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Successfully Reduce Process Safety Events

Other companies can emulate the approach proven effective at Dow

By John Champion, Sheila Van Geffen and Lynnette Borrousch, The Dow Chemical Co.

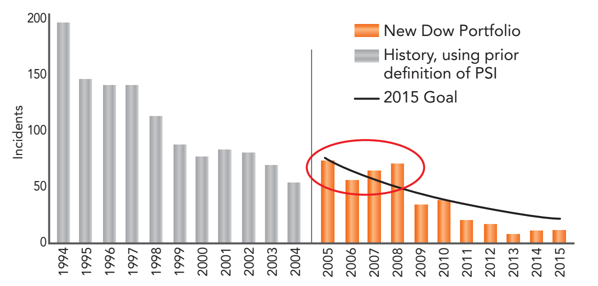
THE PREVENTION of process safety incidents (PSIs) has received emphasis at Dow for a long time. In 1995, business and corporate environmental, health and safety (EH&S) leadership established formal goals to significantly reduce incidents over the next ten years. These goals provided the platform for driving breakthrough performance impacting employees, customers, communities and the environment. This emphasis yielded a more-than-threefold decrease in PSIs over those ten years (Figure 1).

In 2005, another ten-year goal was established to further reduce the number of PSIs and their severity by 75% and 90%, respectively. As Figure 1 shows, this goal was met in 2011 and sustained through 2015.

This article focuses on some of the key programs that enabled us to break through the plateau we had reached in 2005–2008 and continue to drive us closer to zero. A second article next month will cover other crucial programs.

THE BASIS FOR SUCCESS

Figure 2 illustrates the three foundations of effective process safety programs. These



PROCESS SAFETY PERFORMANCE
Figure 1. Dow has significantly reduced the number of incidents per year.

aspects intertwine to form the overall approach to success that we have seen in practice in Dow.

At the base of the triangle, supporting everything we do, is leadership. Leadership support at all levels of the organization is the essential foundation for sustaining success in process safety.

On the left side of the triangle are the process safety systems that Dow has

THE FOUNDATION FOR SUCCESS
Figure 2. An effective process safety program requires three essential elements [1].

implemented globally through our operating discipline management systems. These systems include Dow's Process Risk Management Standard (PRMS) and Global Mechanical Integrity Safety Standard (GMISS) as well as our personal safety standards, and many others. Compliance with these internal requirements, which typically go beyond the minimum mandates of regulations, is what enables long-term success.

On the right side of the triangle is operational discipline, i.e., what occurs in the plant on a daily basis. Operating discipline performed successfully enables effective implementation of process safety systems. For example, an inspection protocol established under GMISS for a facility's piping circuits must be properly followed for effective inspections and a decrease in containment losses resulting from mechanical integrity failures. How the plan is executed will determine whether the outcome is successful or not.

LEADERSHIP AT ALL LEVELS

Dow's commitment to continuously improve both personal and process safety performance aligns to corporate core values. Dow established EH&S as its top priority, engaging all employees across a multitude of business and functional sectors. Dow has clear expectations that all employees are responsible for safety, and measures both business and employee performance against achieving safety expectations. Sponsorship of EH&S begins at the board of directors; it is a key aspect of all leadership roles, as underscored by goals, expectations and resource allocation.

Leadership commitment is critical. Operations benefits from leadership support provided by both the business and corporate EH&S leadership and aligned to Dow's common process safety vision. Business and corporate EH&S leadership define the expectations and strategic goals needed to achieve targets. They allocate the resources necessary to drive improvements and sustain performance. So, let's highlight a few examples of their direct engagement:

Leadership governance. Ensuring that ongoing support, resources and priorities are properly managed is crucial for achieving process safety improvements. The operations governance team (OGT), led by the corporate EH&S director, is designed to drive business and functional accountability for EH&S performance in operations facilities. It also provides functional oversight and direction regarding alignment to Dow corporate EH&S policies, standards and requirements. The OGT oversees the corporate risk management of facilities to drive EH&S improvements and ensure the operating business and regional teams are managed appropriately in accordance with the corporate risk criteria.

Financial commitment. Substantial corporate capital funding is allocated to supplement business capital to manage overall corporate risk and promote timely completion of process safety projects. These projects are identified and prioritized through various assessments. Corporate-funded projects are co-managed by the business group, process safety and EH&S leadership. These corporate funds are designated as high priority EH&S capital to address targeted risk reduction projects along with high priority personal safety improvement projects.

Facility leadership. Production leaders at the individual facility are expected to demonstrate a competent understanding of the facility's chemistry, technology and process safety risks. One mechanism for validating this knowledge is through the new leader reactive chemicals and process hazard analysis work process. This includes having the person make a presentation to subject matter experts, process safety and EH&S professionals. New production leaders are expected to complete this process within the first 90 days of taking responsibility for a facility; they are not authorized to approve high risk management-of-change reviews until successful completion of the process [2].

