FOCUS ARTICLE

How Can Combustible Dust Testing Help in the Assessment of Your Dust Flash Fire/Explosion Risk?

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NFPA 652, the Standard on the Fundamentals of Combustible Dust requires that the owner/operator of a facility conduct a Dust Hazards Analysis (DHA) in situations where powders/dusts that have been determined to be combustible or explosible in nature are present. The DHA must include identification and evaluation of the processes or facility areas where fire, flash fire and explosion hazards exists. In situations where these hazards exist, NFPA 652 requires the identification of safe operating ranges and the safeguards that are in place to manage fire, deflagration and explosion events, in addition to recommendation of additional safeguards where warranted.

The DHA must be based on appropriate and applicable explosibility, self-heating, and electrostatic data for the powder that is representative of the one being present. This data typically includes physiochemical properties of the solid particulate including explosibility and ignitability properties such as the dust deflagration constant (Kst), minimum ignition energy of a dust cloud (MIE), minimum ignition temperature of both dust clouds and layers (MITc and MITl), minimum explosible concentration (MEC), thermal instability (Bulk Powder and Layer), volume resistivity, and electrostatic chargeability.

Flash Fire and Explosion Hazards of Combustible Dusts/Powders

Three elements are required for a fire (1) a fuel; (2) an oxidant, typically the oxygen in air; and (3) a sufficiently energetic ignition source. If any one of these three elements can be removed, fire cannot be initiated. The first two of these elements (fuel and oxidant) when in an appropriate ratio, are referred to as a flammable atmosphere.

For an explosion involving a combustible powder/dust to occur, two additional requirements are necessary: (4) suspension or mixing of the combustible powder/dust in air above the Minimum Explosible Concentration, and (5) confinement. Without suspending powder/dust in air "only" a fire will follow an ignition, but when a flammable powder/dust cloud is ignited, a "flash fire" will ensue and the developing fireball can cause serious injury to people and damage to plant. If the burning powder/dust air mixture is confined inside a vessel or building, the expansion of the hot combustion products will be impeded and the pressure will increase, leading to an explosion. Due to the pressures generated, equipment and building damage are likely.

Hazard vs Risk

A hazard is traditionally defined as a condition that could lead to an event, such as a fire or explosion. The existence of the hazard does not necessarily mean that the event will occur. The risk is defined as the possibility of having the event occurring. Typically, performance of a risk assessment would be necessary to evaluate this possibility. This is an exercise that can be used to identify the hazards and risk factors that have the potential to cause the event to occur. Risk is defined as the product of the likelihood of an event and the consequence or severity of the event (Risk = L*S).

NFPA 652 allows the performance of a properly documented risk assessment that is acceptable to the authorities having jurisdiction (AHJ), as a supplement the DHA to determine what protection methods are to be used. The risk assessment is a very useful tool that can allow the owner to prioritize implementation of the recommendations made as a result of the DHA.

Testing to Assess Risk

Determination of critical properties of a combustible powder/dust can be an invaluable tool in the performance of a risk assessment. Ignitability properties such as MIE, and MIT cloud and layer, MEC, self-heating, volume resistivity, and electrostatic chargeability can be used to assess the likelihood of the event. For example, dust clouds that have a high minimum ignition energy would be less likely to ignite by electrostatic discharges than those that have low minimum ignition energy. Or dust/powders that require extremely dense clouds to be formed to be explosible in nature may be less likely to ignite than dust clouds that are explosible in nature at less dense concentrations.

The dust deflagration index, Kst, is a measure of the rate of burning of an optimal dust cloud under confining conditions. The maximum pressure, also determined by this test, is an indicator of the potential of a confined dust cloud explosion to create overpressures which could be a threat to employees working in the building or to produce damage to building components or equipment. Determination of Kst and Pmax is essential to assess the severity of an event.

Explosibility and ignitability data can be used by a competent individual(s) as part of a risk assessment that may be conducted to determine appropriate levels of protection for the effective management of the risk of combustible dust fires and explosions.

In some cases, modification of the equipment and improved housekeeping practices can serve to reduce the risk of a fire, flash fire or deflagration by reducing either the likelihood or severity factors. Control of ignition sources, through selection of electrical equipment suitable for hazardous areas, implementation of a preventive maintenance program, and establishment of hot work policies, etc. can be very effective in reducing the likelihood factor. Equipment containing powders or dusts that could be suspended and where credible ignition sources can exist, need to be protected against the consequences of an explosion.

