Safety Talk

Combustible Dust

Before you begin

To determine areas and operations where dust accumulations are likely, perform a facility dust hazard assessment. When conducting the assessment, identify:

- Does your facility use or store organic materials (e.g., flour, sugar, wood, coal, cotton, plastic, rubber, etc.)?
- Does your facility use or store combustible metals (e.g., aluminum)?
- Has visible dust from any of these materials collected anywhere in the facility?
- Does your company have a housekeeping program to address how and when to clean up dust?

Introduction

The National Fire Protection Association (NFPA) 652---Standard on the Fundamentals of Combustible Dust---defines combustible dust as "a finely divided combustible particulate solid that presents a fire, flash fire, or explosion hazard when suspended in air over a range of concentrations. Most natural and synthetic organic materials, as well as some metals, are combustible when they are in a dust form.

As a general rule, any activity that generates dust should be evaluated to determine if that dust is combustible. Dusts that collect on horizontal surfaces, rafters, ventilation ducts, or support beams should also be evaluated. These accumulated dusts can become airborne and thus can pose a combustible dust hazard.

Definitions

Combustible dust: a finely divided combustible particulate solid that presents a flash-fire hazard or explosion hazard when suspended in air over a range of concentrations.

Flash fire: Sudden, intense fire caused by ignition of a mixture of air and a dispersed flammable substance such as a combustible solid, combustible liquid, or flammable gas.

Deflagration: propagation of a fire/flame front via transfer of heat at a velocity that is less than the speed of sound.

Explosion: A (dust) deflagration occurring in an enclosure that can burst or rupture the enclosure due to the development of internal pressure from the deflagration.

K_{st} value: Known as the dust deflagration index, this value is used as a measure of the explosion severity of the dust as compared to the severity of a reference dust. This value is also important for designing protective equipment to prevent dust explosions.

Discussion

How does dust catch fire or explode?

For a fire to occur, three basic elements are needed (the fire triangle). They are:

- Fuel.
- Ignition source (heat).
- Oxygen.

For a flash fire to occur one additional element is required (the flash fire square):

- **Dispersion** of dust particles in sufficient quantity and concentration.

For an explosion to occur two additional elements are required:

- **Dispersion** of dust particles in sufficient quantity and concentration.
- **Confinement** of the dust cloud.

It is important to point out that, for each type of event – fire, flash fire, or explosion – all elements must be present concurrently to sustain the event.

Most combustible dust explosions have two or more distinct phases. The first or primary explosion may happen inside processing equipment or in areas where fugitive dust accumulates. The dust collector is a major source of a potential primary dust explosion. This potential occurs during the filter cleaning cycle when a large amount of dust becomes airborne and is available as fuel to be ignited. The initial primary explosion may, in turn, dislodge and entrain additional dust that has accumulated on horizontal surfaces such as process equipment, ventilation ducts, or structural beams. This entrained dust can then become ignited and cause a secondary explosion. Secondary explosions can be far more destructive than the primary explosions.

For accumulated dust, NFPA 652 specifies an accumulated dust depth of 1/32 in (about the thickness of a dime). If this depth is exceeded over a non-separated area greater than 1000 ft2, a dust flash fire or explosion hazard is deemed to exist within the area.

Dust combustibility

In assessing the potential for a dust-explosion hazard, the primary factor to consider is the dust combustibility. One source of information on material combustibility is the Safety Data Sheet (SDS). Another source is the list of combustible dusts contained on the Combustible Dust poster prepared by OSHA.

Depending on the particle size, shape, and the moisture content, different dusts of the same chemical material will have different ignitability and explosion characteristics. These characteristics can change when the material passes through different parts of the process.

Combustible dust analysis

The most accurate method of determining dust combustibility is to have the dust tested by an ISO accredited laboratory. One of the tests performed is to determine the Kst value which is a measure of explosibility compared to a reference dust.

A second test performed is to determine the minimum explosible concentration (MEC). This is a measure of the minimum amount of dust, dispersed in the air required to spread an explosion (i.e., sustain a deflagration). The value is analogous to the lower flammability limit (LEL) for gas/air mixtures.

Still a third test performed is to determine the minimum explosible energy (MIE) which is a measure of the ease and likelihood of ignition of a dust cloud of sufficient concentration.

All three parameters are important in identifying suitable explosion protection methods. For example, a dust's MIE value is important in determining susceptibility of the dust to being ignited via static electricity discharge.

Because a variety of conditions can affect the concentration of combustible dust needed to reach an explosive concentration, there are other laboratory analytical considerations:

- Particle size.
- Particle resistivity.
- Particle conductivity.
- Particle reactivity.
- Particle bulk density.
- Particle moisture absorbency.

