLC/TR 50404:2003

Key points (1)

- For ignition of a flammable materials 3 things must be present
  - Fuel
  - Air (oxygen)
  - The ignition source (ESD)
- The energy of the ESD must be greater than the material Minimum Ignition Energy
- Different types of ESD have different ability to ignite vapours or dusts

Key points (2)

- All materials can generate static electric charges
- Static builds up if it can't dissipate fast enough
- Charge on insulating materials cannot move and tends to build up – insulators cannot be grounded
- Charges on conductors can be released safely to earth by grounding

Key points (3)

- The main ESD control methods are
  - Avoid using insulators that could charge up and cause ESD
  - Be sure all conductors within a hazard Zone are grounded
  - Grounding people through conductive or dissipative footwear and flooring

Specific guidance for many industrial situations is given in CLC/TR 50404:2003

References and further reading

CENELEC. *Electrostatics – Code of practice for the avoidance of hazards due to static electricity*. CLC/TR 50404:2003

CEN. *Non-Electrical equipment for potentially explosive atmospheres – Part 1: Basic method and requirements*. BS EN 13463-1:2001

CENELEC. *Electrical apparatus for explosive gas atmospheres. Part 0: General requirements*. BS EN60079-0:2004