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Dust Gets Its Due

Industry is placing greater emphasis on addressing combustion hazards.

BY SEÁN OTTEWELL, EDITOR AT LARGE

THE DANGERS posed by combustible dusts are no longer being swept under the rug. Tougher regulations and greater corporate resolve are making dust hazard management an increasingly important topic for every manufacturing sector, including the chemical industry.

Testifying to the topic's popularity, a recent *Chemical Processing* webinar on dust control (now available on demand at http://video.webcasts.com/events/putm001/33721/) attracted the second largest attendance of any such event. In it, speakers from the National Fire Protection Association (NFPA), Quincy, Mass., Fike Corporation, Blue Springs, Mo., Chilworth Technology, Plainsboro, N.J., and Camfil Farr APC, Jonesboro, Ark., outlined the key challenges facing the industry today.

THE IMPETUS

The importance of dust management really started to come under regulatory scrutiny in the U.S. in 2003, when the U.S. Chemical Safety Board (CSB), Washington, D.C., determined that lack of attention to dust had resulted in explosions at three U.S. manufacturing plants that year.

A January fire and explosion at West Pharmaceutical Services, Kinston, N.C., was caused by a fine plastic powder that gathered above a suspended ceiling over a manufacturing area; six workers died and many more were injured. Three weeks later, an accumulation of resin dust from a phenolic binder used in a production area led to a blast that killed seven workers at fiberglass insulation manufacturer CTA Acoustics, Corbin, Ky. Then, aluminum dust was found to be the culprit for an October explosion that killed one person and injured many others at Hayes Lemmerz's aluminum wheel plant in Huntington, Ind.

One recommendation of the subsequent CSB studies was that the U.S. Occupational Safety & Health Administration (OSHA), Washington, D.C., get more actively involved in combustible dust hazard management. In late 2007, OSHA issued its National Emphasis Program (NEP) on combustible dust.

The importance of safe practices came to the fore again, when in February 2008, a huge explosion and fire at Imperial Sugar's Port Wentworth refinery, Savannah, Ga., left 14 dead and 38 others seriously injured. The explosion was fueled by massive accumulations of combustible sugar dust throughout the packaging building.

Guy Colonna, division manager of the industrial and chemical engineering department of the NFPA, says he has attended an increasing number of dust-management events like CP's webinar over the last two years. He attributes their popularity to a much greater focus on hazard awareness across all industries and the public following the explosion at Imperial Sugar.

FLAMELESS EXPLOSION VENT
Figure 1. Layers of stainless steel absorb heat generated by combustion, allowing venting without flame release. *Source: Fike.*

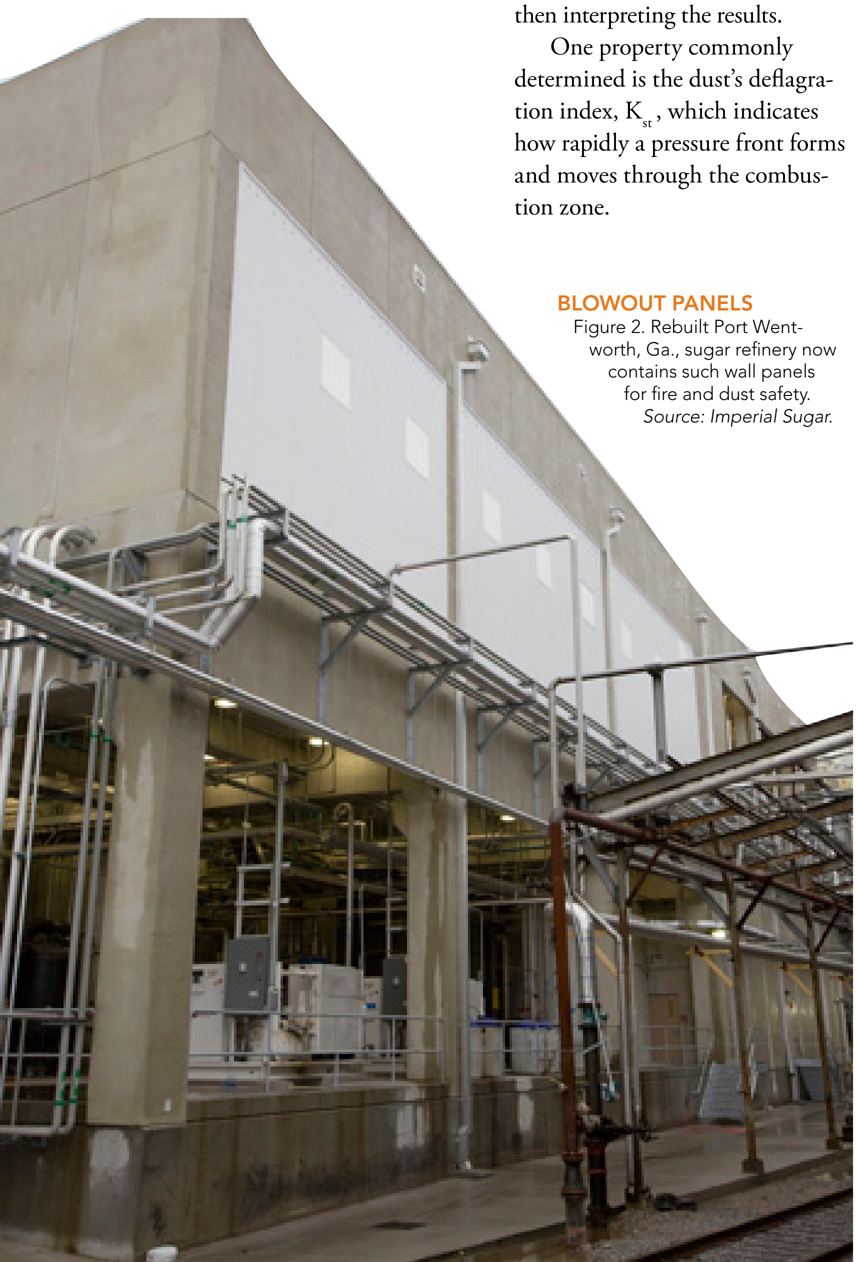
"Earlier incidents during the decade noted and investigated by OSHA and CSB were no less significant in terms of their losses to people and property, but didn't stir everyone the way the Imperial Sugar incident seems to have established a resolve across all affected interests."

He cites data reported by CSB in its November 2006 dust report and similar incident data published by the insurance industry that show explosions and fires involving combustible dusts aren't that rare — about 10 incidents per year took place on average from the early 1980s until 2005 in the U.S.

"Those numbers suggest the various industries have 'coped' with the hazard and operated around the hazard. At this stage, it would appear that industry is no longer looking to cope with the problem and is resolute in finding common understanding about the phenomenon that can lead to more effective hazard assessment and control solutions."

KEY POINTS

In Colonna's experience, two issues commonly crop up in question-and-answer sessions these days — and both are core to coming to grips with combustible dust hazards.



The most common relates to the hazard identification process for examining a facility and any combustible particulates that might be involved as process input, intermediate or final product. This generally requires testing of a sample and then interpreting the results.

One property commonly determined is the dust's deflagration index, K_{st}, which indicates how rapidly a pressure front forms and moves through the combustion zone.

BLOWOUT PANELS

Figure 2. Rebuilt Port Wentworth, Ga., sugar refinery now contains such wall panels for fire and dust safety. *Source: Imperial Sugar.*

"Often, those interpreting the data are seeking guidance on the interpretation for the value reported. Their question asks whether a 'low value' for the K_{st} means there is no problem from the dust in terms of explosibility. The answer to that question is NO. There is no target or threshold value below which no hazard is assumed. Lower values of the index just mean the rate of rise of the pressure with respect to time will be 'slower' (in a relative sense) than other materials that have higher values for the index. The damage pattern from a low K_{st} value dust is different than the damage experienced when the index is greater, but the overpressure is still present and capable of destroying structures — and the fireball also poses a hazard to both personnel and the facility", Colonna says.

The second issue involves the characterization of the dust hazard condition or area. In many cases this is currently is based on the thickness of the layer of accumulated dust. Colonna explains that NFPA 654 presents an equation that enables adjusting the permitted or target layer thickness based on the specific material's bulk density — how packed or non-packed a settled accumulation could be — while still yielding an equivalent mass per area. The layer thickness as used today serves as a trigger for various protective measures as well as housekeeping. The pro-rating equation in the standard permits users to adjust their layer thickness (ultimately that accumulated mass) based on the specific bulk density.