Ignition Sources

Potential ignition sources of combustible dust include:

- Static electricity.
- Human sources.
- Mechanical sources.
- Mechanical sparks and friction.
- Bearings in motor and conveyors.
- Exterior process equipment heated surfaces.
- Cleaning equipment.
- Shop vacuum cleaners.
- Powered Industrial trucks.
- Electrical equipment, receptacles.
- Tools.
- Open flames.

Dust Hazard Analysis [DHA]
NFPA 652 defines a dust hazard analysis as a systematic review to identify and evaluate the potential fire, flash fire, or explosion hazards associated with the presence of one or more combustible particulate solids in a process or facility.

A DHA is usually performed by a 3rd party consultant with information and participation by a cross-functional team of operators, engineers, maintenance, and safety personnel knowledgeable with the process and the facility.

Control measures
Hazard mitigation and dust control recommendations (see: Reference 2) to prevent explosions include:

- Minimizing the escape of dust from process equipment or ventilation systems.
- Using dust collection systems and filters.
- Using surfaces that reduce dust accumulation and help with cleaning.
- Providing access to all hidden areas to permit inspection.
- Conducting regular inspections for dust in open and hidden areas.

In addition, other recommendations include:

- Clean dust residues at regular intervals.
- Use cleaning methods that do not generate dust clouds if ignition sources are present. For example, do not use compressed air.
- Use vacuum cleaners only if approved (e.g., UL, FM) for combustible dust collection.
- Locate relief valves away from dust hazard areas.
- Develop and implement a written program for hazardous dust inspection, housekeeping and control.

It is also important to control potential ignition sources. Depending on the specific operation, effective controls may include:

- Using appropriate electrical equipment and wiring methods.
- Controlling static electricity, including bonding of the equipment to the ground.
- Controlling smoking, open flames and sparks.
- Controlling friction and mechanical sparks.
- Using separator devices to remove foreign materials capable of igniting combustibles from process materials.

In addition, other controls:

- Separate heated surfaces and systems from dusts.
- Use industrial trucks of the proper type.
- Use cartridge-activated tools properly.
- Maintain adequately all of the above equipment.

Furthermore, be sure to follow established hot-work permit systems that explain how you perform hot work (welding, cutting, grinding, etc.) on and around ventilation ductwork and in areas where combustible dust may accumulate.

Electrical Classification
Some production areas where combustible dust is present require specially designed electrical equipment due to the dust concentration and the depth of accumulation of the combustible dust.

An area where the hazard of combustible dust is present is designated as a Class II location. Depending on the airborne concentration of the dust (dust cloud density) and the accumulated layer, the location may be further classified as a Division 1 or a Division 2 area. Electrical equipment must meet the standards of the classification.

Employee Training
Attentive workers are one of the best ways to prevent a combustible dust situation. Workers are the first line of defense in preventing and mitigating fires and explosions. Training topics would include:

- Identification of combustible dust hazards processes.
- Sources of ignition.
- Housekeeping rules.
- Explosion protection systems that have been installed.

Conclusion

Here is a list of questions to ask to determine if you have a combustible dust risk in your place of work?

- Is the dust combustible?
- If you need to have the dust tested by an ISO accredited laboratory, contact your BWC Division of Safety and Hygiene safety or industrial hygiene consultant to obtain a list. A few are also listed here:
  - EMSEL Analytical, Inc.
  - Fauske & Associates LLC.
  - Fike.
- What is the quality of the housekeeping?
- Can dust become airborne?
- Can dust accumulate in hard to reach locations?
- Can dust become confined/concentrated (e.g. in process or dust control equipment)?
- How is equipment grounded?
- Are there ignition sources?
- Do we have fire, flash fire, or explosion hazard?
- What is hazard scenario?
- Can hazard be reduced or eliminated?
- Are there horizontal surfaces in the area of the source?

Group activity

1. Identify dust generating operations in your workplace and determine if the dust is combustible. Look for possible ignition sources within your workplace.
2. Determine presence of 'primary explosion' generators such as dust collectors, hoppers, and other equipment that can CONFINE a cloud of dust.
3. Evaluate your workplace for accumulations of dust and determine if accumulated dust can become airborne.
4. Evaluate the quality of the housekeeping program within your place of employment.
5. Develop a combustible dust hazard scenario for your workplace and identify steps to reduce the potential for a combustible dust incident.

Resources

OSHA: Safety and Health Topics – Combustible Dust: An Explosion Hazard

Ohio Fire Code 1301:7-7-22 Combustible Dust-producing Operations

NFPA 61: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities

NFPA 652: Standard on the Fundamentals of Combustible Dust

NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids