

Guidelines for choosing an explosion protection system for your dust collector — Part I

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Combustible dust hazards with the potential to cause an explosion are a fact of life in bulk solids plants. To mitigate the effects of a dust explosion in your plant, you need to correctly select an explosion protection system for your dust collector and other enclosed dust handling equipment. Part I of this two-part article describes major explosion protection methods and the regulatory standards that cover them. Part II in November will explain how to choose a system with the most suitable and cost-effective method (or combination of methods) for your application. While the guidelines focus on choosing an explosion protection system for a dust collector, they can also be applied to choosing a system for other enclosed equipment and the ductwork between equipment.

In the past decade, the bulk solids industry has seen the introduction of many new explosion protection technologies with advanced capabilities and smarter features. High-profile dust explosions in recent years have also increased OSHA's emphasis on mitigating combustible dust hazards.¹ These factors make it more important than ever for bulk solids plant owners and process engineers like you to know which explosion protection standards and technologies apply to your combustible dust hazards and process requirements so you can select a suitable protection method (or methods).

In a bulk solids plant, dust collectors are the equipment most commonly protected from dust explosions. Before we discuss how to choose the most suitable and cost-effective explosion protection system for your collector, let's look at the basics of venting, isolation, and suppression explosion protection methods.

Venting

Two kinds of explosion venting — explosion relief venting and flameless venting — are available for dust collectors and other enclosed equipment that handles dust. (Also be aware that according to *NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids*,² equipment with venting must also be isolated to prevent flame from propagating between connected equipment; find information on isolation methods in the next section.)

Explosion relief venting. Explosion relief venting, one of the most widely used methods for mitigating dust explosions, requires one (or more) explosion relief vent installed on the wall of a process vessel. The vent consists of a membrane that's constructed of a material weaker than the vessel wall; examples are shown in Figure 1a. During a dust explosion's incipient (beginning) stage, the vent ruptures and directs the explosion's overpressure, flame, burnt and unburnt material, and other combustion by-products away from the vessel to a safe location, as shown in Figure 2. The explosion relief vent is designed to ensure that the explosion's pressure rise doesn't exceed the vessel's pressure shock resistance. These vents are designed according to procedures in *NFPA 68: Standard on Explosion Protection by Deflagration Venting*.³ Subsection 8.8 provides an equation for estimating the vented fireball's size; from this information, you can calculate the safe distance required in front of the vented vessel to protect workers, equipment, and the building structure from the ejecting fireball.

Flameless venting. A relatively new technology, flameless venting protects indoor equipment from dust explosions by combining an explosion relief vent's weak membrane with a mesh trap that arrests flame and retains particles. Examples are shown in Figure 1b. Like an explosion relief vent, the flameless vent's membrane, installed on the process vessel, ruptures during a deflagration. But unlike with a relief vent, the deflagration's overpressure, flame, and material discharge through the membrane into

the mesh trap, which prevents the flame and material from discharging into the surrounding area. Instead, the flameless vent discharges *only* hot gas and overpressure. A safety perimeter must be established around the flameless vent to protect workers from this discharge.

Like the explosion relief vent, the flameless vent is designed according to procedures in NFPA 68. To ensure that the flameless vent can successfully protect the vessel, the ratio of room volume to vessel volume (that is, the ratio of the volume of the room in which the vented vessel is located to the vessel's volume) must also be kept below the flameless vent manufacturer's recommendations. Since any dust or dirt blocking the openings in the mesh trap would compromise the vent's operation, the mesh must also be regularly cleaned to ensure that the surface is free of dust or dirt at all times.⁴ Some vent manufacturers offer low-inertia, fire-resistant fabric covers to help keep the mesh surface clean.

Isolation

Explosion isolation devices prevent a deflagration in a process vessel from propagating through a connection such as a duct, chute, or conveyor to other equipment, where it could cause subsequent explosions. The devices work by mitigating the flame propagation and pressure piling between connected equipment.⁵ An isolation device can be active or passive. An active device has detection components, including one (or more) explosion pressure

detector and flame detector, and controls; the detectors detect explosion pressure or a flame and send a signal to the controls to rapidly deploy the device. A passive device is self-actuated by the airflow from a deflagration. When to provide an isolation device between connected process equipment is described in Subsection 7.1.4 in NFPA 654.

Explosion isolation devices are typically chemical or mechanical. A **chemical isolation device**, as shown in Figure 3a, is an active device that works by rapidly discharging a chemical extinguishing agent, such as sodium bicarbonate, into connecting ductwork to mitigate flame propagation.