"So, materials like tissue paper, which have a very low bulk density compared to wood and other materials, when evaluated for layer thickness on the basis of the bulk density prorating equation are recognized as accumulating in a less packed or thicker layer while still yielding the same amount of accumulated dust mass across a given area," Colonna says. "The equation method for establishing the layer thickness doesn't penalize those materials whose bulk density is low relative to other materials by requiring them to comply with the same layer thickness as more densely layered dusts," he says.

EVOLVING REGULATIONS

Lately, the chemical industry also has become concerned about various regulatory standards and consolidations currently afoot. Much of this revolves around OSHA's notice of its intention to develop a federal standard to address workplace safety requirements to protect workers from combustible dust fire and explosion hazard conditions.

One solution could be to adopt the five existing NFPA dust standards — there are arguments both for and against this strategy. So the NFPA has challenged its four combustible dust technical committees to determine a path that would consolidate the various requirements of its dust standards into a single comprehensive standard.

"Those supporting the concept see that many of the steps in the hazard assessment process are the same regardless of dust type and, once the explosibility properties are determined, the protective measures are the same in general and only become unique in their design due to those properties which become part of the design process. A single comprehensive standard makes enforcement easier and, thus, stronger," notes Colonna.

This changing regulatory landscape is driving increased interest in combustible dust hazards by all industry groups, says Bob Korn, director of sales for explosion protection products for Fike. "OSHA's NEP has pushed a new emphasis on OSHA inspections of U.S. manufacturing facilities. In October, OSHA chief Dr. David Michaels told a safety group that in the three-year-old combustible dust NEP, nearly 9,100 violations have been found, although not all of them have been for dust violations, with initial penalties totalling more than $19.5 million.

DUST COLLECTION
Figure 3. Sugar-refinery rebuild also included this dust-collection system.
Source: Imperial Sugar.

"At a symposium, also in October, OSHA assistant secretary Jordan Barab said OSHA's inspections of refineries under the process safety NEP has resulted in an average of 17 violations per inspection with penalties averaging $166,000," Korn continues. "He said 53 of 58 refineries have been inspected. At hazardous chemical manufacturing facilities, inspectors have averaged nine violations during each of 136 inspections."

This increase in inspection rates, coupled with OSHA's commitment to the creation of a combustible dust standard, has the U.S. chemical industry scrambling to understand the hazards and develop strategies to protect their facilities, Korn believes.

This scramble is reflected in the sort of queries he faced in the webinar question-and-answer session. These typically concerned equipment applications, code compliance issues and hazard assessment. For example:

- What is the anticipated timeline from OSHA on the implementation of its widely discussed combustible dust standard?
- Does your suppression equipment need to be inspected on a regular basis and, if so, how often and who can do the inspection?
- How do the operating costs of inert atmospheres compare with capital costs of suppression or flame-arrest systems?
- What type of explosion suppression/relief systems have you seen installed on direct-contact rotary dryer applications?
- What methods do you use to determine particle size and shape?

Overall, the best advice he can give to a chemical maker today is to perform a hazard analysis or risk assessment of its facilities and understand where it needs to improve housekeeping, add dust collection and provide protection for processes at risk.

"Organizations that are actively engaged in understanding the hazard and taking the necessary actions to provide a safe work environment will dramatically lessen the effect of an OSHA inspection and any resultant fines," Korn continues. "The chemical industry is in the OSHA spotlight due to other recent serious accidents; consequently they are in the top three of industries inspected by OSHA under the combustible dust NEP."

For Fike, whose business centers on supply of explosion-protection and fire-suppression systems, all this regulatory activity is spurring product development. The company relatively recently introduced rectangular flameless explosion vents (Figure 1). It's working on faster-responding suppression devices because speed is key when dealing with a deflagration.

"Our systems must detect the combustion event and inject a chemical suppressant in a matter of milliseconds. From time of detection to full release of the suppressant happens typically in less than 50 milliseconds. It takes approximately 250 milliseconds to blink your eyes, for comparison," says Korn.

The company also is looking at impulse valve technology for opening its chemical suppressant containers for explosion suppression

EXPLOSION SUPRESSION

Figure 4. Multiple units now are installed at Port Wentworth sugar refinery. Source: Imperial Sugar.

and chemical isolation of interconnections between vessels. "The impulse valve will provide the quick activation we need without the use of a pyrotechnic GCA [gas charged activation] device that is currently used. This will be a great benefit to future systems as we can eliminate the shipping and handling issues associated with these GCA devices," Korn explains.