Employee engagement. Personnel operate facilities daily with a clear expectation that EH&S is their top priority. All facility employees, including the operators, are expected to set personal EH&S goals aligned to those of their facility.

Key influential leaders focus on driving desired behaviors through continued engagement in field activity and coaching. All employees, regardless of position, are empowered to report issues and take action to keep themselves and the work environment safe. Operations personnel can shut down the plant if they have an EH&S concern, even for a minor leak.

A game plan is only as good as its execution. We achieve our goals not only through the act of setting a target but also in doing what is needed to reach and exceed that target. Therefore, operating discipline is essential for enabling success on a day-to-day basis. Here, we'll look at two operating discipline systems that contribute to Dow's sustained success in process safety. We'll cover three more in Part 2 (http://bit.ly/2x8xWCb).

CARDINAL RULES

The prevention of large scale accidents that have a low frequency of occurring but high consequences depends upon an acute awareness of worst-case scenarios and the assurance that the protection layers are not compromised. Dow uses cardinal rules to maintain a high awareness of these types of scenarios and help prevent major incidents [3].

Cardinal rules are technology specific; they have been used for some of our processes for a long time. In the last few years, Dow has placed an increased emphasis on

SOME CARDINAL RULES FOR ACRYLIC MONOMERS

1	**Never** thaw frozen acrylic acid or methacrylic acid with steam.
2	**Never** remove liquid from a partially thawed container of acrylic acid or methacrylic acid.
3	**Never** sparge nitrogen through aerobic inhibited monomer.
4	**Always** know the inhibitor concentration of a monomer.

Figure 3. This partial list illustrates the clear and concise nature of the rules.

ensuring that all technologies have cardinal rules developed and then disseminated all the way to the shop floor. These rules follow the format of the biblical Ten Commandments. They are short statements that are expressed in absolute terms like "never" or "always." Limiting the number of these rules for a given technology emphasizes the importance. We consider a maximum of 10–15 effective; any more can dilute the emphasis. Most statements are developed as a result of a significant Dow or industry incident involving the particular technology.

All Dow personnel involved in a technology are required to know, understand and abide by its cardinal rules. Violating a cardinal rule may result (and, in many cases, has resulted) in a significant incident with potential impact to personnel, property and the community. A violation that does not result in an accident is recorded as a near-miss and appropriately investigated. The learnings from the investigation are leveraged across the technology to help prevent recurrence.

An implementation example. The Dow acrylic monomers technology owners formalized their list of cardinal rules in 2010, based on internal and external storage and handling standards that had existed for many years. These standards consist of numerous pages of detailed rules and guidelines for the safe handling of acrylic monomers. Many of the rules and guidelines reflect best practices and learnings from past events, including big and small, internal and external ones. The key benefit of taking an extensive standard and developing a list of cardinal rules is to distill crucial concepts down into short statements that can be more easily hard-wired into people's way of working. Figure 3 shows a few examples of the acrylic monomer rules.

Cardinal Rule	What could happen?	Where Does the Hazard Exist?	Minimum Safeguards
Never thaw frozen acrylic acid or methacrylic acid with steam.	The use of steam can initiate a thermal, uncontrolled polymerization of the monomer, resulting in potential equipment rupture. *Note that a tank truck exploded in 1976 due to this.*	Freezing can occur in pumps, pipe systems and storage vessels that are uninsulated, poorly insulated, have inadequate heat tracing or inadequate temperature control of heating systems.	1. Well-maintained insulation and heat tracing systems to prevent freezing. 2. Procedures and training on the safe methods that can be used for thawing are critical. 3. Never increase the temperature of the heat tracing system above the maximum allowable temperature. 4. The use of a hot water mixing station requires automatic shutoff capability for high temperature.

Table 1. Background on the hazard, its potential impact and minimum safeguards reinforce the importance of the rule.

Behind each of the short statements is detail to reinforce the importance of the rule. Such detail includes a description of what could happen (or has happened) if the rule is violated, where in the plant the hazard exists and what minimum safeguards shall be in place. Table 1 provides an example for one of the rules from Figure 3.

Once their development was finalized, the cardinal rules were incorporated into the training program for all personnel who interact with the technology. Operators, engineers, production leaders and others were trained initially on these rules in instructor-led interactive training sessions with the technology experts. Periodic formal refreshers ensure retention. Furthermore, the rules are built into the daily work practices to maintain awareness in everyone's mind. For example, each operating plant control room prominently displays a copy of the rules as do some staff buildings. The rules are frequent topics of safety meetings and even informal discussions.

