White Paper

“Is it ever Safe to use Plastic Drums and Containers in Hazardous Areas?”

Newson Gale
HOERBIGER Safety Solutions

Author Details:

Mike O’Brien, Managing Director for Newson Gale

If you have any questions relating to the topics discussed in this article, please contact Newson Gale.

Enquiry > Click here to submit a product related query or a request for quotation.

In recent years there has been a proliferation of new and low cost plastic portable containers. Containers ranging in size from 1 litre bottles, to 205 litre drums and 1000 litre IBCs have provided the supply chains of the hazardous process industries with a diverse range of material packaging options. While some packaging options will require plastics that demonstrate specific levels of material compatibly with different products, one of the major drivers of plastic packaging is their relative low cost in comparison to metal containers including metal drums and metal IBCs. The increasing use of plastic containers within the hazardous process industries is coming under increasing scrutiny due to the hazards associated with static electricity. This brief article will address the issues associated with static electricity on plastic packaging, draw on reports and expertise of industry and safety bodies and provide solutions to grounding non-metallic containers, with a particular focus on composite drums and IBCs.

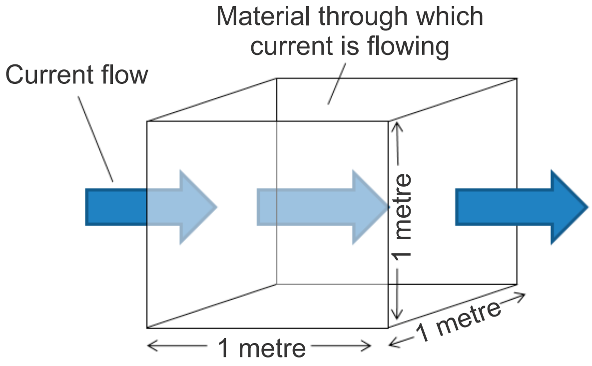
Defining the meaning of the terms “static dissipative”, “conductive” and “insulating”.

It is important to define the terms “conductive”, “insulating” and “static dissipative” (anti-static) in order to fully appreciate the capability of materials to safely dissipate electrostatic charges from objects that are correctly earthed (grounded). Conductive materials permit the transfer of electrostatic charges instantaneously. In static dissipative materials, electrostatic charges are adequately dissipated, albeit at a slower rate than conductive materials. In insulating materials, or to be more precise, poorly conducting materials, electrostatic charges tend to be retained on the material and not readily transferred, even when the material is connected to earth.

Understanding the difference between volume resistance and surface resistance is also important. Resistivity is determined by the intrinsic properties of a material that resist the flow of electrical currents. Volume resistivity, **ρ**, represents the total resistivity value of a section of material through its entire volume. The overall resistance to charge transfer is calculated by multiplying the resistivity value for the material by its length and dividing by the cross sectional area through which the charge is flowing.

$R = \rho l/A$

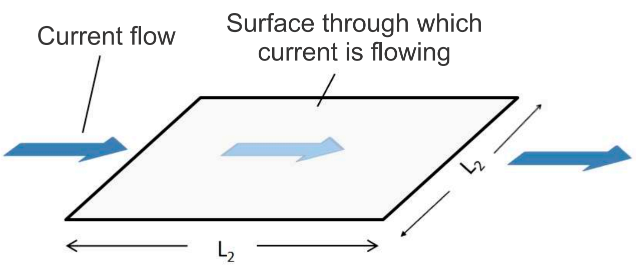
For example, the resistance through a large volume of 1 m length by 1m^2 cross sectional area of PTFE with a resistivity (**ρ**) value of 10^{19} Ω.m, is equal to 1 x 10^{19} ohms(1). For a similar volume of copper with a resistivity value of 1 x 10^{-8} Ω.m, the resistance through the copper will be 1 x 10^{-8} ohms. So even if the PTFE is correctly earthed, charges will experience a very high degree of resistance to their movement to earth, whereas as for metals, charges will experience little or no resistance and be transferred to earth immediately.



Resistance experienced by current flowing through material is influenced by the resistivity value, **ρ**, for the material and the length and cross-sectional area of the material.

Surface resistivity, **λ**, represents the total resistivity across the surface of a material. In essence, a material with a high volume resistivity could be engineered to have a low surface resistivity value, meaning charges that would otherwise not transfer easily through the material, are allowed to transfer across its surface.

Overall surface resistance is calculated in a similar way, where the resistance is calculated from $R = \lambda L_1/L_2$.



