When dust explodes

White Paper

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Simply easy!

Telemecanique
Sensors

Dust can be much more than just a housekeeping issue!

The dust is small solid particles that settle under the effect of their weight but can remain suspended in the air for a certain time.

Dust can be manufactured for a specific purpose (like flour), be generated during processing of solid materials (like sawdust) or result from the solid abrasion during transportation (like cereals).

All dusts capable of undergoing exothermic reactions with air when ignited are **capable of causing an explosion under certain conditions**. This phenomenon has been recognized since the beginning of the industrial era in many fields (wood industry, mining, food processing, metalworking, chemistry…). Dust explosions are still very common today despite the efforts of authorities and businesses.

Dust explosions can originate from [but are not limited to]:

- Plant (bark, cork, cotton, wood...)
- Food (starch, sugar, flour...)
- Metal (aluminum, magnesium, ferroalloys...)
- Industrial (plastics, fabrics, powdered waste, paper, cardboard, ink...)

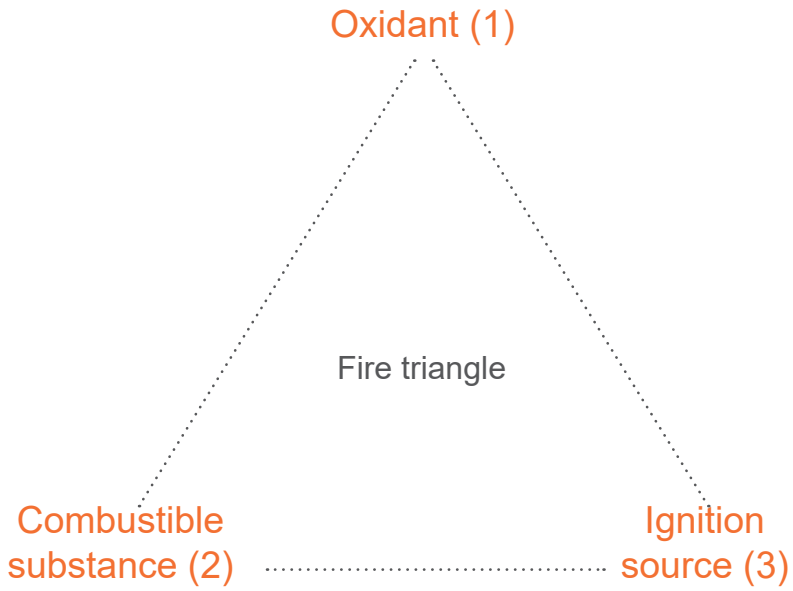
The risk is amplified by industrialization, mechanization, automation, increased storage capacity, higher handling speed and the increasing number of products present in powder form with particle sizes increasingly smaller. When the particle diameter is less than 500 microns (European standard) or 420 microns (material passing a No. 40 U.S. Standard Sieve) this risk has to be taken into account.(1)

"Dust explosions are still very common today, causing injuries and even numerous deaths every year"

(1) This dimension is indicative: INERIS, French notify body reports a feature for irregularly shaped products and particle size greater than 1 mm (floccules buts, fiber), which can still form an explosive atmosphere).

The dust explosions mechanism

An explosion will be only possible if, first, the conditions of combustion, the famous "fire triangle" are there:



(1) Typically and mainly atmospheric oxygen

(2) Dust suspended in the air at a sufficiently high concentration with at least a part of particles smaller than 500 microns. The suspension can be caused, among others, by movements (conveyor belt, elevators, vacuum, etc.), by improper cleaning (blower, sweeping), by a primary explosion (by blowing on deposited dust, spreading and generate a secondary explosion, often more devastating or even by the use of an inappropriate extinguishing on an incipient fire (in powder or CO2 extinguisher)

(3) In industries the main ignition sources are:

- Sparks caused by friction, static electricity, electrical equipment.
- A flame
- A hot surface
- Hot work (welding, ...)
- Self-ignition
- Lightning

An ignition can also take place if the dust (in suspension or deposited) is to a temperature above its own auto ignition temperature (of the order of 300 to 600°C, with some exceptions, such as uranium and its hydride: 20°C)

To allow this combustion to turn into explosion, it also needs to happen in what is called "explosive field." This field sets the dust concentration limits in the air within which the explosions are possible.

