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Best way to prevent explosions is to know contributing factors

Knowing why and how grain dust explosions occur is a good start to formulating a prevention strategy.

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Explosions in grain-handling facilities over the past few years have once again brought the dangers of dust in grain facilities to the forefront. Dust explosions are one of the most challenging, dangerous and least understood hazards facing the industry today.

This article will look at the factors involved and how dust explosions occur.

There are four basic ingredients of a dust explosion: fuel, containment, ignition source and oxygen.

The fuel for a dust explosion appears in two different ways: grain dust suspended in the air at or above the minimum explosive concentration (MEC) or the accumulation of dust layers on electrical or mechanical equipment.

Published values for the MEC of grain dust range between 50 and 100 g/m^3.

To understand just how concentrated MEC is, consider this. Occupational Safety & Health Administration (OSHA) code 1910.1000 states that the maximum concentration of grain dust to which a worker may be exposed is 10 mg/m^3. Dust concentration levels heavier than 15 mg/m^3 create unbearable conditions where a dust mask is essential to breathe.

MEC is 5,000-10,000 times heavier than the OSHA standard. It is so thick that you would not be able to see your hand move if it was 1 ft. from your face. It is unlikely that any facility worker has ever observed MEC in a normal working environment.

Containment, such as in enclosed grain transfer points — bucket elevators, enclosed belt loading or unloading points, grain falling into bins, etc. — is needed for dust concentration to reach MEC levels.

Containment is a necessary, contingent element to enable fuel to accumulate in required proportions of suspension. However, if the fuel is layered instead of suspended, containment may not be necessary.

A layer of dust on heat-generating equipment can, over time, interfere with the dissipation of heat and allow the material to reach ignition temperature. Grain dust is particularly dangerous in this regard due to a phenomenon known as carbonization. A layer of grain dust exposed to air and alternating periods of high and low temperatures will chemically decompose over time and form a cake-like layer on the equipment.

The ignition temperature of carbonized grain is significantly lower than the ignition temperature of a cloud of grain dust — approximately 250°C compared to 390°C, respectively. This somewhat deceptive phenomenon can lead equipment specifiers to purchase improperly rated equipment in dusty, hazardous areas.

This dust layer also poses a potential danger in that it can be stirred up into MEC by another, smaller explosion. This will be discussed further when analyzing how an explosion occurs.

The ignition sources of grain dust explosions can vary from within a system or from an external source. Some equipment, such as dryers, light fixtures and motors (especially improperly rated motors) can produce hot surfaces. Also consider the not-so-obvious blowers, conveyors, bucket elevators, milling machines and other rotating machinery that could develop a hot bearing or belt misalignment. Yet another source of ignition is the introduction of heat between moving and nonmoving parts in process equipment. Mechanical impact and static electricity are also potential sources of sparks.

There are numerous sources of ignition in a grain-handling facility, and it is not possible to engineer a system that eliminates every ignition source in every situation. In most cases, the focus must be on eliminating one or more of the other ingredients of dust explosions.

Oxygen is the final ingredient of a dust explosion. Oxygen is normally mixed with the fuel, whether mixed with the airborne dust suspension or chemically combined with the carbonized dust layer. In the former condition, limiting the amount of oxygen is possible using explosion suppression systems, which use nitrogen, carbon dioxide or other gases to displace the oxidant that supports combustion.

How do they occur?

A grain dust explosion is usually a series of explosions starting with the primary explosion. This primary explosion will generate a fire front and pressure wave leaving the site of the primary. The pressure wave stirs up layered dust into a secondary MEC, which is subsequently ignited by the fire.

Primary explosions are typically around 2 psi, enough pressure to knock over a brick wall, whereas secondary explosions can generate pressures of 80 psi, enough to send those bricks flying multiple city blocks.

Conclusion

You obviously can't design a facility to contain a grain dust explosion. You also can't eliminate every ignition source. So, what can you, as a facility manager, do to prevent dust explosions? Having knowledge of why and how grain dust explosions occur is a good start to formulating a prevention strategy.

In future articles in this section of *Feedstuffs*, the standards and classifications associated with hazardous areas will be explored, and typical explosion prevention strategies of other grain handling facilities will be discussed. ■

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