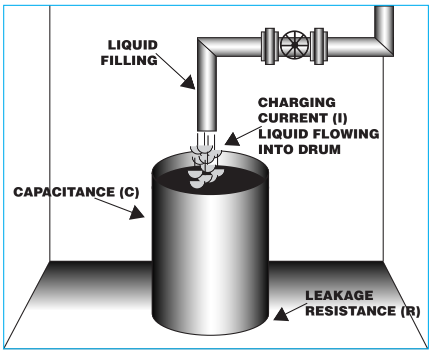
Isolated Conductors-

The hidden danger in hazardous areas

When implementing safety measures in hazardous areas, there are many issues to consider for plant, process and personnel safety. Eliminating potential ignition sources is the starting point for this, both in terms of good engineering design and general operating procedures.

However in any type of flammable atmosphere there may be hidden dangers lurking in the area, in the form of "isolated conductors". These are conductive objects which are either inherently or accidentally insulated from earth, so as to prevent any static electricity generated from safely discharging, resulting in accumulation of charge on the object. These isolated conductors may be any from a large list of commonly used items, including metal flanges, fittings or valves in pipework systems; portable drums, containers or vessels; road tankers and IBC's; and even people ! Isolated conductors are probably the most likely source of static ignition incidents in industry, ranging from small-scale fires through to major damage to plant and injury to personnel.

In order to explain the extent of the danger and how it may be controlled, it is useful to look at the fundamentals of Static Electricity, and how it is manifested. In any industrial process where there is movement, the coming together and separation of materials will generate static. This could be liquid flowing through a pipe, powder dropping down a chute, or a person walking across a floor. The extent of charge generation current is usually very low, typically no greater than 1x10^-4 Amps. If the object or piece of plant is in contact with a good enough earth, this charge will be lost as it is generated, however if the object is insulated from earth, the charge will start to accumulate. Paints, coatings, gaskets, seals and other non-conductive materials can all be sufficiently insulative to prevent safe static dissipation. This charge can quickly build up to a very high potential, with voltages in excess of 30Kv not being uncommon. Depending on the capacitance of the object, this may result in significant levels of energy available for discharge, well above the minimum ignition energy (MIE) of the surrounding flammable atmosphere. Typical MIEs vary according to whether the flammable atmosphere comprises vapour, dust or gas, but many commonly used solvents have MIEs of well below 1mj (see data on tables A & B). If the isolated conductor then comes into proximity with another object at a lower potential, much of this energy could be unleashed in the form of an incendive spark. Of course, in order for there to be static ignition of the flammable atmosphere, there would need to also be a suitable concentration of fuel (vapour, dust or gas) in air, but for the purposes of safe plant design, the very fact that there is an identified flammable atmosphere should suggest that this is possible or likely. The generation/ accumulation/discharge process is explained in diagram 1 - we have used the example of a drum being filled as the filling process is analogous with the phenomena of static accumulation on an isolated conductor with a given capacitance.



Example of unearthed steel drum filling:-

Typical capacitance of drum	50pF
Typical charging current	1x10^-7 Amps
Typical leakage resistance	1x10^11 Ohms

Using Ohm's Law - V=IR
Therefore maximum potential =10kV

Maximum energy = 0.5CV2
Therefore maximum energy availble energy available for discharge =2.5mJ

The problems associated with isolated conductors can be remedied by effective earthing (grounding) and bonding. In the case of fixed installations such as pipework, storage tanks etc, this is relatively simple to implement, however it is more difficult in the case of mobile/portable objects such as drums, IBC's and tankers. In these instances, purpose designed temporary grounding and bonding devices should be used, with strict procedures to ensure they are always in place prior to starting of the process. In the case of people, static dissipative footwear and gloves may be worn to ensure the person is continually "earthed", and if the flammable atmosphere has a very low MIE, static dissipative clothing may also be required. In all cases it is also important to make periodic tests of the control measures used, and in ultra safety critical applications like loading road tankers and bulk containers, constant monitoring and interlocks should be strongly considered. Today, specialised "non-metallic static dissipative" materials are increasingly being used for making drums, flexible containers, linings, and hoses, in applications not suited to traditional materials such as steel, stainless steel etc.

It is also important to note that charge can build up on the actual materials being processed (liquids, powders, gases), so it is necessary to make sure that these are in sufficient contact with earthed, conductive piping, vessels and plant, thus providing a safe discharge path. Any complete Static Safety Audit should also consider non-conductive materials (plastics etc) in use either as part of plant and equipment, or as packaging materials brought into the hazardous area.

In conclusion, the dangers of isolated conductors demand a "holistic" approach to plant, process and personnel safety, as any control measures are only as good as the weakest link in the chain. As the speed and scale of modern manufacturing techniques increase, and the range of materials used and processed grows, this basic approach to safety will be even more important. A recently published "Cenelec" document (RO44-001 - guidance and recommendations for the avoidance of hazards due to static electricity) provides safety managers in the Chemical and Process Industries with practical guidance for specific situations. ■

Table A
Potential stored energy on typical plant items

Object	Capacitance (pf)	Stored energy at 10kV (mJ)	Stored energy at 30kV (mJ)
Road Tanker	5000	250	2250
Person	200	10	90
Steel Bucket	20	1	9
100mm Flange	10	0.5	4.5

Table B
Minimum ignition energy of vapours & powders

Material MIE liquid vapour	(mJ)	Material MIE powder	(mJ)
Propanol	0.65	Wheat Flour	50
Ethyl Acetate	0.46	Sugar	30
Methane	0.28	Aluminium	10
Hexane	0.24	Epoxy Resin	9
Methanol	0.14	Zirconium	5
Carbon Disulphide	0.009		

data source: IchemE

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