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Image 1: Indoor flameless venting

Any facility that handles, transfers, packages, or processes powder- or dust-producing materials could face a high explosion risk from combustible dust. However, you might be surprised that operating an industrial dust collector is not always enough to completely mitigate this danger. If it isn't designed properly for your application with the correct safety systems in place, the dust collector itself can become the source of a deflagration or explosion.

In a closed vessel like a dust collector, an explosion usually begins when a suspended cloud of combustible dust is present in high concentration inside the unit. As the fan draws in large volumes of air, it can pull an outside spark into the collector. When the spark collides with the dust cloud under pressure, it triggers an explosion. The source of the spark or ember could come from the production process, static electricity or even human carelessness.

Chapter 7 of National Fire Protection Association (NFPA) 654 Standard for the Prevention of Fire and Dust Explosions outlines the allowed explosion protection methods for process equipment. This standard requires facility operators to minimize the escape of dust in the maintenance and operation of equipment. Processors and manufacturers must also abide by the methods of fire and explosion protection for specific equipment as stated in the standard. And they must conduct a risk assessment to determine the level of protection necessary to achieve compliance.

In particular, NFPA 654 covers explosion protection for process equipment and requires one or more of the following methods of protection:

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* Oxidant concentration reduction in accordance with NFPA 69

- * Deflagration venting in accordance with NFPA 68
- * Deflagration pressure containment in accordance with NFPA 69
- * Deflagration suppression systems in accordance with NFPA 69
- * Dilution with a noncombustible dust to render the mixture noncombustible
- * Deflagration venting through a listed dust retention and flame-arresting device

With NFPA 654 in mind, here are important considerations for the safe, compliant operation of your dust collection system.

NFPA Standard 68 for Venting Safety

If your facility produces combustible dust, one of your options would be to comply with NFPA 68 Standard on Explosion Protection by Deflagration Venting. This standard applies to the design, location, installation, maintenance, and use of devices and systems that vent combustion gases and pressures resulting from a deflagration within an enclosure. The objective of the standard is to prevent structural failure of the immediate occupied work areas and minimize injury to personnel in areas adjacent to the space. Thorough evaluation of your processes is necessary to determine if you should vent your dust collector indoors or outdoors and to properly design the system for optimal deflagration protection.

Pressure Capabilities

To accurately specify and size the vents, you must understand the pressure capabilities of your collector. Comparing venting vessel strength to the deflagration strength and vent burst pressure are key to effective deflagration protection.

NFPA classifies dusts according to their explosibility, known as their Kst values. Class 1 dusts are rated below 200 Kst, Class 2 dusts range from 200 to 300 KSt, and Class 3 dusts are rated above 300 KSt. If the Kst value of your dust is greater than zero, you must provide explosion protection on your dust collector.

In addition to knowing the Kst (normalized rate of pressure rise), it is also important to understand Pmax (maximum pressure for an unvented dust explosion) and Pred (maximum pressure developed in a vented enclosure during a vented deflagration). Burst pressure of the event is designed to be lower than enclosure strength, which will relieve the pressure of the deflagration before it can build to levels that would destroy the collector enclosure.

Indoor Flameless Venting

NFPA 68 allows flameless venting inside buildings when venting outdoors is not a feasible option, depending on the application. For example, it is not recommended for toxic dust applications because dust can be released into the room where venting occurs.

A flameless vent can be installed over a standard explosion vent to extinguish the flame front as it exits the collector. You will need to establish a safe area around the flameless vent as specified by the manufacturer because pressure is still released from the vent.

A flameless vent consists of a housing that includes a panel of high-temperature mesh that absorbs heat and flame. During an event, the vent opens, releasing the pressure and fireball into the housing. The mesh layers strip the fuel particles from the deflagration, only allowing a portion of the pressure wave and smoke byproduct to pass more safely into the working environment and removing the dangerous flame ball from the equation.

Outdoor Explosion Venting

Explosion venting is a common, cost-effective passive deflagration protection method. When the dust inside the collector combusts, the pressure inside the collector can reach unsafe levels. The explosion vent opens when the pressure reaches a specified level that is lower than the design pressure of the dust collector. The vent opens, allowing the pressure and flame front to exit to a safe area. Venting sets the criteria for the design, location, installation, maintenance and use of these systems. An outdoor dust collector must be designed to vent away from buildings and populated areas.

Explosion venting can usually save the dust collector, but it can still become damaged. After an event, an expert should inspect the entire dust collection system to look for damage to fans, ductwork, door hardware, housing, tube sheet, and filter integrity.

For outdoor explosion venting, you need to determine the vent area required for your collector, the location of the collector and the burst path, and the required quantity of explosion-venting ductwork, if any. You must also protect the inlet and outlet ductwork against the possibility of an explosion, as determined by a risk assessment.

NFPA Standard 69 on Explosion Prevention Systems

If it's not feasible to duct an explosion to the outside through a wall or ceiling in your dust collection application, you'll need an active explosion suppression or suppression-isolation system. A passive deflagration protection system, like venting, reacts to an event. An active deflagration system detects and reacts prior to or during an event. Active systems require detection, control and a pneumatic or electrical response that creates an isolating barrier in response to a deflagration.

Suppression methods are covered in NFPA 69: Standard on Explosion Prevention Systems. NFPA 69 extends beyond explosion venting to address the whole dust collection system—inlet and outlet ducting, spark-extinguishing systems, and methods for preventing an explosion from traveling back into the building or to process locations upstream of inlet duct work.

Active explosion suppression solutions include:

- Chemical isolation is designed to react within milliseconds of detecting an explosion and can be installed in inlet and/or outlet ducting. Typical components include an explosion pressure detector, suppressant canisters and control panel. This system creates a chemical barrier that suppresses the explosion within the ducting and can reduce or eliminate the spread of flame through the ducting. It also minimizes the pressure increase within the connected process equipment.
- Chemical suppression protects the dust collector itself, whereas chemical isolation detects and suppresses explosions within the ducting. The system detects an explosion hazard within milliseconds and releases a chemical agent to extinguish the flame before an explosion can occur. Chemical suppression with isolation can be used when the collector is located within the manufacturing space. It is also used when the collector is handling hazardous dust that can't be released directly into the atmosphere or when it is located in a production area where there is no direct access to an outside wall or ceiling location where the explosion vent ducting can protrude.
- Fast-acting isolation valves are installed in inlet and/or outlet ducting are designed to close within milliseconds of detecting an explosion. They create a physical barrier within the ducting that effectively isolates pressure and flame fronts from either direction, preventing them from spreading further through the ducting to the process equipment.
- High-speed abort gates are installed in the inlet and/or outlet ducting of a dust collection system to divert possible ignition hazards from entering the collector, preventing a possible explosion from occurring and preventing flame and burning debris from entering the facility through the return air system. A mechanical barrier diverts process air to a safe location. Abort gates are activated by a spark detection system located far enough upstream to allow time for the gate to activate.

Final Thoughts

Combustible dust management is complex. To ensure that your processing operation is following the right NFPA standards and using the proper explosion protection technology to maintain a safe dust collector, it's best to consult with an experienced independent professional engineer to help you design and install your system.

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