MAINTAINING CORPORATE MEMORY

Corporate memory is important because bad things can, and have, happened at Dow and in industry: uncontrolled chemical reactions, fires and explosions, mechanical overpressure, building detonation, and more. They can lead to devastating consequences: property damage or destruction, capital losses, environmental impact, and injury or death.

The need to maintain corporate memory gets even more critical as we continue to improve process safety performance. As incidents become less and less frequent, we may become less vigilant over time. Many individuals may never personally experience a serious event during their career. In fact, that is the real goal: to never experience a serious event.

Institutionalizing corporate memory in training can assist in preventing significant events and create a continuum of key knowledge. Dow's training includes:

- chemical properties of hazardous materials;
- hazardous scenarios;
- main protection systems and design features; and
- major incident history.

Chemical properties of hazardous materials. The training program details the properties of those chemicals used at the facility. It includes a list of chemicals, how to recognize them, how to respond to exposure, their flammability and toxicity, reactivity hazards and properties of those chemicals that operate at conditions that could be hazardous (e.g., high temperatures and pressure).

Hazardous scenarios. This training covers the reactive chemistry and hazards associated with systems that could be impacted by those working in the process areas, potentially causing a life-threatening event. The content includes the chemicals involved, typical initiating events and the extent of the impact (distance/consequence). It presents scenarios for both normal operations and abnormal situations.

Main protection systems and design features. The training describes the main protection systems and design features that contribute to safety (e.g., no water in the process, no aluminum used in the process, layout and building design). One key focus area concerns what aspects of the protection strategy the operations personnel can directly affect, such as procedural and emergency response protection layers.

Major incident history. This training reviews past serious events, including the worst flammable and toxic releases, and fatalities that have occurred in the facility or in the technology. Delving into past incidents underlines the importance of protection systems and the credibility of the hazards. Photographs, if available, are provided to illustrate the consequence of the incident. Many trainees will relate more effectively to visual images.

There's More...

This is a two-part series based upon portions of a paper given at the 13th Global Congress on Process Safety in San Antonio, in March 2017. The full paper appears in the Proceedings of the Congress and published in the December 2017 issue of Process Safety Progress. To read part 2, visit http://bit.ly/2x8xWCb.

Each facility must develop the appropriate training. New employees must receive initial training while other employees must get refresher training on a recurring schedule. A variety of delivery methods, from instructor-led training to computer-based self-paced learning, can be used. ●

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Tackle Combustible Dust Safety Challenges

Indoor collection systems and proper venting help to extinguish flames and contain extrafine particulates

By Gerd Ph. Mayer, Eric Finley and Helen Sztarkman, REMBE Inc.

In recent years, production processes have changed in many key industry sectors — food, pharmaceutical, cosmetic — as well as in metal pigments production. Nanoparticles are needed to incorporate a given substance into production media more easily to achieve properties previously unrealizable.

In the past, wet (dust collection) processes were used to remove extremely fine particles generated in production. The need to collect and handle very fine materials in dry processes increased costs and environmental concerns. It also created issues associated with handling high-risk combustible compounds. Dust clouds with hazardous particle concentrations can form and remain for extended periods of time because of reduced sedimentation velocities, causing three primary challenges:

1. High ignition risks
2. High energy content risks
3. Smoldering risks

As a rule of thumb, the smaller the material's particulate, the higher the combustion risk will be. This article will weigh in on such an assumption's accuracy and provide some solutions for preventing or mitigating explosion risks when handling combustible nanoparticulates.

COMBUSTION IS GOING "NANO!"

Traditionally, particulates have been described in millimeters and microns, but now the nanoparticle is in focus as if it is something new. "Nano," as in nanoparticles, describing 1/1,000 of a micron particle's size of, has been in existence since the world was created. Nanoparticles can be found in wildfire fume, ash of erupted volcanos and even in barbecue grill smoke outside of private households. For several decades, nanoparticles have been used, and continue to be used, in the form of carbon black in tire manufacturing.

“Nano” seems to have a dangerous or negative connotation both in general perception and, even more so, in production environments. This is especially true when these particles become airborne and possibly are inhaled by production workers. Products containing nanoparticulates have to be labeled to make people aware of a possible hazard.

While nanoparticles do pose some health threats, they are not always harmful. Nanoparticles already are used in a positive manner for several health applications. For example, silver nanoparticles are used as antibacterial agents in bandages, are integrated in implants for the human body and are embedded in cosmetics and sunscreens in which particles of titanium and zinc oxide reflect sunlight and assist with protective sun exposure.

Numerous other applications for nanoparticles are being developed every day as the need for their specialized properties increases. For this reason, the technical world has started to generate nanoparticles on an industrial scale. Thus, two manufacturing procedures have been developed: the so-called “bottom-up” process, in which the particulates are generated in a narrow particle-size distribution through a chemical-physical procedure, and the “bottom-down” process, which involves grinding in high-energy mills to generate the ultrafine particulates.