EFFECTIVE HOUSEKEEPING

This is a key issue, stresses Dr. Vahid Ebadat, CEO of Chilworth Technology: "The severity of an explosion is often directly related to the size/quantity/spread of the available fuel, in this case, the dust. When one studies the large dust explosions that industry has been experiencing, one realizes that almost always the fatalities and most of the damage has not been the result of the initial event but the so-called secondary dust cloud explosion. Therefore, ensuring that the dust is contained within the protected processing equipment and an effective housekeeping measure is in place would go a long way towards ensuring the safety of people and facilities," Ebadat believes.

The huge accumulations of sugar dust at the Imperial Sugar refinery clearly resulted from a failed housekeeping strategy, something that Chilworth has been working with the company to rectify.

The last stage in the rebuild at the refinery involved the three sugar silos, each with a storage capacity of 6.5 million pounds of sugar, or 19.5 million pounds total — three million pounds more than the former silos held (Figure 3). All sugar begins its curing journey in a primary conditioning silo, where dehumidified air is percolated through the silo for 24 hours and where a dust-collection system removes dust. The sugar then moves to one of the other two silos, where it sits in storage before moving to packaging or to a bulk station for distribution.

Following consultations with Chilworth, Imperial Sugar opted for 56 pressure-relief vents on each of its silos at the Port Wentworth refinery. More unusual, however, is the conveying sugar through the silos via a dense-phase system instead of belt or screw conveyors or bucket elevators. The advanced system uses high-pressure air to pump sugar within pipes at a rate of 225 tons/hr.

"Dense-phase conveying is a form of pneumatic conveying that is used in the grain, flour and chemical industries, and for wood chips and sawdust, and infrequently in the sugar industry. However, use of this method for conveying sugar to the top of a 175-foot-high silo — as at the Port Wentworth refinery — is unusual. Among the safety features of dense-phase pneumatic conveying in conductive piping are: complete containment of the product; minimized generation of static electricity; and no moving parts that could cause frictional heating or impact sparks," notes Ebadat.

The rebuilt refinery also features wall blowout panels (Figure 2), dust collection systems (Figure 3) and explosion suppression devices (Figure 4).

The OSHA NEP has led to an increasing degree of awareness in the issue, he believes. "And rightly so. Many companies still don't realize that combustible dusts can be just as dangerous as flammable liquids and gases." However, in preparing for an OSHA inspection, companies handling and processing combustible powders and dusts have become increasingly more proactive with their combustible dust management activities, he adds.

Ebadat offers four pointers on how to succeed in such activities:

1. Properly assess your dust's fire and explosion characteristics so adequate measures can be taken for the prevention and mitigation of hazards in your own facilities and, if you are shipping the dust to some other facilities, at those locations.
2. Understand your own powder handling and processing operations. You should be able to identify likely ignition sources during both normal and abnormal operating conditions. Also pinpoint location(s) where combustible dust clouds could exist during normal and abnormal operating conditions.
3. Take effective measures to avoid or control ignition sources and formation of combustible dust clouds. Also consider explosion protection (such as venting and suppression) and isolation to lower the risk to a tolerable level.
4. Maintain dust explosion prevention and mitigation measures.

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Mitigating Dust Hazards in Oral Solid Dosage Facilities

A brief summary of best practices.

BY VAHID EBADAT, CHILWORTH GLOBAL

MANY OF the ingredients used in the formulation of pharmaceutical oral solid dosage (OSD) forms have been shown to be combustible. Generally, the fire and explosion hazards associated with flammable solvents are well understood. However, hazards associated with solid ingredients are less so.