Resistance experienced by current flowing across surface is influenced by the surface resistivity value, λ, of the material and the length and breadth of the material.

In general materials can be segmented into three categories, depending on their volume and surface resistivity values.

Material Classification	Volume resistivity, (ρ), Ω.m	Surface resistivity, (λ), Ω/sq.
Conductive	$\rho < 10^2$	$\lambda < 10^5$
Dissipative	$10^2 \leq \rho < 10^9$	$10^5 \leq \lambda < 10^{12}$
Insulating	$\rho \geq 10^9$	$\lambda \geq 10^{12}$

Table 1: range of resistivity values for conductive, static dissipative and insulating materials(1).

In regard to electrostatic ignition hazards within hazardous areas the correct use and specification of containers made from conductive, static dissipative and insulating materials is critical to the safety of workers and the processes in which these containers are used.

Testing of composite IBCs and industry guidance

A report prepared for the Health & Safety Executive in the UK highlights key selection criteria hazardous area operators should take into consideration when using portable containers within hazardous areas(2). The report tested and quantified the levels of electrostatic discharge on containers ranging in size from small 1 litre plastic bottles to 1000 litre rigid IBCs. Rigid IBCs are supplied in a wide range of different materials of construction and can be made of insulating plastic, static dissipative plastic, and insulating plastics surrounded by metal sheet cladding or steel frames. 205 litre plastic drums were not included in these tests.

The generation and measurement of electrostatic discharge was conducted in accordance with EN 13463-1:2001,

"Non-electrical equipment for use in potentially explosive atmospheres. Basic method and requirements".

Controlled laboratory testing highlighted that levels of electrostatic discharge capable of igniting commonly used gases and vapours is possible from all container types. A plastic composite IBC, manufactured with a static dissipative outer layer was tested and this demonstrated safe electrostatic discharge levels, however, the report does indicate that a representative sample would need to be tested to determine if these characteristics are consistent.

Just some, of a number of the report's conclusions and recommendations, are listed below:

- "It is very important with all designs that the frame and any other conducting parts are electrically bonded to earth during any operation where electrostatic charging may occur and that they should not be stored on a highly insulating surface unless separately earthed".
- The earth connection between the frame and conducting parts of taps should be checked at regular intervals.
- Exposed plastic components (e.g. taps and filling caps) should be made of static dissipative materials.
- Metal frames and conducting objects located on IBCs should be "electrically bonded to earth" with a sufficient charge relaxation time permitted.
- A thorough risk assessment should be carried out to determine the most appropriate type of container with a particular focus on electrostatic charging potentials and the presence of flammable gases and vapours in the IIA, IIB and IIC categories.

Given the overwhelming number and availability of IBC options, the SIA and CBA issued "Guidance Notice 51a" which describes the key selection criteria for either stainless steel or composite IBCs with an "anti-static sheet". The IBC selection criteria principally depends on the flash point of the solvent being used and whether the solvent can be defined as having electrically conductive or resistive characteristics. More detailed information can seen in the guidance notice, but a table listing IBC options for resistive solvents (hydrocarbons), and conductive solvents (oxygenated), are summarised in the following table:

IBC Type	Solvent Flash Point		
	< 0°C	0 - 40°C	> 40°C
Composite with anti-static sheath	NO	No: hydrocarbons Yes: oxygenated	YES
Stainless Steel	YES	YES	YES

Table 2: Parameters determining appropriate selection of stainless steel and composite IBCs manufactured with static dissipative sheaths(3).

Standards and practical advice

The main issue with filling non-conductive plastic containers whether it is IBCs, drums or bottles is that the liquid or solid, which is charged through its own movement, will induce charges on the plastic. As the container is filled with more material, more charge will continue to build up on the inside surface of the container, which will set up opposite charges on the outer surface of the container which is exposed to the hazardous atmosphere. The charged outer surface will set up electrical potential differences with objects (e.g. tools, vessels, instruments, operator’s fingers) within the hazardous atmosphere, which could lead to incendive static brush discharges. Alternatively, if objects like metal tools become charged through close proximity to charged plastic containers, and are in themselves isolated from the earth, they could discharge static sparks more readily. The experts and standards conclude that portable containers made from non-conductive plastics should not be used in hazardous areas, unless the complete process is subjected to expert analysis(2)(4). If plastic is to be used this will most likely require inerting of the combustible atmosphere.

Although there is much guidance related to the values of resistance that should be achieved for earthing metal objects (e.g. road tankers, 205 litre drums, etc.) to 10 ohms or less there is little practical guidance addressing maximum values of resistance for static dissipative drums or IBCs. There is just one standard that specifies a maximum value of resistance for static dissipative materials and this only applies to Type C FIBCs which are used for transporting and storing powders. CLC/TR: 50404 states that the resistance through a Type C FIBC bag to its ground connection tabs should be no greater than 1 x 10^8 ohms(5). Currently a number of packaging manufacturers are supplying static dissipative drums and IBCs with various quoted maximum values of resistance ranging from 1 x 10^8 ohms, 1 x 10^6 ohms to 1 x 10^5 ohms.

One example is a composite drum that has a normal PE inner lining, with the outer plastic surface made from static dissipative material. It does not necessarily mean that the liquid in the drum, even if it is conductive, will dissipate its charge quickly, but the surface of the drum exposed to the hazardous atmosphere should not generate potential differences with other earthed objects, or induce potentials on isolated metal objects, provided the correct static grounding techniques are deployed.

As these types of containers become more freely available to hazardous process supply chains, bodies and organisations that publish standards and guidelines for static control within hazardous areas should address the use of such containers. This is particularly important when it comes to the use of combustible liquids with low minimum ignition energies (MIEs). As powders normally have higher MIEs than liquids, it is important for guidance to be published that takes into account the MIEs of combustible liquids, the potential charging levels of filling / dispensing operations and the most appropriate maximum value of resistance through the container to earth.

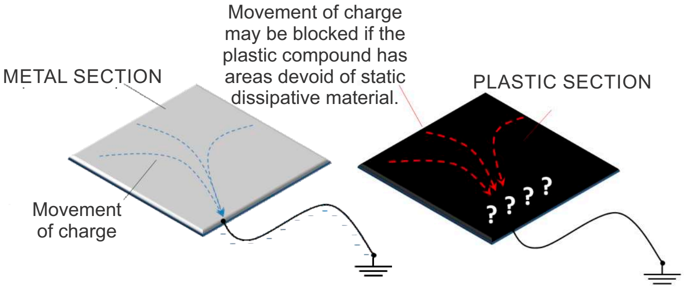
If, for economic or material compatibility issues, manufacturers must use plastic portable containers over metal options, they should ensure their container suppliers provide them with drums or IBCs that fall within the static dissipative category if they are to be used in processes carried out within hazardous areas.

Correct Grounding techniques for static dissipative drums and IBCs

As outlined earlier the maximum resistance value of 10 ohms at which conductive containers (metal containers) at risk of static charge accumulation should be monitored is well documented throughout many standards and process safety publications. When the values of resistance related to composite materials that provide static dissipative functionality come into question, there is little to reference other than CLC/TR: 50404 for Type C FIBCs, which recommends a maximum value of resistance of 1 x 10^8 ohms(5).

Should guidance be issued that addresses the use of such containers directly a different value of resistance may be deemed appropriate. However, as CLC/TR: 50404 is the only standard which provides suitable guidance for static dissipative materials in a hazardous area context it would follow that grounding of static dissipative drums and IBCs should be monitored to 1 x 10^8 ohms or less.

Monitoring not only guarantees that the grounding system is making a secure connection to the composite container, it is also indicating that the area of the container manufactured with static dissipative material is functioning correctly. This is particularly important because for metal drums and IBCs, it can be assumed that the metal will transfer static charges very easily, provided contact inhibitors like paint coatings and rust are penetrated by the earthing system's clamp connection. It is good practice to monitor the performance of composite containers to ensure that insulating plastic drums and IBCs that may make their way into a hazardous area are identified and removed before filling or dispensing can take place. In addition, as static dissipative drums/IBCs are "composite" in nature, it should not be assumed that the embedded static dissipative properties are correctly distributed throughout its structure. As the composite container will be subject to degradation during its lifecycle it is important to ensure that the static dissipative properties of the container are maintained for as long as it used within hazardous areas.



