

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

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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. In October, Part I of this two-part article described major explosion protection methods and the regulatory standards that cover them. Part II explains 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.

Guidelines for selecting an explosion protection system

The following guidelines show 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. These guidelines describe six dust collectors, as shown in Figure 1, each handling successively greater combustible dust hazards and process limitations, and explain why a particular explosion protection system was chosen for each. [*Editor's note:* The systems shown in Figure 1 are somewhat simplified for illustration purposes;

the actual number of explosion protection components in an installed system will depend on the dust collector size, the dust properties, and the process conditions. More detailed illustrations are available from the author.]

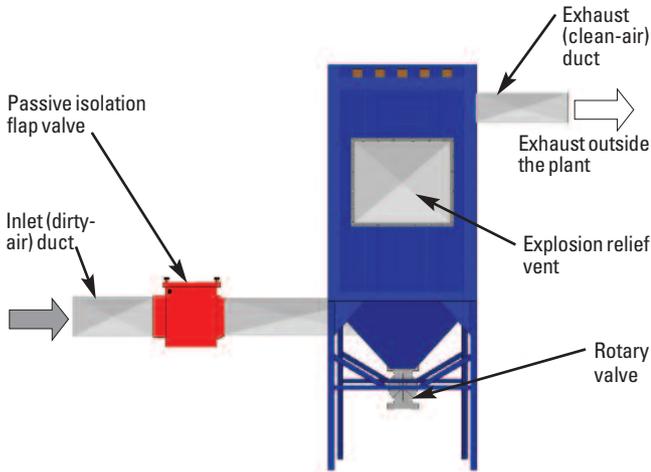
Be aware that each system's design is based on the assumption that the user has already performed a risk assessment of the process's combustible dust hazards and has determined that an explosion protection system is one means of mitigating the hazards. You'll need to perform such a risk assessment before choosing an explosion protection system for your dust collector, as well. This includes learning your dust's maximum deflagration index (K_{St}), which is a measure of the dust's relative explosivity, and the maximum reduced pressure (P_{red}), which is the maximum pressure reached in the collector (or other protected vessel) after a vented or suppressed deflagration.¹

System 1: Outdoor dust collector with explosion relief vent and passive inlet isolation. An explosion protection system like that shown in Figure 1a is suitable for a dust collector that's located outdoors with a 22-inch or smaller inlet duct diameter and that handles a dust that isn't toxic or otherwise harmful. The dust can have a maximum K_{St} of 300 bar-m/s. The P_{red} is limited to 7 psi. This system, one of the most common and cost-effective, includes an explosion relief vent on the collector wall and a passive isolation flap valve on the inlet duct. The rotary valve at the collector's hopper outlet, which functions as a material discharge gate, also serves as an isolation device in this and the following systems to protect downstream equipment and workers in a deflagration. The collector's exhaust is directed outside the plant to a restricted area away from the plant's air intakes.

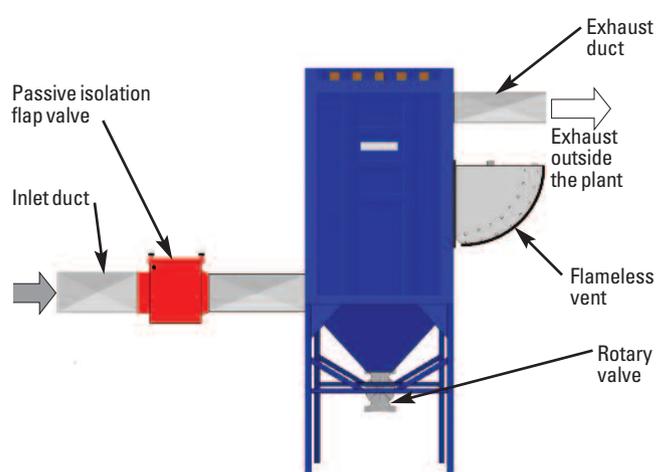
Figure 1

Explosion protection systems for dust collectors with various combustible dust hazards and process requirements

