TECHNICAL NEWS

CORTEM GROUP
To be sure to be safe.

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From food to textile industry: the often disguised explosiveness of dusts

1. Preface

Dust explosions can occur in any activity in which solid materials are treated and finely divided (metals, organic substances, polymers, resins, coals, wood, etc.). Dust may be the end product of a process or an unwanted by-product. Even very common substances such as wheat flour, cocoa powder, icing sugar, tea, coffee, present an explosion hazard, often masked by their familiar appearance, when they are treated, in powder form, on industrial scale in milling, transport, separation, drying processes.
A myriad of small-sized particles is produced during the processes, thus creating dust. The particles with dimensions that are too large to remain suspended in the air are deposited, while the smaller ones remain suspended for an unlimited period.

The powders are measured in microns (µm). The micron is a unit of length equal to 10^{-4} (0,0001) centimeters or about 1/ 25,000 of an inch. For a comparison, red blood cells are 8µm (0.0008 cm) in size, human hair has a diameter of 50÷75µm, while the cotton fiber has a diameter ranging from 15 to 30µm.

2. Features of combustible dust

The *National Fire Protection Association (NFPA)* defines a combustible powder as "a solid combustible particulate" which presents a risk of fire or explosion if suspended in air or in another oxidizing substance over a range of concentrations, regardless of the size or shape of the particles. In general, combustible particles having an effective diameter of 420µm or smaller, as determined by passing through a standard sieve no. 40, are generally considered combustible powders.

However, agglomerates of combustible materials that have lengths greater than their relative diameter (and usually do not pass through a 420µm sieve) can still represent a danger of deflagration. Therefore, any particle having as surface the ratio between area and volume greater than the surface of a sphere with a diameter of 420µm should also be considered a combustible powder.
The vast majority of natural and synthetic organic materials, as well as some metals, can form combustible dust and any industrial process that reduces a combustible material and some normally non-combustible materials in a finely divided state presents a potential risk of fire or explosion.

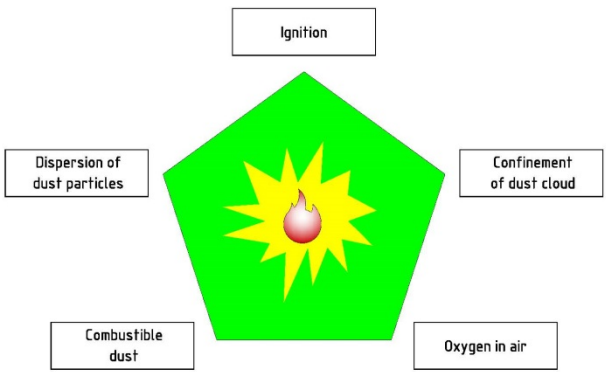
3. What are the elements that cause an explosion of dust?

So that an explosion of combustible dust can occur, the elements necessary for a fire ("fire triangle") must be present. The elements are:

- a source of fuel (combustible dust);
- a heat or ignition source (e.g., electrostatic discharge, an electric current arc, a glowing ember, a hot surface, welding slag, frictional heat, or a flame);
- an oxidizer (oxygen in the air).

The presence of two additional elements makes conditions favorable for a combustible dust explosion. The first is the *dispersal of dust particles into the air* in sufficient quantity and concentration to create a dust cloud. The second is the *confinement (or semi-containment) of the dust cloud in a vessel, area, building, room or process equipment*. When ignited, the dust cloud will burn rapidly and may explode. These five elements form what is referred to as the “dust explosion pentagon” (Figure 1).