The minimum explosion concentration varies depending of the type of dust (wheat: 65g/m3, aluminum 40 to 120 g/m3, uranium 45g/m3, charcoal 40g/m3 polyester 45g/m3) and its size. The maximum explosive concentrations are on the order of 20 to 60 times the minimum concentrations. This is an intrinsic value of dust, but it will vary depending on environmental parameters (temperature, pressure, humidity) and the energy of the ignition source.

And in most of analysis of dust explosions, confinement is considered to be a fifth requirement; this is not a mandatory condition, but can greatly aggravate resulted damages.

The complexity of the phenomenon and the number of parameters make the occurrence of a dust explosion random.

"The finer the dust, the greater the risk"

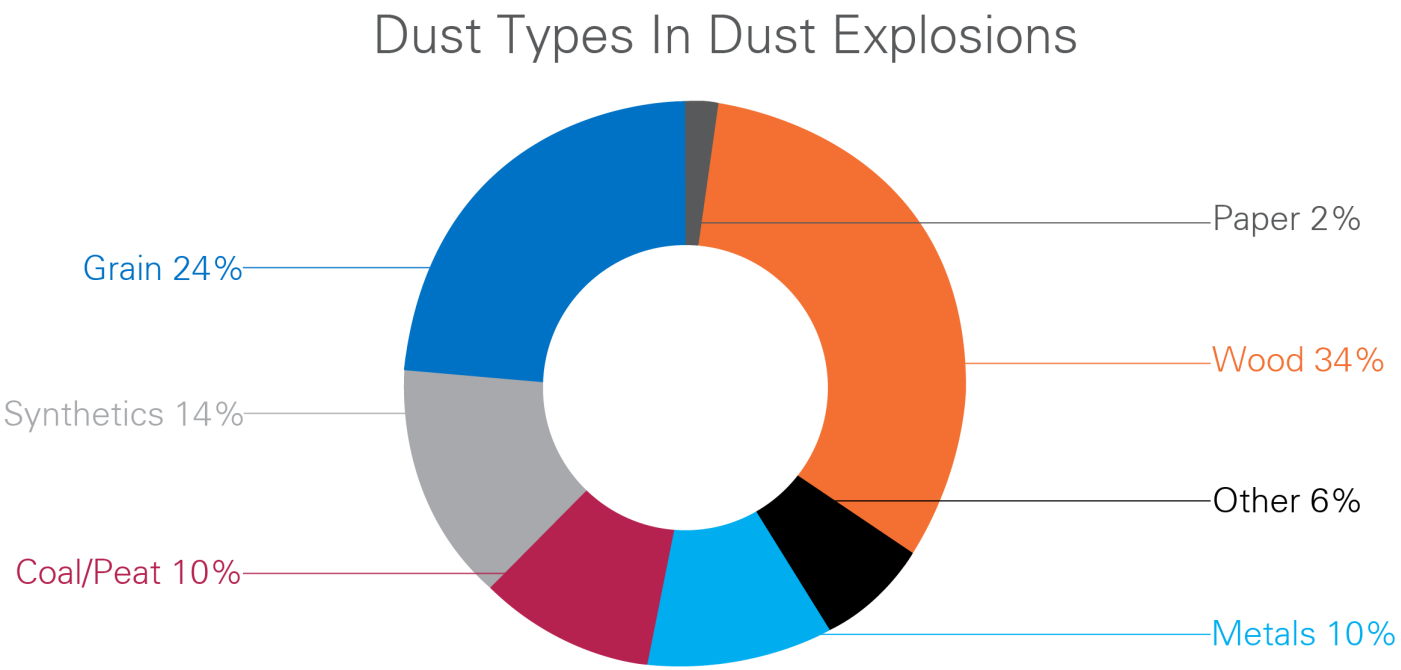
The industries' sectors impacted

The different types of installations mostly concerned in descending order of occurrences:

1 / industries whose processes generate dust:
- Mechanical woodworking
- Mechanical metal working
- Paper and cardboard industry
- Textile industry
- Coal power plants (lignite)
- Etc.

