Combustible dust explosions are a risk in many areas of a dry bulk solids plant, but one of the likeliest locations for an explosion is in the plant’s dust collection system. This article describes seven common ways your dust collection system can fail to comply with combustible dust standards and how you can avoid these mistakes to keep your workers, equipment, and plant safe.

The National Fire Protection Association (NFPA) sets standards and codes to protect buildings against fire and explosion risks, and OSHA is enforcing these standards with increasing vigilance. In a dry bulk solids processing or handling plant, one of the most common locations for a combustible dust explosion is the dust collection system. When explosions occur here, the culprit is often one — or a combination — of the following common mistakes.

**Mistake 1: Maintaining an “If it ain’t broke, don’t fix it” mindset.**

An all-too-common refrain in many bulk solids plants is “I’ve been here for many years, and we’ve never had a problem.” If you’ve heard statements like this in your plant, beware: This mindset can result from a misconception that your dust isn’t explosive simply because your plant hasn’t experienced a dust explosion or fire. But, in fact, the opposite can be true. In some cases, it can take years for dust to accumulate to explosive levels.

You can better understand the dust explosion risks in your plant by reviewing the five elements in the dust explosion pentagon, as shown in Figure 1. All of these elements can exist at various times in a plant, but all must be present at the same time for an explosion to occur. If the first four items are present simultaneously, but the fifth — containment — is not, a flash fire can still erupt.

Let’s examine how these elements work together to initiate an explosion in one type of closed vessel: a cartridge dust collector. The explosion typically begins when an ignition...
source enters the dust collector. (The ignition source — such as a spark or hot ember — can come from many things and, in most cases, is never identified.) When the filters are pulse-cleaned, combustible dust is suspended in high concentration as a dust cloud in the air contained in the collector. All five dust explosion elements are now present, initiating an explosion.

While some incidents involve just one explosion, most include a series of explosions. In these cases, the initial explosion can dislodge ignitable dust hidden on overhead surfaces (such as ductwork) or at other locations over a large plant area, and this can trigger secondary explosions that are ignited by the initial explosion or other ignition source. In plant dust explosions, these secondary explosions have caused the majority of worker injuries and property damage.

So how do you know if your plant is at risk? Just because your plant hasn’t had a dust explosion before is no guarantee of future safety. The hazard level in your plant can change from day to day and even from moment to moment, such as when a new process is started up, there’s a lapse in plant housekeeping, or improper equipment grounding causes a static electricity discharge. It’s up to you to constantly manage change and remain vigilant to identify the conditions in your plant that can create a dust explosion hazard.

Mistake 2: Failing to make a hazard analysis.

Not conducting a hazard analysis is probably the biggest explosion safety oversight in bulk solids plants. NFPA fire and explosion safety standards state that a hazard analysis (also called a risk evaluation) must be conducted in a plant to assess explosion risk and determine what level of fire and explosion protection it requires. Your own personnel or an independent consultant can make this analysis but, ultimately, the authority having jurisdiction must review and approve the findings. (NFPA defines the authority having jurisdiction as an organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.) [Editor’s note: Find a list of standards most applicable to dust collection systems in the sidebar “NFPA standards for equipment handling combustible dusts.”]

The first step in the hazard analysis is to determine whether your dust is explosive. You can contract any of several independent dust explosion testing labs around the US to run a low-cost screening test on your dust sample to establish whether it’s combustible. If the test is positive, the dust’s explosive index ($K_{St}$) and maximum pressure rise ($P_{max}$) must be determined using the test described in ASTM E1226-10: Standard Test Method for Explosibility of Dust Clouds.

Your dust collector supplier needs your dust’s $K_{St}$ and $P_{max}$ values to select the appropriate explosion venting or suppression devices for your collector. Failing to test your dust and provide these values to the supplier will increase your costs because the supplier will have to use worst-case estimates for them and probably add more explosion protection equipment than you need. Worse, the supplier may simply refuse to provide the equipment.
The liability to the dust collector supplier and to you from failing to provide adequate explosion protection is too great to ignore. In fact, any dust with a $K_s$ above zero is now considered explosive, and most dusts fall into this category. If OSHA determines that a dust with even a very low $K_s$ is present in a plant that has no explosion protection in place, the agency will issue a citation. This is one of the biggest changes resulting from OSHA’s reintroduction of its Combustible Dust National Emphasis Program (NEP) in the aftermath of the devastating 2008 explosion at the Imperial Sugar Company in Georgia, an incident in which 13 workers were killed and another 42 were injured.

**Mistake 3: Shopping for price over quality.**

Just as when you purchase any process or handling equipment, you need to base your dust collector buying decision on the unit’s life-cycle cost (sometimes called total cost of ownership) rather than the lowest equipment price. A well-designed dust collector in a carefully engineered dust collection system can rapidly pay for itself in energy and maintenance savings, greatly reducing the collector’s operating costs over that of a unit with a low initial cost. In the event of a dust explosion, a high-quality, heavy-duty collector can offer a less obvious advantage, as full-scale tests and field experience have shown: Unlike a low-end dust collector, which more than likely will require total replacement after an explosion, the heavy-duty collector made of thicker metal and with higher vessel strength will survive the event and can often continue in service, requiring replacement of only the explosion vent and filter elements.

This cartridge dust collector for handling polyethylene dust has an explosion vent with a vertical upblast deflector plate (shown in right foreground) to safely direct an explosion away from the plant building.