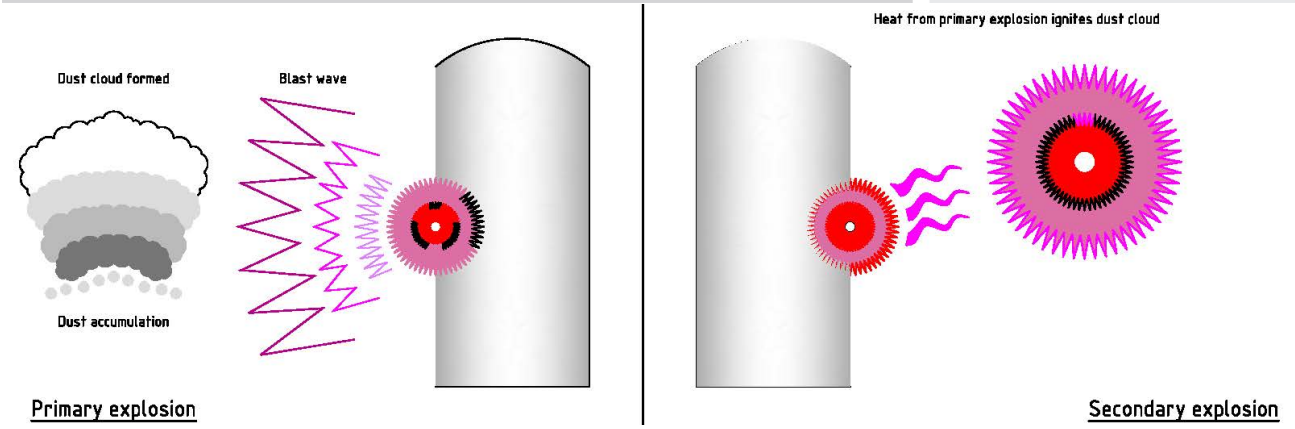
Figure 1



Combined, these elements may cause a rapid combustion known as deflagration (a rapid burning slower than the speed of sound). If this event is confined into an envelope, such as a building, room, vessel or process equipment, the resulting pressure rise can cause an explosion (a rapid burning faster than the speed of sound).

An initial (primary) explosion (*Figure 2*) in processing equipment or in areas where latent dust has accumulated may dislodge additional dust or damage a collection system (such as a duct, vessel or collector). This dust, if ignited, causes additional explosions (secondary explosion) which can cause damages more severe than the original explosion due to increased concentrations and quantities of dispersed combustible dust.

Figure 2



4. Risk evaluation of combustible dusts in the plants

As previously stated, a danger of combustible dust may exist in a variety of industries, including food production industries, industries involved in the production and processing of plastics, wood, rubber, furniture, fabric production, pharmaceuticals, production of paints and inks, processing and storage of coal, processing and transformation of metals and generation of fossil fuels.

During an assessment of the plant hazards for the risk of explosion due to the presence of combustible dust, employers should consider the following variables:

- Processes that use or produce combustible dusts;
- Materials that can become combustible when they are finely milled;
- Hidden areas where combustible dusts may accumulate;
- Potential ignition sources.

5. Dust combustibility

The main factor in assessing the potential dust explosion risks is the combustibility of dust. We therefore reiterate that a combustible powder is characterized by the ability of the material to pass through a standard sieve n. 40 which has a diameter of 420µm or less and presents a risk of fire or explosion when airborne and ignited. Hence different powders of the same chemical material will have different characteristics of flammability and explosiveness, depending on the particle size, particle shape and moisture content, with the possibility that the material changes its characteristics passing through process equipment.

6. Electrical classification

The assessment of the risks of the installation must also identify areas that require special electrical equipment due to the potential presence of combustible dust.

To comply with these requirements, the designer must comply with the provisions of EN 60079-10-2, *"Explosive atmospheres Part 10-2: Classification of areas - Explosive dust atmospheres"*, for everything concerning the classification of the areas with potential explosion risk due to the presence of powders and to the standard EN 60079-31*,"Explosive atmospheres Part 31: Equipment dust ignition protection by enclosure "t" intended for use in the presence of combustible dusts".*

7. Other considerations on hazard analysis

Since a variety of conditions can influence the amount of combustible dust needed to reach an explosive concentration,

the designer will have to analyze the specificity of the risk for each structure, considering the variables such as the size of the dust particles, the dispersion method of dust in the air, the ventilation systems, drafts, moisture, physical barriers and the volume of the area where the dust cloud exists or could potentially exist.
The risk assessment of the plant must consider all the places where the combustible dust is concentrated during the normal operation of the equipment and in case of failure of the equipment. In addition, the assessment must relate to areas where dust can settle, both in normally occupied areas and in hidden spaces.
After evaluating the risks of the presence of combustible dusts and identifying the dangerous positions, the designer will adopt the appropriate solutions in compliance with the provisions of the EN 60079-10-2 standard.

Some recommendations for dust control to prevent explosions can be as follows:

- Provide access to all hidden areas to permit inspection.
- Use cleaning methods that do not generate dust clouds if ignition sources are present (e.g., do not use compressed air).
- Minimize the escape of dust from process equipment or ventilation systems.
- Locate relief valves away from dust hazard areas.
- Use equipment for collecting combustible dust (e.g. automatic sweepers), only if approved and suitable for the specific purpose.
- Develop and implement a written program for hazardous dust inspection, cleaning and control.

8. Conclusions

The problems related to the management of products in the state of "dust" are many and complex, able to cause, if not put into practice, even the loss of people working in explosive atmospheres due to the presence of combustible powders. Therefore, it is of fundamental importance that all operators and designers are particularly attentive to all the problems, in order to prevent, in every possible way, the creation of dangerous situations.