#3 DUST DANGERS

The dangers of dust explosions in flour mills

by David Link, Technical Sales Manager, Kice Industries, United States

Dust explosions in the grain and milling industries usually start inside process equipment such as mills, dryers, mixers, classifiers, conveyors, and storage silos and hoppers. Dust explosions can cause catastrophic loss of life, injuries and destruction of facilities and assets.

There have been many serious incidents dating back to 1878 the Washburn ‘A’ Mill, then the largest flour mill in the US, exploded. The blast claimed 18 lives and destroyed a large amount of the surrounding area. More recently, on February 7, 2008 a sugar dust explosion and subsequent fire at a sugar refinery in Georgia caused 14 deaths and left many workers seriously injured. These incidents are all preventable.

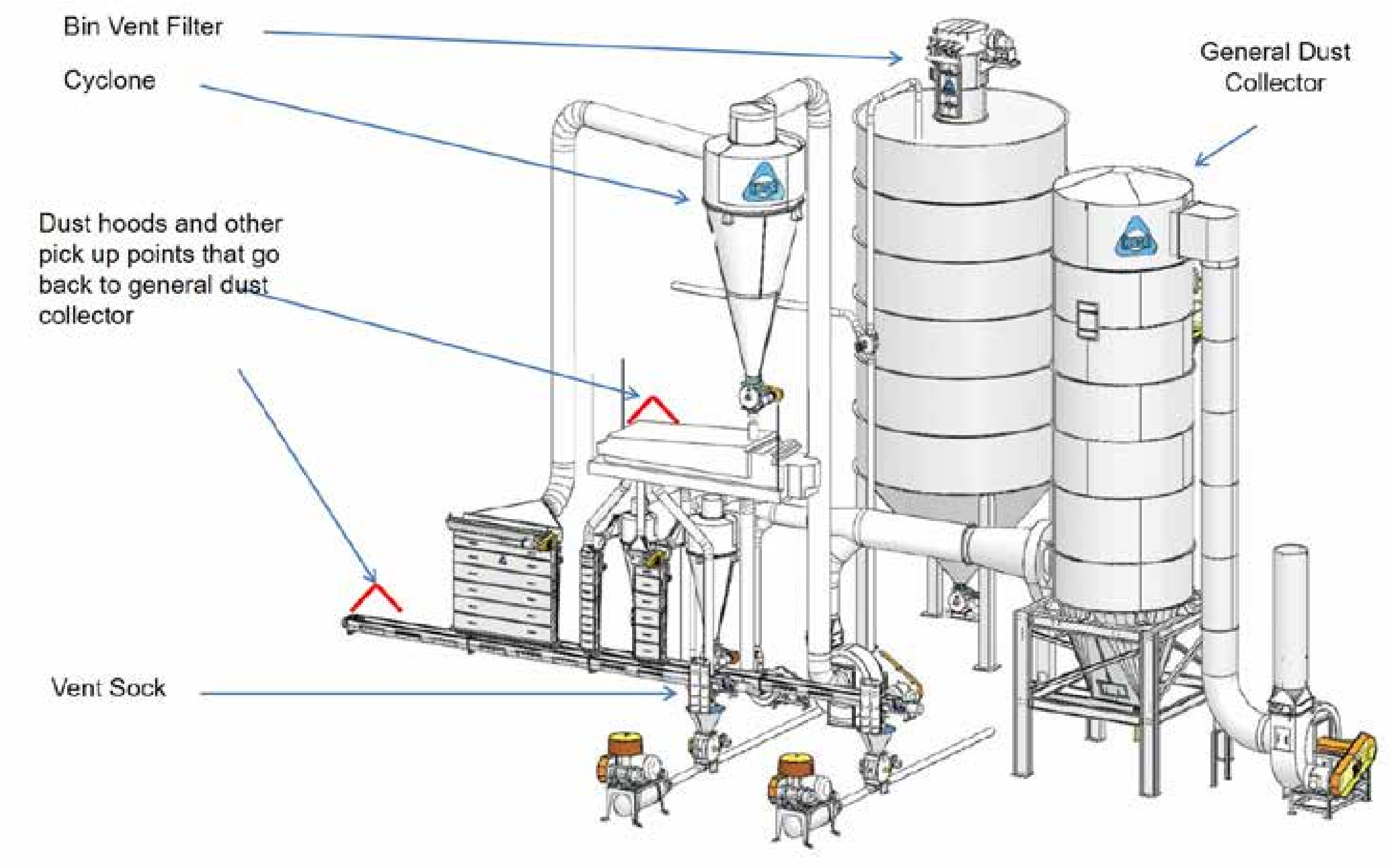
For any given dust type the ease with which dust ignites and the rates with which they burn, vary considerably with factors. The key factors include the primary particle size distribution of the dust, the dust concentration distribution in the cloud, and the cloud turbulence. Two of these factors are entirely dependent on the actual process in which the dust cloud is generated and sustained. This article will give a basic background on dust, factors on the explosion and potential ignition sources. And finally, ways to prevent accidental dust explosions including measures such as explosion isolation that can stop a more serious event from occurring.