Regardless of the method used to generate nanoparticulates, once a substance is turned into dry powder, the risk of combustion increases rapidly.

Catastrophic combustible dust incidents have occurred repeatedly for hundreds of years and have been discussed thoroughly. Authorities have responded, especially after fatalities occurred. An increased awareness of the risk employees are working with every day, supported by information and research, is reflected in regulations and codes, such as the National Fire Protection Association (NFPA) Standards.

Some of the NFPA combustible dust standards address more general considerations that apply to all manufacturing, such as increasing awareness of explosion prevention and measures to avoid hazardous conditions. Other NFPA standards are industry-specific: NFPA 484 for metal dust or NFPA 61 for agricultural production, for example.

A commonality for these industry-specific standards is that they currently focus on particulates in the micrometer range because nanoparticles primarily are being generated as byproducts in negligible amounts. However, because of the increasing nanoparticle industry, the next edition of NFPA 654 is going to address the processing, handling and storage of nanopowders. This will be done to assist the manufacturers in understanding the possible hazard when very small particle sizes are involved.

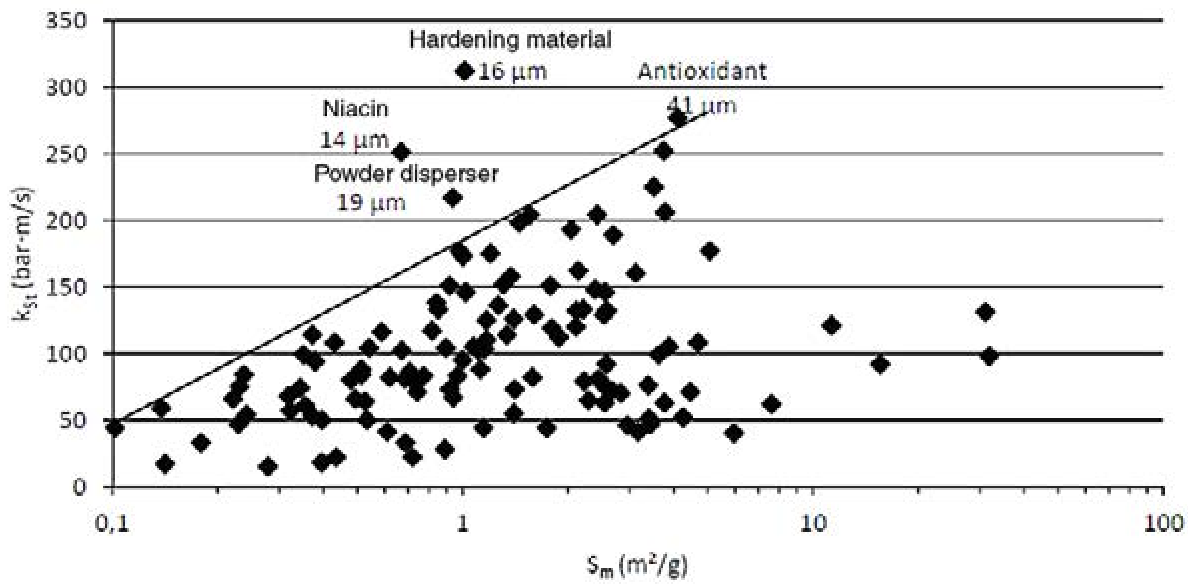
Dust hazard analyses (DHAs) performed for processes and facilities that handle nanopowders will need to include an assessment of the hazards associated with containing and controlling nanopowders in the applicable equipment and processes in addition to the fire and deflagration hazards already addressed.

COMBUSTIBLE DUST AND THE EXPLOSION PENTAGON

Combustion is the process of fine particulates being ignited in air. The prerequisites required for a dust explosion are shown in Figure 1. The fuel source — in this case fine dust particulates suspended in air — must be present, as well as oxygen and an ignition source. The ignition source could be as simple as a spark created by particle friction, any kind of overheated surface or an open flame. These four prerequisites can result in a flash fire. The explosion then occurs when this optimal concentration of dust particles is captured in an enclosure (such as an air material separator (AMS) or a mixer). Most enclosures used for storage, conveying, dust collection, etc., are not designed to contain the subsequent pressure developed and would rupture, thus setting free a massive explosion.

Because this explosion risk exists in almost all areas of industrial processes, a DHA is required per NFPA 652. The hazards must be determined and proper measures must be put into place to reduce the risk for workers and the company as a whole. In many cases, a "management of change" process must be implemented to assist in educating and reducing the overall hazards. In addition, reasonable measures to avoid and control an explosion safely should be undertaken to reduce the threat of a combustible dust explosion.