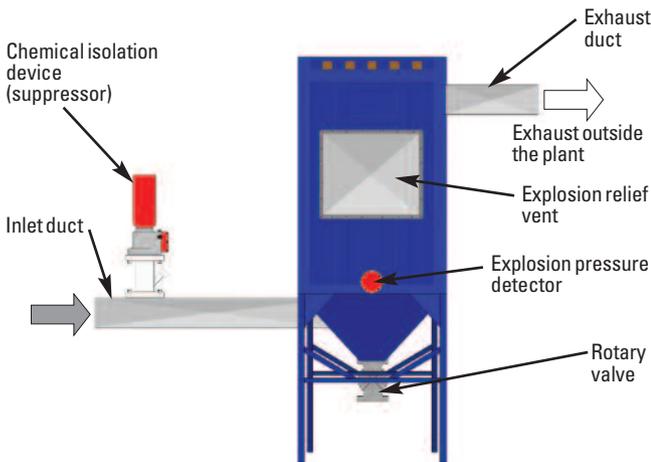
a. System 1: Outdoor unit with explosion relief vent and passive inlet isolation



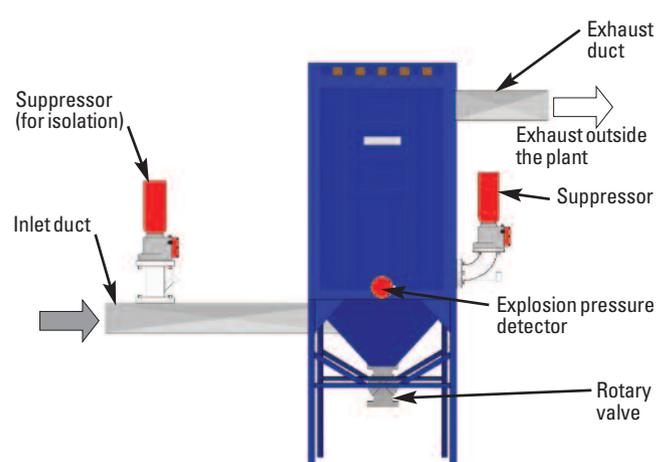
b. System 2: Indoor unit with flameless vent and passive inlet isolation



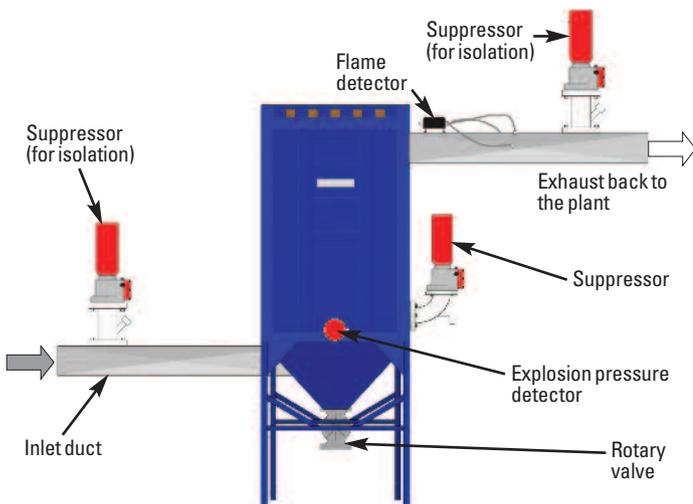
c. System 3: Outdoor unit with explosion relief vent and chemical inlet isolation



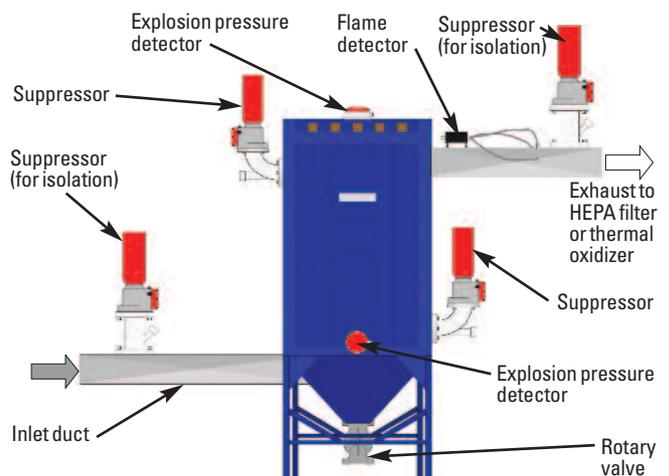
d. System 4: Outdoor or indoor unit with suppression system and chemical inlet isolation



e. System 5: Outdoor or indoor unit with suppression system and chemical inlet and outlet isolation



f. System 6: Outdoor or indoor unit with suppression system and chemical inlet and outlet isolation for hybrid material



