

Grounding & Bonding — transferring flammables

When is Grounding & Bonding Required?

When transferring flammable liquids (flashpoint below 100 °F (37.8 °C),) to or from any container > 4 L (1 gal) the two containers must be electrically bonded together and the container from which liquids are being dispensed must be electrically connected to the ground (grounded).

Why is it needed?

A spark could ignite the flammable vapors. Static ignition of flammable vapors is possible if 1) a spark can be generated due to an electrical difference with sufficient energy to ignite flammable vapors. 2) Flammable vapors are present. Minimize vapors by keeping the flammable container tightly closed.

Note: A charge can be generated if liquids are stirred, poured or pumped. Even conductive liquids can become charged during fine filtration, a two phase system such as oil and water, or in a suspension of a powder in a liquid.

What supplies are needed?

A conductive wire with clamps connecting conductive source container to a conductive receiving container or a rod/s inserted into the solution. One wire is used to connect the two containers and another wire to connect one of the containers to a grounding rod.

Only metal containers should be used for flammable liquids in quantities > 4 L. Exception: plastic containers > 4L may be used for gasoline because the vapors are generally above the upper flammable limit making ignition less likely.

Grounding floor mats should also be considered in areas with nonconductive flooring.

Personal attire

Synthetic clothing, plastic aprons and rubber shoes are all insulating and can build up charge (10-30 mJ). Wear cotton clothing and static dissipating shoes. Removal of garments such as coats and sweaters should always be done away from flammable areas. Note—static dissipating shoes are conductive which is the opposite of electrically insulating shoes.

How to transfer—avoid splashing

Static can build up in small mists can burn, so always transfer in a manner that minimizes the generation of aerosols. If pumping the discharge should release close to the bottom of the container to minimize splashing. If pouring the materials should be close together ideally with a grounded metal funnel. Rate of transfer should be slow enough to minimize turbulent flow. Transfers of flammable liquid must be done in well ventilated areas.

Bonding—electrically connecting two containers with a metal wire



Grounding— electrically grounding the source container with a metal wire



Grounding & Bonding (cont.)

Everyday Examples at the Gas Pump

Always put any portable gas container being filled on the ground. Do not leave it in the bed of a pick-up truck, or trailer.

After getting out of your vehicle, always touch an electrically grounded metal object such as the gas pump to discharge any static electricity. Stay by the pump when putting gas in the vehicle. In the dry Minnesota winters the friction of synthetic clothing against the car seat can build up a static charge. Walking across carpet with a relative humidity of 10-20% can produce 35 kV charge. Static ignition of gasoline vapors has happened by touching the nozzle without first touching a ground.

Flammable liquid Properties

Conductive liquids ($> 10^4$ pS/m) are not likely to generate a static electric charge, unless they become isolated from the ground by a plastic container or suspended in the air. Examples include polar solvents like acetone, methanol, phenol and water.

Semi Conductive liquids ($50- 10^4$ pS/m) examples are chloroform, gasoline (leaded), methylene chloride.

Nonconductive liquids (< 50 pS/m) are a likely accumulate a charge. Examples are hydrocarbons include Benzene, Diethyl ether, Gasoline (unleaded), Heptane, Hexane, Toluene, Xylene.

Most flammable solvents have minimum ignition energies of around 0.2 mJ. Which is less than the level of perceptible shocks to a person's hand (1 mJ). Ammonia and Methylene chloride are much larger, 680, >1000 mJ respectively. Consult NFPA 77 Table B.2 for specific values.

Conductive liquid ignition example

In this example, plastic wrap was removed from a plastic container, this induced a static charge on the container. A conductive liquid, acetone, was poured into the charged plastic container. The acetone took on this charge. A metal funnel was then inserted into the container. A spark can go from the charged acetone to the funnel, or a spark can occur when the charged acetone is poured. In either case the spark could ignite the flammable vapors surrounding the liquid.

References

[Flammable Liquids– OSHA ppt, OSHA 1910.106 Flammable liquids](#)

NFPA 77 Recommended Practice on Static Electricity

[Stewart Browne Manufacturing online booklet "Grounding and Bonding Applications for the Control of Static Electricity"](#)

[ACA. Static Electricity Guide 2010](#) , See Appendix F for drawings of common assemblies. In particular, TA-12 on pg 83

Britton, L. (1999). Avoiding static ignition hazards in chemical operations (CCPS concept book). New York: Center for Chemical Process Safety of the American Institute of Chemical Engineers.