Controlling your dust collection system’s static hazards

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Static electricity is a potential ignition source that can cause a fire or explosion in your dust collection system. This article describes how static electricity accumulates in a dust collection system and how to reduce the chances that it will cause serious harm to your workers, equipment, or plant.

We’re all familiar with static electricity, whether it lifts a child’s hair as she descends a plastic slide or produces sparks that shock us as we walk across the carpet in winter. These little sparks may be — well, shocking — but they’re nothing compared to the static discharges that can cause a damaging fire or explosion in a bulk solids plant.

Static electricity, including that which occurs in a dust collection system, is a potential ignition source in every plant. In fact, a dust collection system was involved in 40 percent of combustible dust incidents that occurred in bulk solids plants up to 2003, according to the American Institute of Chemical Engineers’ Guidelines for Safe Handling of Powders and Bulk Solids. Although static electricity wasn’t the cause of all the incidents, under the right conditions a static electricity charge can produce a spark that ignites the high-density dust cloud formed during filter cleaning and cause an explosion inside the dust collector. Dust in the dust collection system’s filters, ducts, and other components, as well as dust accumulating on workers in the system’s vicinity, is also vulnerable to static ignition.

Let’s take a look at the static electricity that forms in your dust collector and methods for minimizing static ignition hazards.

Static electricity in your dust collection system

In powder processing equipment — and particularly in dust collection systems — most static electricity charges develop when particles collide with other particles or solid surfaces in what’s called the triboelectric effect or tribocharging phenomenon. This means that when two particles rub against or touch each other or a surface, then separate, one or more electrons may move from one particle to the other, causing one particle to be more positively charged and the other to be more negatively charged. This imbalance creates a static electricity charge, which can lead to a static discharge (a spark).

The author’s granddaughter experiences static electricity first-hand.
When a dust cloud denser than the dust’s minimum explosible concentration (MEC) meets a static discharge that has an energy greater than the dust’s minimum ignition energy (MIE), a dust fire or explosion occurs. A bulk solid with an MIE less than 30 millijoules is called static sensitive.

The following must occur simultaneously to cause static ignition of a dust cloud:

**Operations or conditions that can generate static charges.** In a dust collection system, changing out the filters and operating the bag- or cartridge-filter cleaning system are two common ways static charges are generated. The charges’ available energy level depends on the energy in the particle collisions and the dust’s inherent charge accumulation property (called its volume resistivity) — that is, how readily charge accumulates in the dust and how long it holds the charge.

**Charges that accumulate.** Insulating surfaces, such as bag or cartridge filter media, can allow positive and negative charges to accumulate in conductive metal components, such as a bag filter’s cage or cartridge filter’s internal supports.

**Accumulated charges that can cause a static discharge.** If the charge’s voltage is high enough, the charge will pass through the air to a lower-voltage location and discharge as a spark.

**Static discharge with sufficient energy to ignite a dust cloud.** If a combustible dust cloud has a concentration greater than the dust’s MEC and if the static discharge energy is greater than the dust’s MIE, the discharge can ignite a dust fire or explosion.

**Minimizing static ignition hazards with bonding and grounding**

National Fire Protection Association (NFPA) standards basically require that all parts of a process handling combustible dust must be conductive, with a resistance no greater than 1 million ohms, to dissipate static electricity to earth. Information on how to dissipate static by bonding and grounding process components — including those in a dust collection system — is covered in NFPA 77: Recommended Practice on Static Electricity.

But what exactly are bonding and grounding? **Bonding** establishes an electrically conductive path to equalize the static voltage between two conductive system parts. All conductive parts in the system must be bonded — connected — by conductors (special clamps or other devices, detailed later in this section) so that all parts are at the same electrical potential. After conductive parts have been bonded, the electrical continuity between them should be less than 10 to 20 ohms, which can be checked with an electrician’s multimeter, as shown in Figure 1.

**Grounding (or earthing)** bonds all conductive parts of the system to earth, which has an infinite capacity to absorb electrical charges. A ground can be provided either with a rod driven into the earth and bonded to the equipment or by bonding the equipment to the building’s lightning protection grid. The ground’s electrical resistance can be measured with a handheld insulation tester, such as a Megger device, which gives a direct reading of insulation resistance in ohms or megohms. Your electrical resources will know the acceptable Megger readings for your area.

The first step in using bonding and grounding methods to minimize your dust collection system’s static ignition hazards is to identify where static charges accumulate in and around your system. Common locations include the filters, filter housing, dust drum (if the system is so equipped) and its flexible connection to the collector’s dust hopper, connected ducts, flexible hoses, and workers. The following information describes the bonding or grounding methods you can use to can safely dissipate static electrical charges at each of these locations.

**Filters.** Most filters have metal parts: Most bag filters have metal cages, and cartridge filters have an internal metal support structure. Since metals are conductors that can be electrically insulated from the dust collector housing by the nonconductive bag or cartridge media, they can collect static charge. Every time a dust collector cleans the filters,
an adjacent dust cloud with a concentration greater than the dust’s MEC forms. If the dust’s MIE is low, a static discharge from the filter’s metal cage or support structure can ignite the dust cloud, creating an initiating event that will involve the dust in the collector’s hopper as well.

