

14. DUST EXPLOSIONS

Historically dust explosions have occurred in processing plants where dry organic powdered are handled. Grain elevators (storing corn, rice, oats, soybeans, wheat, etc.) are well known for dust explosions, but other powdered materials can cause explosions as well.

It is common knowledge that organic materials can burn. Most often the burning of organic materials does not cause an explosive force. What makes the powdered materials different that when burned they can cause an explosion?

Powdered materials have very high surface areas per unit mass. When burned, a powdered material gives off product gases (CO_2 , H_2O , etc.) at a rate in proportion to the surface area. When the powdered material is confined within a grain elevator or storage building the rapid release of product gases can create a significant gas pressure within the building. With the right conditions dust explosions can exceed 100 psi. Most buildings will collapse if the interior pressure exceeds about 10 psi (70 kPa). Reinforced concrete structures typically can withstand 2 – 8 psi of static pressure.

The dryer and finer the dust, the more explosive is its nature. An acceptable minimum concentration of dust is 1.13 g/cm^3 ; higher concentrations are considered dangerous. Dust explosions can occur within storage buildings, conveying systems, hoppers, sieves, etc. when the conditions are right.

When a dust explosion occurs seven conditions are nearly always present:

1. Oxygen (air)
2. Fuel source (the dust itself)
3. Dust is mixed or suspended in air
4. The dust concentration exceeds a minimum needed for the explosive reaction
5. Ignition source
6. Dry dust
7. All of the elements are in a confined space

Removal of one or more of these conditions can prevent a dust explosion (elimination of three or more is preferred). Motion sensors, belt alignment sensors, heat sensors, and magnets are common safety devices used to prevent dust explosions. How are these devices used to prevent dust explosions?

- Motion sensors can be used to detect when machinery moves in ways that they are not designed (vibrations, friction, etc, that might cause sparks).
- Belts must be properly aligned otherwise the rubbing of belts can cause friction and the friction can cause heat that could be an ignition source.
- Heat sensors can alert operators to trouble spots so that heat sources can be eliminated before an explosion occurs.
- Magnets can remove iron and other metals that when conveyed in the powder can cause sparks.

By their nature, grain elevators and hoppers must handle dusts in concentrations greater than the minimum required. Proper designs of these devices include pressure relief panels that can blow away to reduce the pressure and prevent the explosion from damaging the whole building. Catastrophic explosions (destruction of a large building) usually occur due to secondary explosions. The secondary explosions occur in other locations in building when powders are suddenly suspended into the air because of the vibrations and shocks caused by the primary explosion (the first explosion in a grain elevator).

Probably the most important prevention of secondary explosions is good housekeeping. Do not let powder to accumulate on floors, pipes, walkways, etc. Removal of these powders removes the fuel source for the secondary explosions.

References

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