ELECTROSTATIC HAZARDS IN THE AEROSOL INDUSTRY

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The generation of electrostatic charge is common in everyday life. It arises as the audible 'crackles' when we comb our dry hair, as the 'shock' we feel as we get out of our car and as the cling of dust to the television screen. It is perhaps only to be expected that electrostatics manifests itself in many industrial situations, sometimes causing disruption to production and occasionally providing the ignition source for industrial fire or even explosion.

In the aerosol filling industry, the prerequisites for fire and explosion - flammable atmosphere and electrostatic charging mechanisms are present. Indeed, electrostatics has already revealed its potential to cause massive destruction and now that flammable propellants have replaced inert CFC's it is quite likely to do so again. It is important, then, to study how static can arise in practice, and also how it can be controlled as a first stage in ensuring that **your** plant is not the next one to suffer explosion or fire.

Propellants

The principle flammable propellants in use are liquefied petroleum gas (LPG), dimethyl ether (DME), difluoroethane (DFE) and Butane. Some of their physical properties are shown inTable 1.

TABLE: 1 Physical Properties Table

	lel/uel (%)	Relative density of vapour	Gas Group	Mie (MJ)
Propane	2.2/10	1.56	IIA	
DME	3.4/18.2	1.64	IIB	
DFE	3.9/16.9	2.39	IIA	
Butane	1.8/9	2.1	IIA	

It is evident from Table 1 that all common propellants have vapours which are more dense than air – and do not disperse easily. DFE is seen to be the most dense vapour. DFE and DME have the widest flammable range. DME is the most sensitive vapour being of gas group IIB. It can be ignited with the smallest electrostatic spark.

Vapour Release

In the aerosol filling process, flammable concentrations of propellant vapour and air can occur both routinely at certain locations and by accident elsewhere. A small release may occur as the aerosol is filled, usually at a filling machine and under pressure, but leaks could also occur at the joints of filling equipment or after can filling if the valve or its seal fails. A heated water bath is generally used to test can integrity, although risk of flammable vapour release exists before the water bath check, and also in the reject can facility. Once a can is filled and pressurised then clearly other locations could arise where flammable gas release may accidentally occur even if the can has been leak tested. Subsequent mechanical damage can be sustained and accidental can operation are both conceivable.

Whatever the location or situation, it is thankfully the case that to create a fire or explosion both a flammable vapour concentration and a sufficiently energetic ignition source are required together. We concentrate now on electrostatic ignition, but recognise that static is just one of many potential sources of ignition.

Electrostatic Hazards

(a) **Operators**

Whenever people move about there is the prospect of charge generation through, most likely, triboelectrification or induction processes. Tribo charging can occur as an operator's foot separates from the floor or through sliding/separation contact of clothing with other surfaces. Induction charging can arise if an operator works in an area of plant where he can be influenced by other surfaces which are electrically charged (e.g. shrinkwrap). If an operator becomes charged he has the potential to create an electrostatic spark discharge when he touches metal plant. The energy released by this type of discharge is given by the equation $E=\frac{1}{2}CV^2$, where C is the capacitance of the operator and V, the voltage to which he is raised. With a typical 200pF operator capacitance, it can be seen that less than 2KV on an operator is required for him to be able to produce propellant vapour - incendive spark discharge.

The key to controlling static electricity in this case is the use of antistatic footwear, but the floor in critical areas must also have sufficient conductivity to provide operator grounding. The resistance of an operator to ground should not exceed $10^8\Omega$ in such critical areas.

(b) **Metal plant**

As with operators, metal plant – including pipelines, can conveyors, metal reject can containers etc. should be grounded at all times. Failure to do this could lead to charge building up on unearthed metal plant with a spark discharge risk of energy again given by $E=\frac{1}{2}CV^2$. Metal plant can become charged in several ways, which again could include tribo charging as cans pass along a conveyor, for example, or charging due to the flow of liquid in a pipeline.

Questions often arise as to the resistance level to ground of metal plant to avoid static charge accumulation on the metal plant. In fact resistance values of $10^6\Omega$ can be acceptably low to prevent the accumulation of hazardous charge levels, but it is probably advisable to specify an upper level of 10Ω as a practical working standard.

(c) **Flexible hoses**

The use of antistatic or conducting flexible hoses will prevent the accumulation of static charge on the hose, but only if the hose is properly grounded. Antistatic and conducting hoses must also be connected to earth and it is important to ensure electrical continuity along the full length of the transfer line of which they may be a part.

(d) **Aerosol cans**

There is no doubt that an aerosol emission – containing either droplets or powder – will generate electrostatic charge. Charge can be generated on any surface to which the aerosol emission is directed. Charge will also be generated on the valve and can and on the aerosol droplets themselves. What is less clear is the level of charge that is generated in any particular circumstance since this will be dependent on the propellant droplet or powder content, nozzle material of construction, nozzle aperture size and can fill pressure. It is the case, however, that there are some circumstances where propellant vapour incendive discharges can arise and basic precautions are needed to prevent the inadvertent formation of isolated conductors to guard against these. For example, cans should be kept grounded at all times – particularly when on the filling conveyors. Can grounding (and container grounding) is also important where cans are rejected, since it is here that the risk of flammable vapour emissions is significant.

We would also advocate certain electrostatic charging tests on aerosol cans during normal and abnormal release since there are undoubtedly some can–product-propellant combinations which would produce high charge levels and it is important to identify these so that preventative measures can be taken.

(e) **Insulating material**

When free plastic surfaces are charged (usually by rubbing with some other material) charge can build up on them. In high charge situations, so called electrostatic ‘brush’ discharges can be produced. These charges have an energy content up to about 4mJ and can clearly, therefore, be incendive to propellant vapour. If insulating plastics are used on plant they should ideally be separated away from flammable atmospheres. It is only acceptable to bring these plastics into Zone 1 areas where it can be shown that they cannot become charged.

Summary

In summary, both sensitive flammable atmospheres and charge generating mechanisms occur in aerosol can filling operations. Good earthing and bonding of equipment, cans and operators is an important safeguard against the electrostatic hazard, although additional precautions relating to materials selection and segregation should be considered too. It is viewed as important that a specialist electrostatic focused hazard assessment be performed for all aerosol filling facilities – in addition to a more general hazard assessment since electrostatic problems are easily overlooked.

This paper has focused on electrostatic ignition hazards and their control. Many other fire and explosion prevention measures are additionally required at aerosol filling plant, that include isolation, access control, proper selection of electrical equipment, gas detection etc.

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