To prevent this, you must bond the filter’s cage or support structure to the dust collector — for example, to the metal tubesheet, the metal support rails in the collector’s media plenum, or the collector housing. You can also use a bag filter that has braided wire inside and outside the bag cuff, as shown in Figure 2a, which makes an electrical contact between the filter’s cage and the tubesheet, as shown in Figure 2b. Another option is using conductive filter media (also called antistatic filter media), which is formulated with impregnated carbon or threaded with metallic or other conductive fibers. Section 15.10.4 in NFPA 77 recommends these filters for hybrid dusts (dusts mixed with flammable vapors) that have an MIE less than 4 millijoules and for conductive combustible dusts, such as metal or carbon dusts.

**Filter housing.** The filter housing — that is, the structure that contains the collector’s bag or cartridge filters — is usually made of metal, so it must be bonded in a continuous path to the other conductive elements in the collector — the tubesheet, dirty-air plenum, dust hopper, and rotary airlock discharge valve — and to a ground. To bond the housing, you can use jumper wires between bolts on the housing. If the jumper wire isn’t insulated, you can

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**Figure 2**

**Bonding devices**

a. Grounded filter bag with braided wire inside and outside bag cuff

b. Same bag provides bonding between cage and tubesheet

c. Bonding cable and clamp with pointed tips attaches to dust drum

d. Jumper wires bypassing insulated duct flanges to maintain continuous duct bonding
easily check the integrity of the bonding wire by giving it a tug to see if it’s connected or broken; if the wire is insulated, use a multimeter to check the continuity.

Another technique is to use a star washer under a bolt and nut to cut through the collector flange’s paint and make electrical contact. A third bonding method is to tack-weld the housing sections to provide an electrical path. With any method, use a multimeter to confirm continuity with the ground.

Don’t forget to ensure that the dust collector’s access doors are bonded, either by their fastening design or with a bonding cable.

**Dust drum and flexible connection.** If your system includes a dust drum below the collector’s hopper, it must be bonded to the system ground. The easiest way to do this is to get a special bonding cable with a clamp that has pointed tips to cut through the paint on the drum, as shown in Figure 2c, and connect the cable to the ground. In many cases, the drum with a clamped-on lid is strong enough to hold up to a vented dust explosion in the collector.

The flexible connection between the dust drum and collector bottom (or rotary airlock discharge valve) should be static-conductive or formulated with static-dissipative compounds to carry static charge to either the drum or valve bonding. The flexible connection can be made of a static-conductive or -dissipative material, or a bonding wire can be wound through it and touch the conductive elements at both ends. Make sure that the flexible connection is strong enough to hold up to a vented dust explosion.

If you have any plastic duct, wrapping wire around it won’t dissipate the static charge formed on the duct’s inside surface.

**Connected ducts.** Settled dust in a duct can be ignited by a static discharge, so you must bond all metal duct sections in your dust collection system to the collector to eliminate any potential difference in their electrical charges. Because the flanges that connect duct sections have gaskets that are insulating, effective bonding approaches include using jumper wires to bypass insulated flanges, as shown in Figure 2d; duct with uninsulated ring clamps at the flanges; a Morris coupling rubber sleeve with conductive ribbon to connect duct sections; or star washers, as described earlier, with a flange bolt.

**Caution:** If you have any plastic duct, wrapping wire around it won’t dissipate the static charge formed on the duct’s inside surface. Plastic is an electrical insulator, so it can’t conduct static to the wire. It’s also not good practice to string a grounded wire inside a plastic duct; static discharges from the duct’s inside surface can jump to the wire and ignite the dust. Replace the duct with metal duct or with plastic duct formulated with antistatic compounds.

**Flexible hoses.** If your dust collection system has flexible hoses, you must bond them to dissipate static charge. Just as with the flexible connection on your dust drum, you can choose flexible hoses that are static-conductive or formulated with static-dissipative compounds. If a flexible hose has internal wires, these need to be bonded to the connecting metal duct at each hose end. Some hoses have a conductive cuff at each end that bonds the wire in the hose to the metal duct.

**Workers.** If your dust’s MIE is low enough that static charge from a worker (typically 20 to 30 millijoules) can ignite a dust cloud, determine whether your workers require appropriate personal protective equipment (PPE), including flame-resistant garments and static-dissipating shoes. Workers may need such apparel when they perform system maintenance tasks that generate dust, including replacing filters inside the dust collector, cleaning out a dust bridge from the collector’s hopper, or replacing the dust drum under the collector. You can find helpful guidelines in NFPA 2113: Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures.

**Maintaining bonds and grounds**

Once you’ve gone to the trouble of bonding and grounding all components in your dust collection system, complete two documentation steps: First, record the ohm resistance values for the bonding devices you’ve tested and the insulation resistance results for the grounding devices. (If you can, photograph the devices so any changes will be easy to spot later.) Second, conduct regular visual inspections of the bonding and grounding devices to ensure that they’re still there, intact, and doing the job. Make more frequent inspections for a low-MIE dust. Also, after a major down day in which much of the equipment is disassembled and reassembled, confirm that the bonding and grounding devices have been properly reassembled and check their electrical continuity.

**References**


2. For more information on MIE, MEC, and other conditions necessary for a dust explosion, see the later section “For further reading” or contact the author.

4. The Megger insulation tester is available from www.megger.com; similar devices are available from other suppliers.


**For further reading**

Find more information on this topic in articles listed under “Static electricity,” “Safety,” and “Dust collection and dust control,” in Powder and Bulk Engineering’s article index later in this issue or in the Article Archive on PBE’s website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.) You can also find books and webinars on this topic in the website Store.

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