When assessing dust cloud flash fire and explosion hazards one should not only consider the active pharmaceutical ingredients (API) but also the excipient ingredients that are used. In order to evaluate the potential explosion hazards associated with the use of powders/dusts, the following data (also shown in Table 1) are usually relevant:

DUST EXPLOSION TEST DATA REQUIREMENTS FOR SPECIFIC UNIT OPERATIONS

Unit Operation	Explosion Screening[1]	MIE (mJ)	MIT – Cloud[2] (°C)	MIT – Layer[2] (°C)	Explosion Severity – Kst (bar.m/s)	LOC[3] (%)	MEC (g/m³)	Volume Resistivity[4] (Ω.m)	Chargeability[5] (C/Kg)	Self-Heating Onset Temp. (°C)
Manual Handling / Pouring	X	X						X	X	
Sieving / Screening	X	X						X	X	
Tumble / Double Cone Blending	X	X			X	X		X	X	
Ribbon Blending	X	X	X	X	X	X		X	X	
Milling	X	X	X	X	X	X		X	X	X
Jet Milling	X	X			X	X		X	X	
Drying (Fluidized Bed, Spray, Tumble)	X	X			X	X		X	X	X
Tray Drying	X	X								X
Pneumatic Conveying	X	X			X		X	X	X	
Screw Conveying	X	X	X					X	X	
Transfer to Hopper / Bin / Tote / Container	X	X			X			X	X	
Dust Collector and Exhaust Ventilation	X	X			X		X	X	X	

Table 1. Dust Explosion Test Data Requirements for Some Specific Unit Operations

1. Explosibility Screening test is only conducted if the combustibility of the powder/dust (present in the process/facility) is not yet established. If the dust is found to be non-combustible, other tests in the table may not be required.
2. MIT-cloud and MIT-layer may be required for equipment temperature rating specification in Class II classified areas of buildings/rooms.
3. LOC is determined if the basis of safety is inert gas blanketing.
4. Volume Resistivity should be considered if the Minimum Ignition Energy is less than 25mJ.
5. Chargeability should be considered if the Minimum Ignition Energy is less than 25mJ.

EXAMPLES OF PROPERTIES OF PHARMACEUTICAL EXCIPIENTS

Power/Dust	Explosion Screening	MIE (mJ)	MIT – Cloud (°C)	MIT – Layer (°C)	Explosion Severity – Kst (bar.m/s)	LOC (%)	MEC (g/m^3)	Volume Resistivity (Ω.m)	Chargeability (C/Kg)	Self-Heating Onset Temp. (°C)
Cellulose	Go	40	410	300	229	-	80	$>10^9$	$>10^{-4}$	-
Cellulose Acetate	Go	20	340	-	122	5	-	$>10^9$	$>10^{-5}$	-
Cornstarch	Go	30	390	-	202	-	30	$>10^9$	$>10^{-6}$	-
Dextrin	Go	40	410	440	168	-	-	$>10^9$	-	-
Gelatin	Go	-	620	480	23	-	-	$>10^9$	$>10^{-5}$	-
Lactose	Go	80	450	>450	81	-	-	$>10^9$	$>10^{-5}$	212
Metallic Stearates	Go	<1 - 5	520	-	99 – 210	-	-	$>10^9$	-	-
Methyl Cellulose	Go	12 - 105	360	340	157 – 209	12	-	$>10^9$	-	-
Stearic Acid	Go	25	290	-	159	-	15	$>10^9$	-	-
Sugar	Go	14	370	400	138	-	-	$>10^9$	$>10^{-5}$	-

Table 2. Examples of Properties of Pharmaceutical Excipients

Explosion Screening/Classification (is the dust cloud explosible?): Determining whether the dust cloud will explode (create pressure or flame that propagates away from the ignition source) when exposed to an ignition source.

Minimum Explosible Concentration (MEC): The lowest concentration of dust suspended in air that can give rise to flame propagation upon ignition.

Minimum Ignition Temperature, Dust Cloud (MIT-Cloud): The lowest temperature capable of igniting the dust dispersed in the form of a cloud.

Minimum Ignition Temperature, Dust Layer (MIT-Layer): The lowest surface temperature capable of igniting a dust layer of standard thickness (5 to 12.7 mm depending on test method)

Self-Heating: Ignition of bulk powders can occur by a process of self-heating when the powder temperature is raised to a level at which the heat liberated by the exothermic oxidation or decomposition reaction is sufficient to exceed the heat losses and produce a "runaway" increase in temperature.

Minimum Ignition Energy (MIE): The lowest electrical spark energy that is capable of igniting the dust cloud at its optimum concentration for ignition. MIE data is used primarily to assess the susceptibility of dust clouds to electrostatic discharges/sparks.

