Plastic shocks and visible sparks

Static electricity is painfully familiar to anyone who has walked across a carpet or pulled off a sweater and then received a shock on touching a doorknob. It poses a significant threat in the chemical industry, where filling or emptying containers of various types and sizes can lead to sparks and the possible ignition of flammable vapors. Although incidents involving spark-initiated fires and explosions are relatively rare, recent studies indicate that electrostatic hazards can show up in unexpected places.

Safety consultant Jack E. Owens, associated with Condux, Inc., in Newark, Del., cites a problem that may occur when small plastic bottles, partially filled with a liquid such as methanol, are carried in a plastic bag or even a coat pocket. He describes an incident in which a small fire occurred when a technician attempted to pour methanol from a 1-liter plastic bottle, which had been carried in a plastic bag, into a metal can. A spark jumped from the liquid to the can and ignited the methanol fumes.

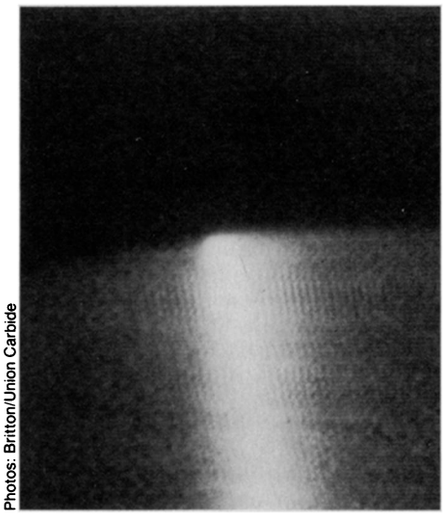
In this case, the bottle had been charged by contact with the plastic bag. The accumulated charge on the bottle's outside surface induced an opposite charge in the conductive liquid inside the bottle. The induced charge was large enough to generate a spark when the liquid came near a metal object.

"People normally haven't considered small bottles as being a problem," says Owens. "This is an effort on my part to make engineers aware of the fact that even with small-sized bottles, there can be a hazard." Owens presented his findings in Minneapolis at a special symposium on electrostatic hazards held at a recent meeting of the American Institute of Chemical Engineers.

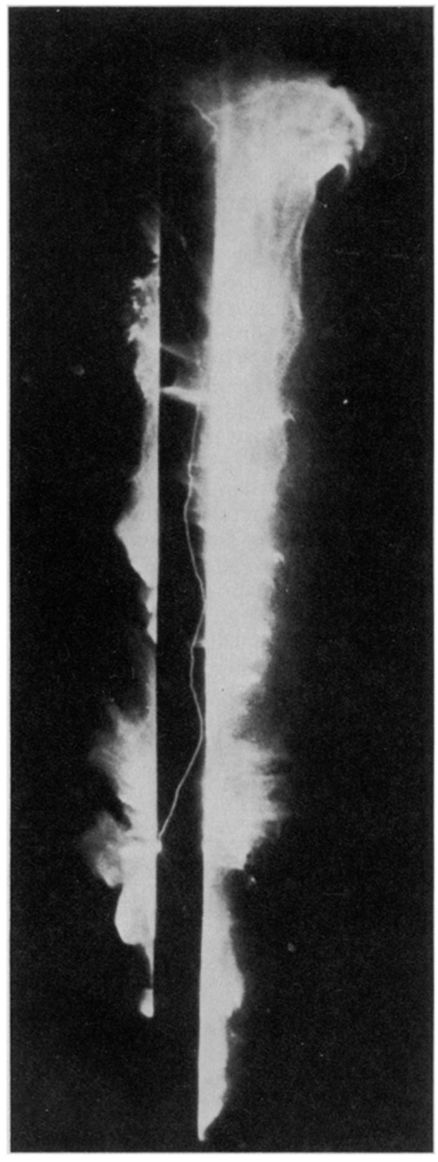
Similar problems involving induction charging occur when metal drums lined with plastic are being filled with a conductive liquid or when rags soaked with a conductive solvent are tossed into a plastic-lined drum. Potential hazards can also be created when a solvent-based semiconductive coating is applied to one surface of a nonconductive film. The human body itself can store charges large enough to cause sparks that can ignite flammable vapors.

One constant threat is the possibility of electric discharges during the transfer of chemical powders into or out of large metal silos. Over the last few years, chemical companies have reported a number of explosions that appear to have been triggered by sparks during powder-conveying operations.

Laurence G. Britton of Union Carbide Corp. in South Charleston, W. Va., has devised two instruments that can monitor the buildup of charge as a powder is poured into or out of a silo. The equipment, he says, is rugged and designed to be safe enough for use in hazardous environments. Neither instrument significantly slows silo operations, and both can be used effectively without great expert knowledge.



Photos: Britton/Union Carbide



Above, a 1.5-meter-long spark flashes from a silo wall (top) to the tip of a powder cone inside the silo. In the photo at right, a spark from a punctured polypropylene pipe, which has accumulated an internal electric charge, ignites a diesel-oil mist.

One is a device that goes directly into a filling tube to measure the polarity and magnitude of the charge being sucked into a silo. The other is an electronic image-intensification system that can look directly into a silo while it is being filled or emptied. Using this surveillance system, Britton was able to record several different types of sparking that occur inside silos. "We recorded events that people had never seen before," says Britton.

In his experiments with the loading of granular polyethylene into a silo with a diameter of 11 feet, Britton observed that most of the static discharge occurs during the settling of the powder bed. As the powder settles, the charge is concentrated. The excess charge is released as thousands of tiny sparks or a few large ones.

"It's the big ones that we have to watch out for," says Britton. "There's not an awful lot you can do about these large discharges without more study to find out what causes them. In the meantime, you ought to be very careful about controlling the amount of energy it takes to ignite the material you're conveying."

Both the type of material and the size of its particles affect the likelihood of a fire or an explosion during silo operations. For example, fine particles are a greater hazard than coarse material, says Britton. Mixtures containing a finely powdered additive or materials that give off a flammable vapor should be avoided.

Britton is presently investigating some of the electrostatic hazards associated with the filling of 55-gallon metal drums. Even when such drums are grounded, the process of pouring in a flammable liquid such as toluene may ignite the liquid. Britton has found that a variety of factors influence the chances of an explosion. The liquid must have a low conductivity and be highly flammable; it must also evaporate easily enough at the filling temperature to form a vapor-air mixture that supports ignition.

For a large enough spark to be created, the liquid also should be negatively charged, says Britton. His experiments show that different filters used to clean liquids as they are transferred can generate different charges. Even something as simple as changing a filter's pore size can reverse the charge on a liquid passing through the filter.

"Nobody really knows how and why things get charged up," says Britton. "It can't be predicted easily." — *I. Peterson*