More system details:

- The design limitations of the passive isolation valve in this system produce the restrictions on the collector's inlet duct diameter, the dust's maximum K_{St} value, and the P_{red} value. The collector and all of the connected inlets and outlets also must be designed to withstand pressure of at least the P_{red} value.
- Because flame and material will be released from the collector in a deflagration that ruptures the explosion relief vent, this system is generally suitable only for an outdoor collector. (It may also be suitable for an indoor collector located close to an outside wall with a vent duct to direct overpressure, flame, and material to a safe outdoor area.)
- This system meets NFPA 68, 69, and 654¹ requirements.
- You can maintain this system without assistance from the manufacturer.

System 2: Indoor dust collector with flameless vent and passive inlet isolation. You can choose an explosion protection system like that shown in Figure 1b if your dust collector is located indoors, the inlet duct diameter is 22 inches or less, and your dust isn't toxic or otherwise harmful and has a maximum K_{St} of 250 bar-m/s. Similar to System 1, the P_{red} is limited to 7 psi. This system includes a flameless vent on the collector wall and a passive isolation flap valve on the inlet duct. The unit's exhaust is also directed outside the plant to a restricted area away from the plant's air intakes.

More system details:

- The system manufacturer recommends a safety perimeter of 5 meters (16.4 feet) on the side of the collector with the flameless vent to protect workers and equipment.
- The system manufacturer recommends that the passive isolation device have an isolation distance (that is, the distance between the device and the collector) of 2 to 4 meters (6.5 to 13.1 feet), depending on the device's size.
- The flameless vent's flow-restricting design produces the system's maximum K_{St} limit, and the passive isolation flap valve's design limits the inlet duct diameter and P_{red} . The collector and all of the connected inlets and outlets also must be designed to withstand pressure of at least the P_{red} value.
- While no flame will be released from the system's flameless vent in a deflagration, hot gas can be released.
- This system meets NFPA 68, 69, and 654 requirements.
- You can maintain this system without help from the manufacturer.

System 3: Outdoor dust collector with explosion relief vent and chemical inlet isolation. Like System 1, this explosion protection system is also suitable for an outdoor dust collector that doesn't handle a toxic or other harmful dust. But unlike System 1, this system can protect a collector with an inlet duct of any diameter and handle a dust with a maximum K_{St} of 500 bar-m/s. This system also allows a P_{red} greater than 7 psi. This system, as shown in Figure 1c, includes an explosion relief vent on the collector wall and chemical isolation at the inlet; the isolation components include a chemical isolation device (that is, a suppressor) on the inlet and an explosion pressure detector on the wall of the collector's dirty side, where a dust explosion is most likely to occur. The collector's exhaust is also directed to a restricted area away from the plant's air intakes.

More system details:

- The system's chemical isolation device allows it to handle greater inlet duct diameters and greater P_{red} values. The device can handle greater pressure because it has no pressure restriction: It stops the flame, not the pressure. However, the collector and all of the connected inlets and outlets also must be designed to withstand pressure of at least the P_{red} value.
- The system's combination of an explosion relief valve, which doesn't restrict flow like a flameless vent does, and a fast-deploying chemical isolation device allows the system to handle larger maximum K_{St} values.
- In a deflagration that actuates the system, flame and material will be released from the collector.
- This system meets NFPA 68, 69, and 654 requirements.
- The system must be maintained by the manufacturer or a worker trained by the manufacturer.