**Mistake 4: Using noncompliant explosion protection devices.**

A close cousin of the “price versus quality” issue involves using noncompliant — or uncertified — explosion protection devices. For instance, back-flap dampers and similar devices are sometimes reverse-engineered to function as explosion protection devices by suppliers who don’t have the appropriate expertise or don’t properly test the devices to satisfy explosion protection standards or performance-based requirements. This means that no test results exist to prove that the devices will comply with current standards. If an OSHA inspector finds this situation in your plant, you’ll have to replace the noncompliant device and your plant may be subject to a fine. But worse yet, if a dust explosion occurs, there’s no guarantee that the noncompliant device will perform as expected and protect your workers and plant.

Also be aware that there’s no such thing as an “NFPA-approved” explosion protection device. A supplier may correctly state that a device is “manufactured in accordance with NFPA standards” or “carries ATEX and CE certification,” or both, but the supplier must provide test data to support these claims. While such devices may cost more than their noncompliant counterparts, in the long run they’ll save you money, headaches, and even lives.

**Mistake 5: Practicing poor housekeeping.**

In an October 2011 update to OSHA’s Combustible Dust NEP, the agency reported that a common violation found during plant inspections involved “hazardous levels of dust accumulation in the workplaces due to poor housekeeping practices.” In our experience, an OSHA inspector who finds that running a finger across a dusty surface leaves a path or walking leaves a footprint on a dusty floor will usually consider this a citable condition. Even diligent work-surface and floor cleanup isn’t sufficient if more elevated areas in the plant (such as horizontal overhead surfaces like ductwork and rafters or the tops of machinery) are neglected. The NFPA recently tightened its definition of hazardous surface dust in NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids to mean any dust layer $\frac{1}{64}$ inch (0.4 millimeter) or greater, compared with a previous limit of $\frac{1}{32}$ inch (0.8 millimeter) or greater.

A simple but important housekeeping requirement for your dust collector is to change the filters when airflow through the dust collection system reaches the pressure drop limit prescribed by the collector supplier or when the pressure drop across the collector impairs the system’s ability to capture dust and allows it to escape into the plant. While some long-life cartridge filters can operate for 2 years or even longer between changeouts, you’ll probably need to replace your filters much more frequently, particularly in a heavy dust-loading application. You can also remove spilled dust and accumulated surface dust from the...
area surrounding the collector by using a listed portable vacuum (that is, a portable vacuum included in a list published by an organization — such as UL — that’s acceptable to the authority having jurisdiction). Using compressed air to blow dust from surfaces is permitted only under certain conditions, because blowing the dust can increase the explosion hazard by creating a combustible dust cloud.

Dust resting in the hopper can also affect the dust collection system’s performance, which will lead to an airflow loss that reduces dust conveying velocities through the system.

A common housekeeping misstep is to store dust in the collector’s hopper. Avoid this mistake by equipping the hopper with a device that discharges the dust into a drum or other storage container after it’s pulse-cleaned off the filters. Also empty this container regularly to prevent dust from backing up into the hopper where it can create a potential fire or explosion risk. Dust resting in the hopper can also affect the dust collection system’s performance, which will lead to an airflow loss that reduces dust conveying velocities through the system. These reduced velocities allow dust buildup in the ductwork and dust emissions at the dust-capture hoods in your process.

Mistake 6: Failing to recognize the hazards of an “open” dust collector.

One fairly common misconception is that an “open” dust collector — the type that’s often incorporated into bag-dump stations, downdraft tables, and booths in bulk solids processes — isn’t an explosion hazard. While it’s true that this type of collector differs from a conventional bag or cartridge collector in that it doesn’t consist of a tightly contained vessel, the collector can include four of the five ingredients in the dust explosion pentagon: combustible dust, an ignition source, oxygen, and dust dispersed in sufficient concentration to be explosive. This means the collector still poses a risk of a flash fire directed by a pressure front — a potentially fatal risk for workers in the area. So if you use an open dust collector in your process, you still need to test and evaluate your dust’s combustibility and equip the area with the fire and explosion protection devices required to handle your dust’s hazards.

Mistake 7: Overengineering your system’s explosion protection.

While the mistakes we’ve discussed so far cover not doing enough to comply with combustible dust hazards, sometimes you can err on the side of doing too much. This results in overengineering: using explosion protection solutions that may be needlessly expensive and time-consuming to monitor and maintain.

NFPA uses relatively conservative textbook calculations in its standards for specifying explosion protection equipment — and justifiably so. But NFPA also allows using data from real-world destructive tests of a collector in place of the agency’s own standard calculations, as long as the collector supplier can provide data that proves the collector is designed to meet a specific set of criteria for a given situation. This makes using real-world destructive test data a permissible strategy, and it’s one that’s often overlooked.

One example is using a dust collector explosion test to show that the collector will stand up to an explosion’s anticipated pressure conditions, instead of choosing explosion protection equipment for the collector using the reduced pressure calculations in NFPA 68: Standard on Explosion Protection by Deflagration Venting. By combining field testing with a full-scale dust collection laboratory test apparatus to prove certain assumptions, this approach could allow you to install longer duct lengths in your application, use one explosion vent rather than several, or even use an explosion vent instead of a more costly chemical suppression system. Find out if your dust collector supplier can provide real-world test data for your collector to help you avoid overengineering the unit and reduce your equipment costs — without compromising safety.

References

1. For more information about NFPA standards for equipment handling combustible dusts, contact National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555; fax 617-770-0700 (www.nfpa.org).
3. Find more information on this ASTM International standard at www.astm.org.
4. For more information on ATEX certification and CE markings, go to http://tinyurl.com/ATEXinfo.

For further reading

Find more information on combustible dust hazards and dust collection in articles listed under “Safety” and “Dust collection and dust control” in Powder and Bulk Engineering’s comprehensive article index (in the December 2011 issue and at PBE’s website, www.powderbulk.com) and in books and CDs available on the website at the PBE Bookstore. You can also purchase copies of past PBE articles at www.powderbulk.com.

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