A **mechanical isolation device** can be either an active device, such as a high-speed gate valve, or a passive device, such as a flap valve, as shown in Figure 3b. Milliseconds after the active high-speed gate valve's detectors sense explosion pressure or flame, the controls rapidly deploy a mechanical barrier — closing the valve's gate — across the connecting ductwork.⁶ The passive valve, which can have a flap or float, is self-actuated by the airflow from a deflagration so it requires no detectors or controls. This device is typically used to isolate nuisance-dust-handling equipment with relatively low dust loads.

Suppression

Explosion suppression systems are often installed in applications where it's not possible to safely vent an explosion away from process equipment or where the process material is toxic or harmful to workers and the environment. The system detects an incipient dust explosion very soon after ignition and discharges enough chemical suppressant (a chemical extinguishing agent) quickly enough into the developing fireball in the equipment to extinguish all flame before a destructive overpressure develops.⁷ (For a detailed illustration of the basic steps in suppressing a deflagration, see reference 8.) Major components in a typical explosion suppression system are one (or more) explosion

Figure 1

Vent types

a. Explosion relief vents



b. Flameless vents

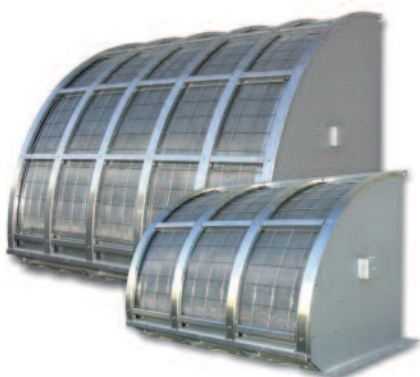


Figure 2

Explosion relief vent safely directing explosion away from outdoor dust collector



Figure 3

Explosion isolation equipment

a. Chemical isolation device (active)



b. Mechanical isolation devices

Active (gate valve)

Passive (flap valve)



suppressor, as shown in Figure 4 (this is the same as the chemical isolation device discussed in the last section), one (or more) explosion pressure detector, one (or more) flame detector, and a control panel. Explosion suppression systems are designed according to *NFPA 69: Standard on Explosion Protection Systems*.⁹ **PBE**

Next month: Part II shows how a dust collector can be equipped with an explosion protection system using venting, isolation, or suppression (or a combination) to handle particular combustible dust hazards and process requirements.

References

1. Emre Ergun, "Advancements in explosion suppression product safety, reliability, and performance," *Proceedings of American Institute of Chemical Engineers 42nd Annual Loss Prevention Symposium*, Houston, April 2008.
2. *NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids* (2006), National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555, fax 617-770-0700 (www.nfpa.org).
3. *NFPA 68: Standard on Explosion Protection by Deflagration Venting*, (2007), National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555, fax 617-770-0700 (www.nfpa.org).

Figure 4

Explosion suppressor



4. *Explosion Protection Using Flameless Venting — A Review*, Report HSL/2006/105, P. Holbrow, Health & Safety Laboratory, Buxton, Derbyshire, England, 2006.
5. R.K. Eckhoff, "Status and trends in dust explosion prevention and mitigation," *Fire & Safety*, Spring 2008.
6. P. E. Moore and R. Siwek, "Explosion suppression overview," *Proceedings of the Ninth International Symposium on Loss Prevention and Safety Promotion in the Process Industries*, Barcelona, Spain, May 1998, pages 745–758.
7. Stanley S. Grossel and Robert G. Zalosh, *Guidelines for Safe Handling of Powders and Bulk Solids* (2005 edition), Center for Chemical Process Safety of the American Institute of Chemical Engineers (AIChE), 3 Park Avenue, New York, NY 10016-5991; 800-242-4363, fax 203-775-5177 (www.aiche.org).
8. Explosion Suppression illustration on page 4 in *Industrial Explosion Protection*, INCOM Explosionsschutz AG, Olten, Switzerland; brochure available at <http://tinyurl.com/suppressionillustration>.
9. *NFPA 69: Standard on Explosion Protection Systems* (2008), National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555, fax 617-770-0700 (www.nfpa.org).

For further reading

Find more information on explosion protection in articles listed under "Safety" in *Powder and Bulk Engineering's* comprehensive article index (in the December 2010 issue and at *PBE's* website, www.powderbulk.com) and in books 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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