DUST EXPLOSION PENTAGON
Figure 1. These five criteria must be present for a dust explosion to occur.



K_{ST} VALUE AND SPECIFIC SURFACE AREA
Figure 2. Smaller particles create higher K_{st} values, resulting in a bigger explosion.

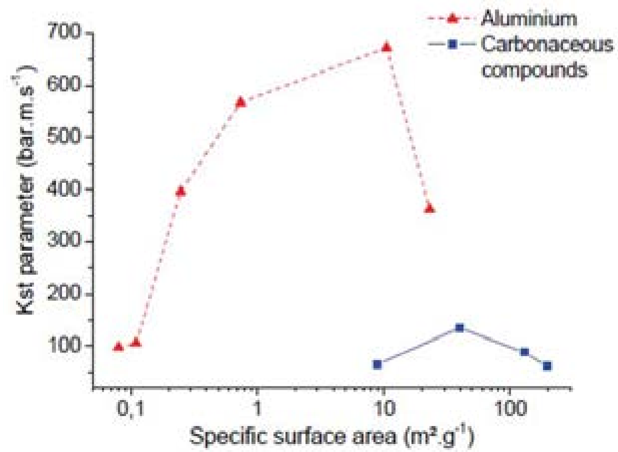
COMBUSTIBLE DUST CRITICAL PARAMETERS

Any dust that has a K_{st} value (the maximum pressure rise in a 1 m³ test vessel) greater than zero is considered a "combustible dust." These dusts are classified into ST1 dust (K_{st} < 200 bar m/s, ST2 dust (> 200 – 300 bar m/s) and ST3 dust (K_{st} value > 300 bar m/s). Along with K_{st}, each combustible dust has a specific maximum explosion pressure (P_{max}) that it can reach during an explosion.

K_{st} and Pmax values for each material are different, and "typical" data can be taken from literature. Different numerical data exist for the same chemical composition because these values vary with physical proportions such as size and shape of dust particles as well as overall moisture content. Tables with published K_{st} values classify material by diameter; often the particle diameter x50.3 is the parameter used, based on the sieve/mesh diameter classification process. As almost any reaction depends on the particle surface available, a particle diameter x50.2 is the best particle diameter to use. Particulates or particle size distributions then are determined by the specific surface area (S_m) measured in (m²/g). Figure 2 shows the correlation between K_{st} value and specific surface area.

The graph shows how smaller particles create higher K_{st} values and thus a more intense explosion. There is no existing physical law or axiom per se, so we rely on the regression analysis method to describe mathematically the correlation between the two parameters. Of course, variances can be assumed due to passivation of the fine particulates or internal moisture content in micropores. Extending the regression line on the graph, higher K_{st} values for ultrafine nanoparticulates for S_m > 10 m²/g could be expected. This assumption is based on published data and is not verified.

Surprisingly, when examining Figure 3, the correlation between K_{st} value and S_m for aluminum does not follow the regression line seen in Figure 2. In fact, this trend resembles the outliers seen in Figure 2 in which the K_{st}, after reaching a maximum value, drops to much lower values with S_m > 10 m²/g (<200nm particle diameter). One explanation could be that particles, once airborne, no longer are dispersed as single particles but have formed agglomerates because of interparticle bonds, thus reducing the specific area for reaction.



ALUMINUM AND CARBONACEOUS COMPOUNDS
Figure 3. When comparing the evolution of the K_{st} value for aluminum and carbonaceous compounds as a function of the specific surface area (S_m[15]), the correlation between K_{st} value and S_m for aluminum doesn't follow the regression line seen in Figure 2.

The explosion properties of a range of nanopowders have been characterized, including aluminum, iron zinc, copper and several carbon materials. Generally, nanopowder explosibility (maximum explosion pressure, rates of pressure rise and equivalent K_{st}) is broadly similar to conventional micron-scaled powders.

One change that is certain is nanoparticle minimum ignition energy (MIE). The MIE is reduced for nanoparticulates, so the combustion takes less energy to be triggered and thus an explosion's development has to be detected at a very early stage. Any delay in activation of protection equipment to avoid equipment damage has to be minimized to accommodate the dangerous reduction of MIE for nanoparticles compared to the micron-scale powders.

An explosion with common particulates, such as those existing in the food processing, woodworking, grain handling or similar facilities, creates high explosion pressure in an enclosure. If vented freely outside of a building, or correctly vented through a duct to the outside, it will create intense flames and pressure that are harmful to personnel, equipment and property that may be in its path.