Electrostatic Chargeability: The propensity of powder particles to become charged when flowing through conveyances or during handling and processing

Volume Resistivity: The primary criterion for classifying powders as low, moderately, or highly insulating. Insulating powders have a propensity to retain electrostatic charge and can produce hazardous electrostatic discharges when exposed to grounded facilities, equipment, or personnel.

Limiting Oxidant Concentration (LOC): The minimum concentration of oxygen (displaced by an inert gas such as nitrogen or carbon dioxide) capable of supporting combustion. An atmosphere having an oxygen concentration below the LOC is not capable of supporting a dust explosion.

Explosion Severity (Maximum Explosion Pressure and Maximum Rate of Pressure Rise): The maximum rate of pressure rise is measured and used to calculate the deflagration index (Kst) value of the dust cloud. These data are used to design dust explosion protection measures.

TYPICAL BASES OF SAFETY FOR PHARMACEUTICAL UNIT OPERATIONS

Basis of safe operation	Required test(s)	Comments	Discussion
Prevention of Flammable Atmosphere: Fuel Management	Minimum Explosible Concentration (MEC)	Use of Local Exhaust Ventilation (LEV) to remove dust at release points and prevent explosible dust cloud formation. Information on the ease of cloud formation is needed to determine the required dilution air flow.	Three design criteria are required for effective LEV: Adequate capture velocity to control the dust release and direct it to a disposal system; Adequate carry velocity must be maintained within the collection system to prevent dust drop-out; and Adequate dilution air must be provided to ensure that the collection system does not contain an explosible dust concentration. In addition, the dust collection system may require explosion protection and explosion isolation.
Prevention of Flammable Atmosphere: Inert gas blanketing	Limiting Oxygen Concentration (LOC)	Reduces oxygen concentration below minimum necessary to support combustion.	Inert gas blanketing or purging may be a practical means of ensuring safety with a closed loop system. Where several non-inerted operations are interconnected this measure may not be feasible.
Elimination of potential ignition sources	Minimum Ignition Energy (MIE), Minimum Ignition Temperature (MIT), Self-heating Testing	Obtain information on sensitivity of powder to ignition by sources such as electrostatic discharges, frictional sparks and heating, and self-heating. Appropriate steps are taken to exclude ignition sources.	Depending on the results of the tests, steps such as electrical bonding and grounding, regular maintenance of the mechanical parts of plant, regular cleaning of the ducts and filter units, spark or ember detection, etc. can reduce the probability of an ignition. Elimination of ignition source(s) is often used (as a secondary bases of safety) in conjunction with other measures such as elimination of flammable atmosphere or explosion protection.
Explosion resistant equipment (Containment)	Maximum Explosion Pressure (P_{max})	Vessel/equipment and associated ducts built strong enough to withstand the maximum explosion pressure.	Although possible, explosion containment is generally not feasible for large vessels/equipment due to the high costs associated with ensuring that they are strong enough to withstand the maximum explosion pressure (typically 8- 10 bar). Smaller items such as transfer lines, screw conveyors and rotary valves can often be more easily designed for containment. Explosion isolation should also be provided to ensure that an explosion cannot propagate to any interconnected equipment or the work area. Operating vessels built for containment can be cumbersome as all openings have to be sealed to the correct pressure resistance before the process can start.
Explosion pressure relief venting	Explosion Severity: Deflagration Index (K_{St}) and Maximum Explosion Pressure (P_{max})	Combustion products are relieved through a vent to limit pressure rise to the strength of the vessel.	Explosion venting is the most commonly used protection measure for vessels/equipment such as dust collectors, large bins, and dryers. The explosion relief vent must be located to direct any products of an explosion (i.e. fireball, pressure wave and burning particulates) to a safe area outside of the building. Explosion isolation should also be provided to ensure that an explosion cannot propagate to any interconnected equipment or the work area.
Explosion suppression	Explosion Severity (K_{St}), Maximum Explosion Pressure (P_{max})	Initiation of an explosion is detected and a suitable suppressant is injected into the explosion to prevent pressure rise above the strength of the vessel..	Explosion suppression is commonly used when, for example, the location of the vessel/equipment prevents the use of relief venting or if the powder material is hazardous to health and/or the environment. Explosion isolation should also be provided to ensure that an explosion cannot propagate to any interconnected equipment or the work area. This active safeguard is generally more expensive than relief venting.