How We Can Help

We have state-of-the-art laboratory testing capabilities and can perform all of the important testing to determine the Ignitability and Explosion severity properties of combustible dust/powders. Testing is in accordance with universally recognized ASTM standard test methods. In addition, we have highly experienced Senior Process Safety Specialists who have extensive experience in the arena of combustible dusts and have conducted DHAs in industrial facilities in the US and throughout the world. We are available to provide testing quotations and experience in addition to proposals to conduct DHAs in industrial settings where solid combustible particulate is present.

References

- NFPA 652 (2016) "Standard on the Fundamentals of Combustible Dust", The National Fire Protection Association, One Batterymarch Park, Quincy, MA 02169-7471
- ASTM E1226, Standard Test Method for Explosibility of Dust Clouds, 2012a.
- ASTM E1515, Standard Test Method for Minimum Explosible Concentration of Combustible Dusts.
- ASTM E2019 Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air.
- ASTM E2021 Standard Test Method for Hot-Surface Ignition Temperature of Dust Layers.
- ASTM E1491 Standard Test Method for Minimum Autoignition Temperature of Dust Clouds.

Would you like to get more information?

Contact Us

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Steven J. Luzik, PE, CFEI is a Senior Process Safety Specialist with over 30 years experience in the area of fire and explosion hazards including gas/vapor explosions, dust explosions and fire and explosion protection strategies. He graduated from the University of Notre Dame with a BS degree in Chemical Engineering. He is a registered Professional Engineer in the State of Pennsylvania and a Certified Fire and Explosion Investigator (CFEI) with the National Association of Fire Investigators (NAFI). As a former Mine Safety and Health Administration [MSHA] manager and technical specialist, he has investigated a multitude of incidents involving flammable vapors, gases and dusts that have included surface and underground mining facilities and industrial facilities where fires and explosions have occurred. He has conducted dust explosion hazard assessment at several coal-fired power plants.

He also has served as a moderator of a flammability and dust explosibility laboratory, processing requests from MSHA and other Federal agencies for testing to determine the flammability and explosibility properties of solids, liquids, dusts and vapors. In this capacity, he has been called upon to provide expert testimony on the explosibility hazards associated with the manufacturing, processing and handling of these materials. He is a member of the American Society for testing and Materials (ASTM) E-27 Committee on Hazardous Properties of Chemicals, the National Association of Fire Investigators (NAFI) and the National fire Protection Association (NFPA). He has authored numerous publications in the areas of fire and explosion prevention, protection and investigation.

DEKRA Process Safety

The breadth and depth of expertise in process safety makes us globally recognized specialists and trusted advisors. We help our clients to understand and evaluate their risks, and work together to develop pragmatic solutions. Our value-adding and practical approach integrates specialist process safety management, engineering and testing. We seek to educate and grow client competence to provide sustainable performance improvement. Partnering with our clients we combine technical expertise with a passion for life preservation, harm reduction and asset protection. As a part of the world's leading expert organization DEKRA, we are the global partner for a safe world.

Process Safety Management (PSM) Programs

> Design and creation of relevant PSM programs
> Support the implementation, monitoring, and sustainability of PSM programs
> Audit existing PSM programs, comparing with best practices around the world
> Correct and improve deficient programs

Process Safety Information/Data (Laboratory Testing)

> Flammability/combustibility properties of dusts, gases, vapors, mists, and hybrid atmospheres
> Chemical reaction hazards and chemical process optimization (reaction and adiabatic calorimetry RC1, ARC, VSP, Dewar)
> Thermal instability (DSC, DTA, and powder specific tests)
> Energetic materials, explosives, propellants, pyrotechnics to DOT, UN, etc. protocols
> Regulatory testing: REACH, UN, CLP, ADR, OSHA, DOT
> Electrostatic testing for powders, liquids, process equipment, liners, shoes, FIBCs

Specialist Consulting (Technical/Engineering)

> Dust, gas, and vapor flash fire and explosion hazards
> Electrostatic hazards, problems, and applications
> Reactive chemical, self-heating, and thermal instability hazards
> Hazardous area classification
> Mechanical equipment ignition risk assessment
> Transport & classification of dangerous goods

We have offices throughout North America, Europe, and Asia.
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