Nanoparticulates added into this explosion scenario create additional considerations as they are a potential threat to the environment and personnel. Unburned airborne nanoparticles can cause serious harm. Nanoparticles can cross natural barriers easily when inhaled and eventually cross the brain barrier. Preliminary results show that the accumulation of metal nanoparticles in the human body, when inhaled over a period of time, can cause cancer and, in general, can harm the immune system. There also seems to be an impact on diseases such as Alzheimer's.

MITIGATING COMBUSTIBLE DUST EXPLOSIONS

Metal powders frequently do not have a very high K_{st} value compared to many organic materials. The same can be said for metal nanopowders. However, metal nanopowders can ignite easily due to their large specific area or, more commonly, by forming hydrogen when coming in contact with moisture. The flame front spreads rapidly, and the explosion pressure develops at high speeds. The flames easily can reach 3,500°C – 4,500°C, which is far greater than that of a typical dust explosion from sugar, wood, paper, cornstarch, etc.

To mitigate the effects of a combustible metal dust explosion, consideration should be given whether a high concentration of nanoparticulates is involved. If that is the case, only methodologies containing the explosion should be used to avoid nanoparticulate release into the environment.

INDOOR EXPLOSION VENTING SYSTEM
Figure 4. The first venting system of this type was used for process applications without an option to vent outside or use chemical suppression.

Explosion control and particulate retention are the priorities in the event of a combustible dust explosion involving nanoparticulates of any kind. Two protection options would be a flameless venting system with particulate retention or a chemical suppression system.

The indoor flameless venting and particulate retention system (Figure 4), developed in Germany by REMBE, releases the pressure and dissipates the heat from an explosion. The system is referenced in NFPA 68, 2018 edition, Annex A. Fig.6.9.

This easy, safe venting solution first was developed for use in flour, sugar and similar indoor process applications in which ducting to the outside was not an option and chemical suppression not acceptable.

ALUMINUM POWDER EXPLOSION
Figure 5. The indoor venting system "extinguished" the flame, and the ultrafine particulates were captured and remain inside.

Over the years, given the increasing demand for indoor venting systems in other applications, research and development led to additional innovations. This system now has ATEX certification for use in hybrid mixtures, gaseous application and metal dust applications within application limits.

Figure 5 shows a freely vented explosion test with an indoor venting system installed. The integrated special mesh material effectively "extinguished" the flame through heat dissipation and, with its multilayer structure, captured ultrafine particulates inside.

The chemical suppression method, depending on fast reaction of a triggering system, will stop the development of an explosion efficiently but may not completely extinguish the particles in an enclosure. In the event of a metal dust explosion, because of the extreme heat developed, regular extinguishing agents will not work; the so-called Class D fire extinguishing agent has to be used.

CONCLUSION

To date, what we can say is the explosion properties for nanopowders are not very different from the commonly known parameters of micron-scaled materials. The maximum explosion pressure seems to increase slightly, the minimum ignition energy is reduced, and the K_{st} may actually decrease. Once the explosion starts, the course of the explosion and its violent impact are no more severe than micron scale powders.

The knowledge and experience base of explosion properties when it comes to industrially produced nanomaterials is minimal, and additional data similar to that existing for micron-scale particulates needs to be developed. Further research is required.

The existing systems for explosion mitigation, if certified for a range of explosion properties, also can be used for nanopowders. Steps need to be undertaken for some mitigation systems to ensure, after an explosion, harmful, unburned particles are not released to the environment and possibly inhaled. The indoor venting system, if certified for metal powders, functions as a particulate retention system, so the risk for unburned nanopowders becoming airborne is minimized. ●

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KEEP
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Use Asset Management Software to Improve EH&S Programs

Ability to capture events and link documents improves environmental, health and safety efforts

By Jeromy Risner, CMRP, Aptean

Environmental incidents, occupational illnesses and injuries are preventable through proper training, engineering controls and management controls. Understanding the strong correlation between reliability and safety, the best Computerized Maintenance Management Software (CMMS) and Enterprise Asset Management (EAM) solutions provide the necessary functionality to record and track any type of incident or audit finding and link documentation and procedures as well as improve equipment reliability. This capability will support and strengthen your environmental, health and safety (EH&S) programs.

These solutions support reliability and maintenance process improvement by providing historical data, helping control maintenance processes and functioning as a tool for implementing improvement. To be effective, maintenance organizations need quick access to critical information to perform tasks effectively, efficiently and safely. Integrating incident tracking, permit requirements, material safety data sheets and other EH&S concerns with your adopted reliability and maintenance strategy can lead to significant, sustainable cultural improvements.

INCIDENT MANAGEMENT AND TRACKING

Event Tracking capabilities allow users to enter any type of incident or event without requiring a work order. These features should be configured easily, enabling users to define their own event types including, but not limited to:

- Accident or safety incidents

- Hazardous material spills and movements
- Safety and housekeeping inspection findings
- Safety observations
- Shift logs and notes
- Employee training and certifications
- Emergency preparedness drills

Each event type should have its own associated user-defined fields. Reports, photographs, videos and other documentation should be linked to the specific events, and users then can select applicable failure codes, conditions and actions.