System 4: Outdoor or indoor dust collector with suppression system and chemical inlet isolation. You can use an explosion protection system like that in Figure 1d for an outdoor or indoor dust collector that handles any type of dust, even a toxic or otherwise harmful dust, with a maximum K_{St} of 500 bar-m/s. This system also allows a P_{red} greater than 7 psi. Like System 3, this system can handle any inlet duct diameter. The system has no explosion relief venting. It uses a suppressor (a chemical isolation device) at the inlet duct to provide explosion isolation from upstream equipment and a suppression system that includes a suppressor on the collector's dirty side (below the filters) and an explosion pressure detector on the collector. The collector's exhaust is also directed outside the plant to a restricted area away from the plant's air intakes.

More system details:

- The suppressors' lack of pressure restriction allows the system to handle greater inlet duct diameters and greater P_{red} values, and the suppressors' fast deployment allows the system to handle greater maximum K_{St} values. How-

ever, the collector and all of the connected inlets and outlets also must be designed to withstand pressure of at least the P_{red} value.

- In a deflagration that actuates the system, no flame or toxic or harmful dust will be released from the collector.
- This system meets NFPA 69 and 654 requirements.
- The system must be maintained by the manufacturer or a worker trained by the manufacturer.

System 5: Outdoor or indoor dust collector with suppression system and chemical inlet and outlet isolation. You can use a system like that shown in Figure 1e for an outdoor or indoor dust collector that recirculates the clean exhaust air to the plant and handles a dust that isn't toxic or otherwise harmful, with a maximum K_{St} of 500 bar-m/s. The system also allows a P_{red} greater than 7 psi. The inlet and exhaust duct diameters can also be over 22 inches. The system includes suppressors on the inlet and exhaust ducts (for isolation from upstream and downstream equipment), as well as a suppression system that includes a suppressor on the dirty-air side of the collector (below the filters), an explosion pressure detector on the collector's dirty-air side, and a flame detector at the exhaust duct.

More system details:

- The system's suppressors allow it to handle inlet and exhaust duct diameters over 22 inches and to handle greater P_{red} values; their fast deployment allows the system to handle larger maximum K_{St} values, as well.
- In a deflagration that actuates the system, no flame or material will be released from the collector.
- This system meets NFPA 69 and 654 requirements.
- The system must be maintained by the manufacturer or a worker trained by the manufacturer.

System 6: Outdoor or indoor dust collector with suppression system and chemical inlet and outlet isolation for hybrid material. If your outdoor or indoor dust collector handles a hybrid material — that is, a mixture of combustible dust and flammable vapor or gas (common in pharmaceutical and some specialty chemical processes) — it can be equipped with a system like that shown in Figure 1f. Typically, the system's exhaust air is sent to a high-efficiency particulate air (HEPA) filter or thermal oxidizer to remove hazardous elements from the air. This system, which is also suitable for hybrid materials containing a toxic or otherwise harmful dust, includes suppressors on the inlet and exhaust ducts for isolation from upstream and downstream equipment, as in System 5. But unlike System 5, it has a suppression system with suppressors on both the dirty-air and clean-air sides of the collector. This is because in an explosion in the collector's dirty-air side, flammable vapor or gas is most likely to ignite in the collector's clean-air side, as well. The suppression system also has multiple explosion pressure detectors on the col-

lector's dirty-air and clean-air sides, as well as a flame detector on the exhaust duct.

More system details:

- The system's suppressors allow it to handle larger inlet and outlet duct diameters and greater maximum K_{St} and P_{red} values. However, the collector and all of the connected inlets and outlets also must be designed to withstand pressure of at least the P_{red} value.
- In a deflagration that actuates the system, no flame or material will be released from the collector.
- This system meets NFPA 69 and 654 requirements.
- The system must be maintained by the manufacturer or a worker trained by the manufacturer.

Some final advice

With the variety of explosion safety technologies available today, the job of selecting the right explosion protection system for your dust collector or other process equipment can seem daunting. Cut through the confusion by learning about the NFPA standards for safely handling combustible dusts and then working closely with your explosion protection equipment supplier to design a system that complies with these standards and handles your dust hazards and process conditions. With the right system in place, you'll protect your workers and equipment and keep your plant operating safely.

PBE

Reference

1. *NFPA 68: Standard on Explosion Protection by Deflagration Venting* (2007), *NFPA 69: Standard on Explosion Protection Systems* (2008), and *NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids* (2006) are available from 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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