Table 3. Typical Bases of Safety for Some Pharmaceutical Unit Operations

Explosibility Screening test is only conducted if the combustibility of the powder/dust (present in the process/facility) is not yet established. If the dust is found to be non-combustible, other tests in the table may not be required.

MIT-cloud and MIT-layer may be required for equipment temperature rating specification in Class II classified areas of buildings/rooms.

LOC is determined if the basis of safety is inert gas blanketing.

Volume Resistivity should be considered if the Minimum Ignition Energy is less than 25mJ.

Chargeability should be considered if the Minimum Ignition Energy is less than 25mJ.

Table 2 lists the properties of a number of common pharmaceutical excipients from a number of publically available sources. It should be noted that these properties are dependent upon parameters such as: particle size, moisture content, oxidant concentration, and the presence of flammable vapors; and caution should be exercised in their use.

As stated earlier, when handling combustible solid materials, an explosion hazard is present whenever the fine particulate becomes suspended in air. This may be intentional (fluidized bed drying) or unintentional, such as during vessel charging. Operations where dust explosion hazards must be considered during the design and operation of an OSD facility will typically include: powder charging operations, blending, granulation, drying, milling, compression/coating, and dust collection. A primary Basis of Safety needs to be defined and documented for each operation. Common options are summarized in Table 3.

References

1. NFPA 68, "Venting of Deflagrations"
2. NFPA 69, "Standard on Explosion Prevention Systems"

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Lessons Learned from Imperial Sugar

Preventing a recurrence of the 2008 fatal explosion.

BY DAVID PHILLIPS, PLANT OPERATIONS EDITOR, *FOOD PROCESSING*

FOURTEEN LIVES were lost after a 2008 explosion at the Imperial Sugar refinery in Port Wentworth, Ga., caused a chain reaction fire and secondary explosion. Combustible dust was the culprit in the larger explosion, and those who have studied the incident closely in the years since say the biggest tragedy is that it never should have happened.

This is crucial to the food industry because numerous food category operations, from bakery to confectionary and even brewing, deal with powdered ingredients and other materials that have the potential to form hazardous dust layers. According to a finding in the United Kingdom, more than 30 percent of all explosions involve food or animal feed.

After the Port Wentworth explosion, the federal Occupational Safety and Health Administration (OSHA) made a commitment toward investigating the entire issue of combustible dust explosions, with an eye toward the possibility of tighter regulations or enforcement. So far, the result four years later is the issuance of an updated Combustible Dust National Emphasis Program (NEP).

While OSHA continues to study the issue and could eventually enact stricter regulations, those in the industry say there may be little political support for such actions during a presidential election year. Many have expressed disappointment at OSHA's inactivity, saying the NEP does not have teeth. These critics include the Chemical Safety Board, a federal advisory organization charged with guiding regulatory agencies on such issues. The CSB played a role in the post-disaster investigation at Port Wentworth and made recommendations to OSHA.

The principle of isolation took the separation concept to a more tactical level, ensuring that separate systems were isolated from each other as much as possible and employing technologies such as rotary lock valves and dense-phase conveying of the sugar to reduce explosion potentials and to segment the process to prevent small incidents from propagating into catastrophic failures.

"We believe the safety recommendations that followed from our investigation of this accident will go far in saving lives," said CSB Chairman Rafael Moure-Eraso, in a statement issued this Feb. 7, on the four-year anniversary of the disaster. "I am pleased to report that on this accident anniversary all but one of our recommendations have been successfully adopted by their recipients.

"Specifically, the CSB called on the Occupational Safety and Health Administration to proceed expeditiously on our 2006 recommendation that OSHA promulgate a new combustible dust standard for general industry," he continued. "We believe such a standard is necessary to reduce or eliminate hazards from fires and explosions from a wide variety of combustible powders and dust. I am disappointed that OSHA has not moved forward on this recommendation. Completing a comprehensive OSHA dust standard is the major piece of unfinished business from the Imperial Sugar tragedy."

AVOIDANCE OR MITIGATION?

Design and build firms who work in the food processing arena are accustomed to meeting sanitation requirements in new plants and expansions. The practices outlined in these requirements often go hand in hand with the kinds of steps that can prevent dust collection problems. One such design and build firm is Stellar (www.stellar.net), Jacksonville, Fla., which works with clients in meat, bakery and other food arenas.

