How to Tackle Combustible Dusts With Successful Dust Control Systems

If your process is dusty, you better find out if your dusts are combustible. A process hazard analysis for combustible dusts will guide you to equipment and procedures for explosion prevention

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Does My Dust Control System Reflect NFPA 654 Requirements?

The following checklist can serve as a quick audit of your dust control system. If you answer "no" to any of these questions, further investigation is recommended as well as correction to meet the intent of NFPA 654 or NFPA 91 and related NFPA standards to reduce the risk of dust deflagration.
1. Do you have a completed process hazard analysis (or a similar process safety study) and associated equipment explosion prevention and protection strategies as described in NFPA 654 for site processes that handle combustible dust?
2. Have you updated the process hazard analysis within the last five years &#151 or sooner if there has been a process modification?
3. Are key points of the process hazard analysis incorporated into site standard operating procedures?
4. Are dust accumulations on floors, equipment, and overhead items (ducts, conduit, and structure) less than 1/32 to 1/16 in. (0.8-1.6 mm.) due to routine housekeeping or process equipment and dust control system design or both?
5. Do cleanup methods avoid the generation of large clouds of dust?
6. Are fugitive dust sources adequately contained by dust control system hoods and enclosures?
7. Do test data for each dust control system show that adequate conveying velocity exists in each branch of the system ductwork to prevent internal dust accumulation?
8. Were dust control duct branches added after system redesigns? Ducts usually get larger on the way to the dust collector.
9. Do duct branches that are no longer needed have an air inlet at the old connection on the duct main to maintain airflow required to meet downstream conveying velocity requirements? Do not use a blank flange.
10. Are there trained personnel who inspect, maintain, and troubleshoot the dust control systems to keep them within design duct conveying velocity range?
11. Does the site "management of change" review process include dust control systems and use trained personnel to make changes?

Many solids processing companies have a serious potential for a dust explosion and may not even recognize the risks. If the dusts in your dust control system are combustible, you may be risking injury or damage from a dust explosion if those systems are not designed or operated in accordance with NFPA recommendations.

Combustible dust incidents resulting in fatalities can be avoided if available guidance such as NFPA 654 and other standards are followed.

To see what your risk might be, answer the following two questions. If you answer "yes" to these questions, your dust control system may be an explosion hazard. 1. Do you have combustible dusts? If you don't know, read the "Combustible Dusts" section below. 2. Do you lack adequate conveying velocity in some or all branches of your dust control system? Low velocity causes dust accumulation in the duct and the risk of fueling a dust explosion if ignited &#151 a significant factor in several recent incidents. Typical dust control conveying velocities are in the range of 3,500 to 4,000 ft/min (17.5 to 20 m/sec). Figures 1 and 2 show examples of dust control systems that visibly do not have adequate conveying velocity in all branches. If your ducts resemble these, read the "Dust Control Checklist" below.

Combustible Dusts

Figure 1: Signs of poor duct conveying velocity include blind flanges on disconnected ducts.

The U.S. Chemical Safety Board (USCSB) investigated combustible dust hazards in several dust explosions across the U.S. and posted its findings on its web site, www.csb.gov. Angela Blair, lead investigator for the USCSB, stated: "Our data collected over 25 years shows that there have been at least 281 combustible dust incidents resulting in 119 fatalities and 718 injuries. This data does not include grain handling and coal mine dust incidents. The incidents we investigated could have been avoided if available guidance such as NFPA 654 and other standards had been followed in process design, operation, and maintenance." Significant factors that contributed to the severity of some of the incidents included poor dust control design and lack of housekeeping. OSHA reports on its web site that the vast majority of natural and synthetic organic materials, as well as some metals, can form combustible dusts. It also says that "a combustible dust explosion hazard may exist in a variety of industries, including: food (e.g., candy, starch, flour, feed,) plastics, wood, rubber, furniture, textiles, pesticides, pharmaceuticals, dyes, coal, metals (Al, Cr, Fe, Mg, Zn,) and fossil fuel power generation."

Just the Facts About NFPA Terms

&#149 NFPA 654 is the standard for the prevention of fire and dust explosions from the manufacturing, processing, and handling of combustible particulate solids. &#149 NFPA 91 is the standard for exhaust systems for air conveying of vapors, gases, mists, and non-combustible particulate solids. &#149 NFPA 68 is the guide for venting of deflagrations.

Knowing that your dusts are not combustible requires the use of standardized laboratory tests. The tests described below should be completed with representative particle size distribution and particle moisture content samples. There are additional combustible tests that might be required for explosion protection or prevention design. See NFPA 68 for more information &#149 Kst: deflagration index for dusts (bar-m/sec) calculated from the two closed vessel test results below. 1. Maximum Rate of Pressure Rise (dP/dt) (bar/sec): rate of pressure rise in a closed vessel at optimum dust concentration. 2. Pmax (bars): maximum pressure at optimum dust concentration developed in a closed vessel. Examples of dust deflagration hazard classes include the following: ST-1 (Kst less than 200): Powdered milk, charcoal, sulfur, and zinc. ST-2 (Kst between 200 and 300): Cellulose, wood flour, and methyl acrylate. ST-3 (Kst greater than 300): Anthraquinone, aluminum, and magnesium. &#149 Minimum Ignition Energy (MIE): minimum amount of energy released (milli-joules or mJ)at a point in a combustible mixture that causes flame propagation away from the point. &#149 Minimum Explosible Concentration (MEC): minimum suspended dust concentration (mass/volume) that will support a dust deflagration.

Dust Control Checklist

Figure 2: Another indication of poor duct conveying velocity is having ducts that don't enlarge after branches are added. In this case, impossible conveying velocities are required in the same diameter: first 4,000 fpm, then 8,000 fpm, and finally 12,000 fpm.

Combustible dust deflagrations will not occur if any one of the five parts of the "explosion pentagon" is missing. These five parts are listed below. The items in parentheses are general examples of those hazards. 1. Ignition (hot surfaces, electrical devices, static electricity) 2. Fuel (accumulated and dispersed dusts) 3. Oxidizer (ambient oxygen) 4. Dust dispersion (mechanisms to disperse accumulated dusts) 5. Confinement (by equipment or building) Safe operations around combustible dusts require designs and procedures to eliminate or minimize as many of the sides of the "explosion pentagon" as possible. The adjacent article, "Does My Dust Control System Reflect NFPA 654 Requirements?" is a checklist for a quick audit of your dust control system. In conclusion, if your process is dusty, you should have the data to know that your dusts are not combustible. This article has focused on dust control, which is only part of the story in NFPA 654. It's the key reference to use for a total process hazard analysis. A thorough process hazard analysis for combustible dusts will guide you to equipment and procedures for explosion prevention or protection &#151 or both &#151 to mitigate the risk of dust deflagrations. Dust control systems are an engineering control method often used to reduce dust levels. However, on-going protection depends on having adequate conveying velocity in all branches to reliably exhaust the required airflow at all the hoods and prevent dust accumulation in the ducts. On-going protection also depends on having trained personnel to maintain the system and keep it within design parameters. In addition, robust "management of change" procedures keep the safe equipment and procedures in place to prevent dust deflagration conditions through the inevitable process changes that are made at any manufacturing site.

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