2. / Food industries employing powdered ingredients:
- Manufacture of animal nutrition
- Mill
- Bakery

3. / Grain storage facilities:
- Cereals: wheat, barley, oats, rice, rye, corn
- Oilseeds: sunflower, rapeseed, soybean, cotton, palm
- Protein crops: peas, beans, lupins.



Source : UN discussions on Dust Explosion Hazards, January 2016

How to prevent a dust explosion?

To guarantee the highest possible level of safety in these areas, the legislatures of most countries have developed appropriate obligations in the form of laws, regulations and standards.

For the electrical equipments,
At the international level, the IEC is attempting to get closer to the aim of "a single global test and certificate" with the **IECEx** Scheme (www.iecex.com)

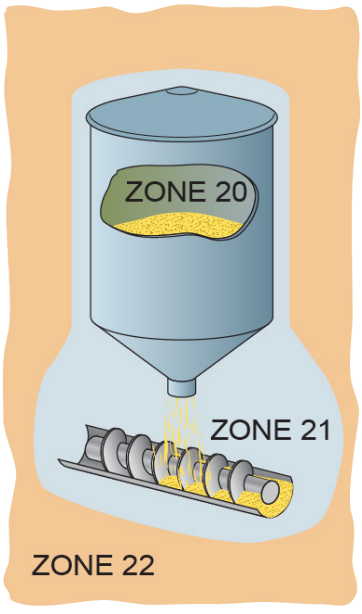
The European Union has created the prerequisites for complete standardization. All related electrical devices **must** satisfy the European Directive **ATEX**(2) 94/9/CE (since April 2016, a new Directive **ATEX** 2014/34/EU starts to be applicable, manufacturers have a 2 years transitional period to update their certifications).

The US National Electrical Code (**NEC**) and the Canadian Electrical Code (**CEC**) define hazardous areas in 2 different definitions: NEC 502 (Class/Division) and NEC 506 (Zone System).

Class/Division method is still the dominant method used in North America even if they are trending more towards the Zone System.

ATEX, IECex and NEC 506 use the same protection concepts: **Zone system**.

The Zone defines the probability of the hazardous material, dust, being present in sufficient quantities to produce explosive or ignitable mixtures.
Zone 20 - An area where combustible dusts or ignitable fibers and flying are present continuously or for long periods of time.
Zone 21 - An area where combustible dusts or ignitable fibers and flying are likely to occur under normal operating conditions.
Zone 22 - An area where combustible dusts or ignitable fibers and flying are not likely to occur under normal operating conditions and do so only for a short period of time.



Grain Silo

(2) **ATEX** as AT: atmosphere and EX: explosive.

A zone is divided into groups and subgroups. Associated to a temperature code, it defines the protection concept for which an electrical equipment has been designed.

Today Telemecanique Sensors is offering various ranges of Sensors ATEX certified for a use in Zone 21

Limit switches, pressure switches and inductive sensors:
http://www.tesensors.com/global/en/product/limit-switches/atex-ref/

Safety switches combining safety and ATEX approvals:
http://www.tesensors.com/global/en/product/safety-switches/atex-preventa-xcs-ref/

Cable rope switches combining safety and ATEX approvals:
http://www.tesensors.com/global/en/product/safety-switches/atex-preventa-xy2-ref/

"Discover Telemecanique Sensors offer, compliant with explosive atmosphere environments (zone 21)"

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