The 1878 explosion led to reforms in the milling industry to reduce dust in the air during milling and to improve housekeeping. Sanitation and cleanliness became a battle cry, and more attentiveness to the issue began. Part of the problem early on was the ubiquitous open conveying systems that allowed dust to spread all over the mill. Bucket, screw, and drag systems were the typical mechanical devices available until pneumatics came along, and while many mechanical systems are still in use today, the dust they generate is being contained and collected by modern dust control systems.

The nature of dust

Microscopic airborne particles are released into the air at various stages of the processing facility, especially where raw grain enters the initial grinding area, but the sifting and packaging areas can also generate a lot of particulate matter. Every area along the line where product is handled generates dust that needs to be contained. It is important to ensure that employees are not exposed to excessive amounts of airborne particulates. It is equally important to contain that particulate matter from a general sanitation and housekeeping standpoint to meet current industry standards.

A common mistake is to believe that because a plant has been operating for years without a fire or dust explosion, it must be safe. This is never a valid basis for determining whether a facility is doing a good job preventing dust explosions. Combustible dust explosions are a risk in many areas of a mill. Facilities create dust particles that can become airborne and dispersed throughout the plant. It’s when these particles are in a combustible environment that they represent a significant risk for an industrial accident. The serious hazards associated with handling fine dust and



powdered materials may be overlooked by many plant personnel because they are not fully understood.

The presence of dust in a factory is now at the top of the list of items to inspect during an audit. Facilities must now implement a strategic plan for managing combustible dust at their locations and be proactive in mitigating these dust issues.

The National Fire Protection Association (NFPA) sets standards and codes to protect buildings against fire and explosion risks, and the Occupational Safety & Health Administration (OSHA) is enforcing these standards with increasing vigilance.

Regulatory standards (NFPA) and what it means for Dust Control

NFPA 652: Standard on the Fundamentals of Combustible Dust, 2016 Edition was issued by the NFPA in 2015. The scope of the standard is to provide the basic principles of and requirements for identifying and managing the fire and explosion hazards of combustible dusts and particulate solids. The intent is to provide overarching minimum requirements for combustible dust and to reference the appropriate specific NFPA standards for a given industry or material that is being handled, but it does not supersede those existing standards.

8.3.3.3.6* The air-material separator (AMS) selected for the system shall be designed to allow for the characteristics of the combustible dust being separated from the air or gas flow.

Equipment that emits dust should have suction vent connections and/or suction hoods attached. These connect to a manifold, which then connects to a separator (cyclone and/ or baghouse dust filter). With a baghouse filter, efficiencies could exceed 99 percent depending on the type of filter media and dust characteristics. Dust characteristics must be carefully considered during filter selection and system design. Filter bags and "dust cake" on the surface of media act to separate particles from incoming dirty airstream, resulting in clean air exiting the baghouse to the atmosphere.

Cyclone efficiency is highly dependent on many factors including particle size distribution, particle density, cyclone design/dimension and quality of fabrication/installation. With a cyclone application, the dust-laden air creates a downward moving vortex in the cyclone, and solid particles are thrown outside by centrifugal force. The dust then drops out of the air flow under gravity as the air vortex reverses and clean air exits at the top of the cyclone.

Another crucial aspect of NFPA 652 is the requirement of the Dust Hazard Analysis (DHA). The owner/operator of a facility is responsible for ensuring a DHA has been completed in accordance with the standard where materials have been determined to be combustible or explosible. This is a retroactive requirement. Existing facilities are allowed three years from the effective date of the standard (September 7, 2015) to complete a DHA. Reasonable progress towards completing a DHA shall be made during this time.

The standard allows for two options for determining the combustibility or how explosive the dust or particulate material is. First, historical facility data or published data that are accurate representations of current materials and process conditions. Second, analysis of representative samples according to defined test methods in the standard. There are several labs that can perform the required testing and analysis according to the methods required.

Specific to the milling and grain industry, NFPA 61: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities, 2017 Edition was also recently updated. This standard addresses the requirements for facility construction, ventilation and venting, heat transfer operations, dust control measures, equipment design and installation, explosion prevention and protection, pneumatic conveying, and building fire prevention. This standard was reorganised from 13 Chapters into 9 Chapters that align with NFPA 652. It now also includes the requirements for performing and documenting a DHA.