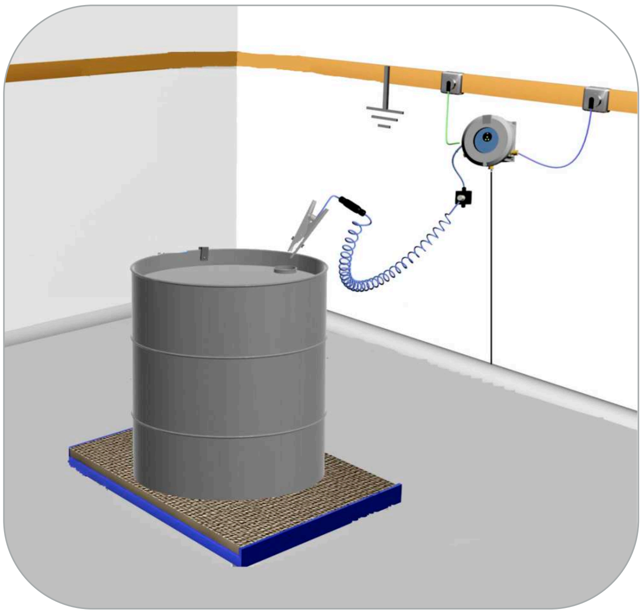
Static charges freely move through metals,
but may be impeded and accumulate on plastic surface

Example of Solution to safe grounding of static dissipative containers

One example of monitoring the integrity of a static dissipative drum used on a filling line is to connect a static earth monitoring system to the drum. The static earthing system, which sends an intrinsically safe current through the drum, monitors the drum to the resistance specified in CLC/TR: 50404 which recommends 1 x 10^8 ohms or less. The current return path to the system is made through the drum to the surface the drum is sitting on which, for example, can be a weighing scale, conveying line or purposely made steel sheet. This surface is connected to the site's pre-verified earthing point, which, in this example, is the copper bus-bar running along the wall. The current returns to the ground monitoring system via the earthed bus-bar. In this example the system is not only proving that the composite drum is providing the required safe level of static dissipative performance in a continuous monitored circuit to 1 x 10^8 ohms, it is also proving the drum has a continuous connection to earth via the bus-bar for the duration of the filling process.

If a grounded metal surface for the drum to sit on is not possible, then two separate clamps can be mounted on opposite sides of the top rim of the drum. Alternatively, a single 2 pole clamp can monitor the integrity of its connection to the drum via two tips located on the grounding clamp. Depending on the preferred method of connection, the earthing system is proving that the drum is connected to ground for the duration of the filling process.

The earthing system should be interlocked with the drum filling line so that if the drum has not been grounded by the operator, or the drum is not static dissipative, filling cannot take place ensuring hazardous static charges cannot accumulate on the drum.



Example of correct
grounding technique for
a static dissipative drum

Conclusion

If plastic portable containers are to be used in hazardous areas it important to ensure the containers are capable of safely dissipating static electricity when they are earthed. In order to remove the risk of incendive electrostatic ignitions, the material of the container, and especially the surface exposed to the hazardous atmosphere should be static dissipative. When containers are being filled or emptied it is equally important to use static earthing systems that can determine if the drum is actually static dissipative to a maximum resistance of 1×10^8 ohms. This will ensure that "rogue" containers made of normal plastic cannot be used in the hazardous area. A static earthing system will also ensure that the static dissipative content of the container has not degraded through normal lifecycle effects and is reliably performing its intended safety function of dissipating potentially hazardous electrostatic charges from its surface once it has been connected to earth.

References:

(1) *"Electrostatic Ignitions of Fires and Explosions", Pratt, T.H., Center for Process Chemical Safety (2000).*

(2) *Research Report RR804 "Plastic Containers for flammable liquids/hazardous areas, Electrostatic Risks", Health & Safety Laboratory (2010).*

(3) *"Use of IBCs for Oxygenated Solvents and Hydrocarbon Solvents", Solvents Industry Association & Chemical Business Association, (2003).*

(4) *"Avoiding Static Ignition Hazards in Chemical Operations", Britton, L.G., Center for Process Chemical Safety (1999).*

(5) *CLC/TR 50404: "Electrostatics. Code of practice for the avoidance of hazards due to static electricity", CENELEC (2003).*

United Kingdom
Newson Gale Ltd
Omega House
Private Road 8
Colwick, Nottingham
NG4 2JX, UK
+44 (0)115 940 7500
groundit@newson-gale.co.uk

Deutschland
IEP Technologies GmbH
Kaiserswerther Str. 85C
40878 Ratingen
Germany

+49 (0)2102 5889 0
erdung@newson-gale.de

United States
IEP Technologies, LLC
417-1 South Street
Marlborough, MA 01752
USA

+1 732 961 7610
groundit@newson-gale.com

South East Asia
Newson Gale S.E.A. Pte Ltd
136 Joo Seng Road, #03-01
Singapore
368360

+65 6704 9461
ngsea@newson-gale.com

Newson Gale
HOERBIGER Safety Solutions

www.newson-gale.co.uk

NG UK White Paper 23 070918