ISC Safety Lore

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Key lessons from incidents related to dust explosions

Introduction

Dust explosions can occur in any industrial site that handles bulk powders. Dusts involved include common products like sugar, flour, cocoa; chemicals, dyestuffs and pharmaceuticals, plastics, metals such as aluminium and magnesium and traditional fuels such as coal and wood. There are five conditions necessary for a dust explosion to occur, called the “explosion pentagon”, which are the presence of combustible dust, oxidant, ignition source, concentration of dust mixed in the air within explosive range and confinement. The two broad categories of dust explosions are primary and secondary. A dust explosion initiated under conditions of confinement is called a primary dust explosion. The force of the primary explosion may disturb surrounding dust, forming another dust cloud, and the flame from the primary explosion subsequently ignites that suspended dust cloud. Secondary explosions are also initiated under conditions of confinement and generally more destructive than the primary explosion.

Case 1 – Pharmaceutical company

On January 29 2003, a dust explosion at a pharmaceutical company that manufactured small rubber parts for pharmaceutical delivery devices killed six workers and injured 38 others, including two firefighters who responded to the event. The damage caused by the explosion was so extensive, that the manufacturing facility was severely damaged. A student at a school one kilometre away was injured by shattered glass. Businesses located in the same industrial park were damaged, and windborne burning debris ignited fires in wooded areas more than 3 kilometres away.

Key findings

The company was aware the rubber compounding process could cause dusty conditions in the facility, and it took extensive precautions to reduce dust accumulation. Additionally, because the facility produced supplies for medical use, good housekeeping was a high priority. Crews continuously cleaned dust from visible areas, vacuuming and wiping up dust on exposed surfaces and the company installed ventilation and dust collection systems at the mixers. However, polyethylene dust (used in the process in slurry form as an anti-tacking agent) was also drawn upward through several ventilation air intakes located over an acoustic tile ceiling installed above the rubber-production area. Above that ceiling — visible only to maintenance workers — approximately one ton of combustible dust built up gradually. The first explosion dispersed other dust accumulations into the air around the production area and ignited them, causing a more devastating secondary explosion and fires.

Case 2 – Chemical plant

On August 2 2014, a catastrophic dust explosion occurred in a large industrial plant for polishing various aluminium-alloy parts. The explosion occurred during manual polishing of the surfaces of aluminium-alloy wheel hubs for the car industry. 75 people lost their lives immediately and another 185 were injured. Subsequently, 71 of the seriously injured also died, which increased the total loss of lives to 146. A series of explosions was initiated in one of the external dust filters which then propagated into the main building via the dust extraction ducting and reached the second floor. At the same time, the spreading flame was sucked into the ducts toward seven other external dust filters, which also exploded.

Key findings

The investigation concluded that the explosion was most probably initiated by self-ignition of contaminated aluminium-alloy dust in the dust collecting barrel below the external bag filter unit in which the initial primary explosion took place. At the same time, neither the dust collectors, the dust extraction ducting, nor the electrical sockets were earthed. There was a misconception about that dust explosions occur only if large amount of dust is present. However, even quite thin dust layers can produce dust cloud within the explosive range. Another misconception in place was that dust not visible in air cannot explode. Good housekeeping and periodic dust removal could prevent accumulation of combustible dust which would reduce the risk of dust explosions.

The ISC believes that leadership across six key functional elements is vital to achieve good process safety outcomes. These elements are:

- systems & procedures
- engineering & design
- assurance
- knowledge & competence
- human factors
- culture

In the *What can I do* section below you can see how each of these elements plays a part.

Figure 1: The ISC Framework

What can I do?	
Management	
	• Dust explosions are process incidents and they require effective application of the principles of process safety to prevent or mitigate such events.
	• Knowledge about how dust explosion can occur is key in operation, ensure that employees are regularly trained on combustible dust hazards to keep their knowledge up to date. The explosion pentagon is a primary information in that regards.
	• Develop and implement written operating procedures for dust maintenance and good housekeeping operations.
	• Combustible metal dust can react exothermically with water, as such, avoid installing sprinkler system in facilities where combustible metals are processed.
	• Ensure that facilities are designed in a way to minimise accumulation of dust and that spaces inaccessible to housekeeping are sealed. For example, segregating dust-producing operations; sealing walls and ceilings and using electrical equipment suitable for explosive atmospheres.
	• Implement a hazardous dust control program that includes dust inspection, testing and housekeeping.
	• Ensure to develop an effective permit-to-work system to control hot work, welding etc. in the facility.
	• To reduce the buildup and spread of combustible dust consider installing a safer dust collector, connected to an efficient source capture extraction system. Extracting the dust in immediate proximity to where it is produced, source capture is an effective method of preventing dust from spreading.
Process Engineer/Supervisor	
	• Ensure you are trained on the hazardous characteristics of combustible dusts and that knowledge is transferred to operators working on the floor.
	• Ensure that emergency procedures are known to operators and they follow safe operating procedures. If operators report dust explosion hazard, investigate it immediately and ensure the hazard is removed or addressed.
	• Ensure controlling the use of open flames and static electricity. Don't allow smoking.
	• Dust is considered an undue hazard if it creates the potential for an explosion. Some of the conditions that may indicate the potential for an explosion include a dust cloud in the air; dust buildup on floors and other surfaces and a dust collector located indoors. Make sure that you check these locations on a regular basis, included in the dust control program.
	• Make sure that regular monitoring and removal of dust are performed not only in primary areas where dust accumulates, such as on production floors, but also in other areas such as cable trays, duct work and false ceilings, as well as behind equipment and in other hidden areas.
Operator	
	• Make sure that you are aware and understand the hazards associated with combustible dust and about dust explosions.
	• Should you see an accumulation of dust you believe could lead to a fire or explosion, immediately report the hazard to your supervisor or employer, and you can refuse to continue working until the situation is resolved.
	• Make sure that work areas are kept clear of dust accumulations. Use vacuum cleaners specifically approved for dust collection. Avoid the use of sweeping brushes and compressed air except for non-dusty cleaning activities.
	• Keep heated systems and surfaces away from combustible dust.