Which technology to use and when?

It is important to understand the characteristics of the material being handled and the process conditions. These NFPA standards provide guidelines for addressing hazardous material. However, there is not a single solution for all applications. Defining these requirements begins during the design phase or project improvement phase of a facility and continues through the operation and maintenance of the plant. The best solutions are a function of evaluating the risk conditions (DHA), understanding owner/operator requirements, and the options available:

Risk Conditions (DHA)

- Determine hazards of materials (Kst, Pmax, MIE, MEC, AIT, MIT, etc.)
- Identify and assess operating hazards and zone requirements
- Rating required for the protected equipment (i.e., Pred for material air separator)
- Control of possible ignition sources (spark detection, prevention, spark resistant, static)

Additional Owner/Operator Requirements

- Suppression
- Passive isolation
- Active isolation
- Direct venting (with or without ducting)
- Flameless venting
- Equipment location
- Authority Having Jurisdiction (AHJ) or specific insurer requirements
- Operating costs and maintenance
- Manage and communicate hazards

An important element of your strategy - dust collection system

It is essential to understand how the dust collection system integrates into the overall risk assessment and operation of your facility. A well-designed system that is compliant can assist greatly in managing any dispersed dust. It can also provide important energy and maintenance savings for your facility, giving you a reduced cost of operation as opposed to a unit with a lower initial price.

Containing and capturing dust:

Before dust can be controlled, it must be contained first. Most often, this means making sure equipment is "tight" and gasketed properly. Equipment that emit emits dust should have suction vent connections and/or suction hoods attached.

These connect to a manifold, which then connects to a separator (cyclone and/ or baghouse dust filter). The entire dust control system is placed under a vacuum using a suction fan. In many mills, five-pound bags are being filled with flour particles 24/7. As the bags are filled with flour, the displaced air containing flour dust is collected and filtered.

The recovered flour that is returned to the product stream pays big dividends over time. It also helps prevent sanitation and health problem. No dust control system is 100 percent effective, but flour explosions are becoming less common, as mills continue to improve sanitation and worker health and reduce the potential for disaster.

Expectations of a good Dust Collection System:

- Reduce fugitive dust inside the facility and on equipment
- Protect the assets (people, equipment, and facilities)
- Reduce the "tracking of dust" everywhere
- Increase storage capacity
- Reduce potential for explosions
- Better product flow ability

Maintaining the Solution

An important item that affects the continued performance of a dust control system is proper maintenance. When it comes to maintenance, dust control systems are often overlooked and ignored. If a piece of machinery (such as a conveyor) goes down, the whole operation is interrupted. Such a disruption cannot be ignored and requires immediate attention.

However, if a dust control duct gets plugged with material, it is often not even noticed since the suction will often get worse progressively. Soon, the dust control system is rendered ineffective due to lack of attention. The solution is to include the dust control system in your planned maintenance program.

Regularly inspect the system, just as you do with other equipment, to make sure it is operating properly. Check not only the obvious things, such as fan drive belts and bearings but also for a plugged cyclone, a worn-out elbow, a plugged-up duct or hood. Many of these problems will affect the amount of suction at the hood. Therefore, by taking an air reading (static pressure) at the hood and comparing it with the reading recorded when the system was originally installed, it can be determined if the system is still functioning properly. This type of reading is simple to take, and the equipment required to do it with is inexpensive and easy to use.

It is important to realise that a properly designed and balanced system operates properly only if that design is maintained. In other words, any change made to the system (such as, adding an additional pickup point or blanking off an existing pickup point) will adversely affect the operation of the entire system. The system was designed for a certain amount of air to flow through a certain size duct. There is only a certain quantity of air the system is designed to handle. When additional pickup points are added to the system, the total quantity of air does not change but is merely robbed from the existing pickup points.

Likewise, when pickup points are blanked off, the system is starved for air at that point, and the air velocity in the duct drops, causing the dust to settle out and plug the line. Whenever any change in a system is contemplated, the design calculations must be rechecked to see if such a change could be properly incorporated into the existing system and, if so, what modifications would have to be made to permit it. Many good dust control systems (as well as, air systems of all types) have been rendered totally ineffective by modifications made without design considerations.

Working with an experienced and reputable system designer will help ensure you are installing a safe and cost-effective solution. Kice Industries has been designing, analysing and building dust control systems and equipment for over 70 years. When designing a dust control system, one must consider many factors. Kice engineers understand the principles of handling air and apply their experience to every situation.

www.kice.com