"In most of the facilities we build, there is not a single flat horizontal surface other than the floor," says Phil Hinrichs, Stellar's vice president of risk management. "We utilize insulated metal panels to enclose I-beams or other structural protrusions. It's an aluminum skin with insulation and they interlock and you seal each joint."

Lighting fixtures are wash-down ready, as is the processing equipment, Hinrichs says. Cleaning crews can spray the rooms from ceiling to floor, and floor drains are designed with clean-in-place systems for sanitation.

Of course, not all work areas in every type of food processing operation lend themselves to wash-downs. Yet, even in dry environments, building design can incorporate ventilation and circulation features which, when combined with that prohibition of flat surfaces, will drastically reduce opportunities for dust collection.

Hinrichs says that often the difference between a plant designed with safety as a priority and one that simply meets the bare standards has to do with the financial resources a company has. "A company that is operating on a real thin margin just might not be able to afford to do as much," he says.

Finally, separation and isolation would be backstopped by suppression. This included canister-type chemical suppressant systems in specific parts of the process, ample water mains for traditional firefighting, and explosion vents for rooms, buildings, tanks, silos, and elevators to dissipate energy should an explosion occur.

Dust explosions like the one at Imperial Sugar often have a similar causal pattern and sequence of events. Dust accumulated on surfaces can present a risk, even if it is as thin as 1/32 of an inch. It may go unnoticed until something out of the ordinary takes place, which was the case in Georgia.

According to several reports, a small explosion at the Port Wentworth plant disturbed a layer of dust that had built up due to inadequate cleaning in the plant. That dust dispersed into the air inside the plant. A few minutes later, a spark or some other ignition source caused the suspended dust to catch fire and explode, setting off a deadly chain reaction.

Within seconds, the fire and explosions spread along conveyor lines to several buildings and a silo, and employees were caught in cascading sheets of burning sugar dust. More than 40 were injured, some suffering third-degree burns. Thirteen died during the incident or shortly thereafter. One died of his injuries several months later.

Investigations by the Chemical Safety Board determined that Imperial Sugar had not conducted evacuation drills and the explosion and fires disabled most emergency lighting, trapping workers in a dark maze of corridors.

In July 2008, CSB found violations at the Port Wentworth plant and at an Imperial Sugar plant in Gramercy, La., where an inspection five weeks after the Georgia fire found sugar dust four feet thick in some areas. The agency proposed fines of $8.7 million for more than 200 violations found at Port Wentworth and at another plant. It was the third-largest fine in the agency's history. In 2010, a settlement was reached, with the company agreeing to pay more than $6 million.

Design features and fire suppression technologies might have lessened the damage, injury and loss of life at the Imperial Sugar plant. The company has taken numerous steps since the reconstruction of the plant to incorporate prevention efforts into the daily routines at all of its facilities. These include the hiring of a full-time certified safety professional. As described in the *NFPA Journal* (March/April 2010), which is published by the National Fire Protection Assn., the reconstruction of the Port Wentworth plant included numerous features designed to prevent and minimize fires and explosions.

One mitigation activity that can prevent such incidents from occurring involves safe, certified removal of dust by specialized professionals, such as Hughes Environmental (www.hughesenv.com) Louisville, Ky. Companies like Hughes clean ventilation systems and are trained to remove combustible dust as well, using explosion-proof vacuum equipment.

Fike Corp. (www.fike.com) Blue Springs, Mo., offers fire and explosion detection and suppression technologies. The company, which has locations and clients worldwide, provided much of the new Port Wentworth suppressant systems described in the *NFPA Journal* article.

Bob Korn, director of sales and marketing at Fike, says technologies such as flame filters or flame quenchers allow safe explosion venting, even in areas that are occupied by personnel. Simpler technology provides directed venting from interiors to unoccupied plant exteriors. The more advanced technologies have been available for around 10 years, Korn says. They include detection systems that go to work in the fraction of a blink of an eye.

"In fire suppression, you have minutes to work with; but for an explosion, it is measured in milliseconds," Korn says. "They will detect a minute pressure increase and the system will activate. This takes place in about 50 to 70 milliseconds. To put that into perspective, it takes about 250 milliseconds to blink your eye."

These technologies, along with serious best practices in housekeeping and safety awareness, can prevent tragic explosions. Those food manufactures that are serious about safety would be wise to employ them with or without the urging of government regulators.

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