A follow-up work order feature lets users capture an incident and then launch a separate but related action item automatically to correct any deficiencies found.

SAFETY MANAGEMENT

Various features are available to support safety management practices.

Document Linking. To support safe work practices, Document Linking allows safety procedures, instructions and other documents to be linked to your assets. The advantage of linking documents to assets is an automatic carryover of pertinent safety procedures and instructions to all emergency, routine and preventive maintenance work orders generated against the specific asset.

This beneficial feature reduces users' valuable time spent searching for or waiting on the appropriate documentation. Immediate access to the proper safe work procedures ensures consistent and precise work execution. Whether it's lockout/tagout (LOTO) procedures, material safety data sheets (MSDS) or instructional training videos, pictorials or manuals, your CMMS/EAM solution should allow users to link any type of file to any asset.

Procedures also can be linked to a specific department or area. This benefits users by carrying the document to all assets within that department or area automatically. Also of use is the ability to provide additional ISO and mechanical integrity fields. The mechanical integrity field allows users to identify equipment within process safety management (PSM) boundaries and automatically links applicable procedures through association. Internal audit procedures for ISO compliance also should be linked in the same manner by means of the ISO field.

Permits and Personal Protective Equipment. Each work order should feature an area to specify permit and personal protective equipment (PPE) requirements. Permits and PPE should be user-defined fields, ensuring the solution conforms to your organization's specific needs.

The planner then can flag required permits and PPE for each individual job. Start work, hot work, confined-space entry and other permits are identified as required along with safety glasses, respirators, hearing protection and other PPE. Quick and easy identification of the proper permit and PPE requirements will support your safe work culture.

Safety Findings. Another valuable feature is a safety flag for identifying safety-related work orders. This permits safety managers to extract all safety findings quickly and monitor action items as they progress through the work management process. The added benefit is that safety work can be managed separately from corrective and preventive maintenance (PM) work activity, or it can be combined with the maintenance supervisor's work backlog for routine work processing and assignment.

Inspections and Observations. Also useful is an area to indicate special work order types for inspection routes with the ability to capture feedback from those routes for history and follow-up activity. For example, in the food processing industry, many regulations require daily sanitary inspections for the processing assets. Users need to specify daily inspection checklists in the system for each processing equipment asset and then capture comments and findings for each.

In other industries, too, observations and follow-up requirements need to be captured and follow-up work orders generated from the inspection feedback. Those observations should be entered as comments on the inspection reports or as separate events. The solution's asset-specific component, condition and action codes should allow precise, quick identification of problems found and corrective actions taken.

Handheld devices often are used to support inspection routes. This eliminates paper from the operation and improves efficiency, reduces the opportunity for clerical errors and protects the environment further. Mobile maintenance applications support inspection routes in addition to routine and emergency work orders.

Logs. Maintenance management solutions should have an event module that permits users to capture any log information. Many users track shift logs and supervisor notes with an Event Tracking module. Additionally, casual inspections, safety observations and other findings should be tracked in the same historical repository as your maintenance and other activities. Event Tracking allows users to define any type of log or activity and then delineate those entries through user-configurable reporting.

Material Safety Data Sheets. A solution's inventory module should provide the ability to link MSDS to inventory items, including hazardous materials. Additionally, local safe handling procedures should be linked to the item. MSDS information should be able to be printed.

Disaster Response and Emergency Preparedness. Some systems offer the ability to create and store disaster and emergency response plans as predefined templates for maintenance and emergency response activities. Using preplanned templates ensures that the proper processes, safety equipment and materials are deployed in a disaster drill or emergency response. These templates should be accessible and deployable in a matter of seconds should the need arise.

These plans can be used to stage periodic emergency preparedness drills and capture feedback, observations and lessons learned to improve readiness and training. You should be able to capture a complete history of disaster drills and results within the Event Tracking module. Consider CMMS/EAM solutions that have document linking features so users can link associated video, photographs and other documents along with the disaster drill event.

HEALTH CONSIDERATIONS

To support your employee health program, look at solutions with a resource module that can capture employee data such as:

- Health seminars
- Orientations
- Exposure information
- Inoculations
- Lost time accidents

The resource module should be user-configurable to capture and track any desired employee information. The document linking feature within the asset management solution should link certificates, medical reports and releases to employee records. This then becomes a single repository for employee fit-to-work information along with certifications and training records.

For periodic recertification and training requirements, choose a solution that provides an optional expiration date on each record that can trigger both employee and supervisor notification of upcoming requirements. The solution should also feature the capability to create health-related work orders for managing and tracking. Similar to safety-related work orders, user-defined priority codes should enable users to identify a work order as safety- and health-related.

Employee exposure to hazardous materials should be trackable within a resource module with related records for examinations and follow-up activities, and all this information should be linked to the exposed individual. For hazardous materials, maintenance management solutions should feature the ability to identify work orders issued to particular substances. This identification then will provide a cross-reference for all employees that were assigned to those work orders. Therefore, if a specific material caused a particular health issue or concern, then all employees that may have been exposed (assigned to those work orders) to the hazardous substance can be identified quickly. This information then can be used to warrant health examinations or other follow-up activities.

ENVIRONMENTAL CARE

To support care and concern for the environment, Event Tracking allows users to manage:

- Environmental inspections
- Material handling
- Hazardous material spills
- Emissions tracking

Environmental Inspections. Event Tracking can capture environmental inspections, including internal and formal regulatory reporting. This allows users to create events to record inspections, create follow-up work orders automatically for corrective actions and address any findings or recommendations. Your organization then has an audit trail of all inspections and follow-up corrective work in a central repository for all plant activities.

Material Handling. Note that hazardous material management within a CMMS/ EAM solution typically is intended for maintenance activities only. CMMS/ EAM solutions generally do not formally track hazardous materials produced by manufacturing operations or other sources; however, Event Tracking may be used to manually manage and track the process and quantities.

Top CMMS/EAM solutions feature an indicator for inventory items to track hazardous materials (hazmat). When receiving hazardous materials, the maintenance management solution allows users to link MSDS to the material records and record the storage location. They also feature a separate indicator to designate required receipt inspections before storing the hazardous material, and this indicator can be used to identify specific laboratory requirements.

When hazardous materials are issued or returned, the solution should record the user ID of who made the issue, who received the material, any associated work order, quantity issued and a date/time stamp of the transaction. This lets management track hazardous materials usage with a full audit trail. With a document linking feature, MSDS information that has been associated with a hazardous material also can be printed at the time of issue.

When hazardous materials are slated for disposal, an event record should be created in the CMMS/EAM solution to manage the process, and follow-up work orders associated with the event then can be used to track every stage, inspection and lab report after the material has been "issued for disposal." All labeling and movement tracking are the user's responsibility.

Hazardous Material Spills. CMMS/EAM solutions may support hazmat spill response and activity tracking through a progression of capabilities. First, spills can be captured as events with Event Tracking, and then a follow-up work order can be triggered immediately from the event with HazMat cleanup procedures, predefined response tasks and inspection activities. The solution should feature predefined templates for maintenance and emergency response activities. Using preplanned templates ensures the deployment of proper processes, safety equipment and materials in the HazMat response. Finally, all reports, photos, videos and inspections should be linked back to the original event, providing an audit trail for all HazMat activity.

Emissions Tracking. As with environmental inspections, emissions, including internal and regulatory reporting, can be captured with Event Tracking. Users can create events to record emissions and create follow-up work orders automatically for corrective actions to address any findings or recommendations to prevent recurrence. Your organization will benefit from an audit trail in a central repository of all emissions and releases and follow-up corrective work. ●

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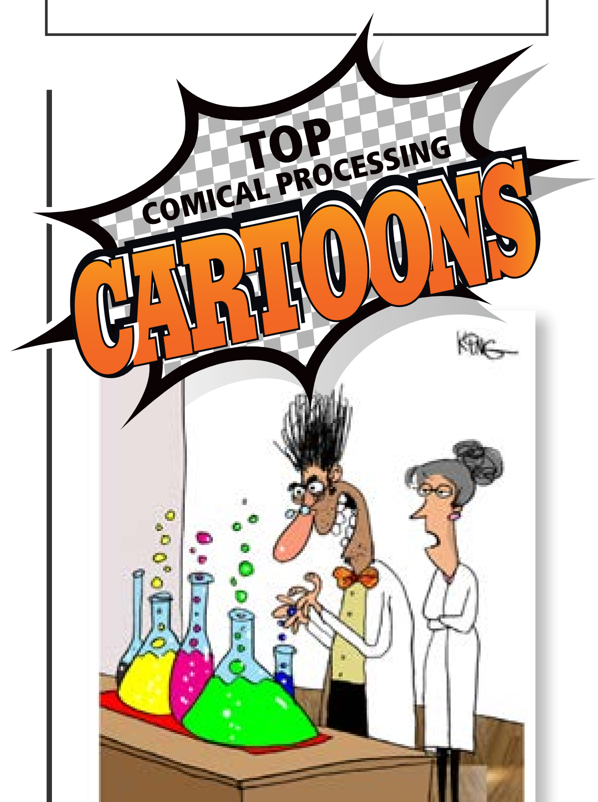

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