The Importance of Traceable Fire & Explosion Data for Dust, Gas & Vapor

Sigma-HSE

Introduction

The process industry manufactures many types of unique products using a wide range of processing equipment.

The storage, processing, handling, and packaging of materials create potentially hazardous conditions in the workplace with a risk of fire and explosion.

To mitigate the risk of fire and explosion, industry is required under different Health & Safety legislation, for example, DSEAR/ATEX/NFPA in the UK/EU/USA and in some cases with the added compliance requirement of COMAH/Seveso to undertake adequate risk assessment and identify hazardous areas.

To perform risk assessments adequately a Safety Data Sheet (SDS) is used to understand the physical properties of the material being processed.

Subject to the Basis of Safety, an SDS may not provide all necessary data needed and relying on this data alone could result in expensive over-engineering of the levels of protection within a site.

Typical equipment used in process manufacturing conditions are:

- Grinders and Mills
- Dust Collectors
- Mixers/Blenders
- Hoppers and Silos
- FIBC Handling (charging & discharging)
- Dust/Vapor Hybrid Atmospheres
- Pneumatic Conveyors
- Dryers/Granulators
- Tabletting Machines
- Sachet Filling
- Rip & Tip Operations
- Centrifuges
- Storage Tanks
- Processing Vessels and Mixers
- Vapor Extraction Systems
- Pipelines and Pipework
- Decanting Operations

Laboratory Testing & the Basis of Safety

Sigma-HSE has made process safety testing as compact and comprehensive as possible by breaking it down into three main Basis of Safety approaches.

1. Avoidance of Ignition Sources

This approach looks at testing of materials to determine how sensitive they are to specific ignition sources such as electrostatic discharges, mechanical sparks and hot surfaces. This Basis of Safety is often used when charging vessels from sacks, IBC's or FIBC's, pneumatic conveying and tabletting operations.

Many materials that can create a flammable atmosphere are found to be insensitive to ignition and therefore, it is easy, practical and cost effective to ensure that an ignition source capable of initiating a reaction is not present.

A sub-group of avoidance of ignition sources are the electrostatic properties of products and materials being used to ensure process conditions are met. This may vary from the electrostatic properties of the materials being processed, electrostatic properties of containers/transfer mediums and even Personal Protection Equipment (PPE).

2. Explosion Prevention and Protection

Explosion prevention & protection accepts that an ignition is possible. If potential ignition sources cannot be controlled, then explosion prevention, either ensures that airborne levels of material are kept to a level below the lower explosive limit (if a flammable atmosphere is not present) or reduces oxygen concentration, by using inert gas blanketing to a level where combustion will not occur.

For explosion protection, test data determines whether containment, venting or suppression systems can be applied safely.

3. Thermal Decomposition

If materials are used at elevated temperature, such as those experienced in drying operations, then it needs to be determined whether they can undergo an exothermic or self-heating reaction close to the dryer operating temperature.

As an example, in API manufacturing operations, solvent evaporation is the main application for the need to increase the temperature. As these operations are performed at low temperature circa 60°C, thermal stability is not an issue.

However, for the manufacture of an incipient or bulk intermediate, higher temperatures may be encountered and therefore data on self-heating is required.

Based on the 3 above groups we have created the following tailored testing packages to address each area within the industry:

Avoidance of Ignition Sources | Explosion Prevention & Protection | Thermal Stability

Avoidance of Ignition Sources

MIT Test

MIT and LIT data is used for the determination of the maximum permitted surface temperature of electrical and non electrical equipment.

This test data is used where explosion prevention or protection cannot be applied such as charging/discharging of vessels, some conveying systems, milling/ sieving operations or tabletting.

Minimum Ignition Energy (MIE) (with & without inductance) – Standard: BS EN ISO/IEC 80079-20-2: 2016, ASTM 2019-03

The Minimum Ignition Energy test is conducted to determine the lowest spark energy that will ignite a powder when dispersed in air, as a dust cloud. Looking at electrostatic and mechanical spark discharges as potential ignition sources.

Minimum Ignition Temperature (MIT) – Standards: BS EN 50281-2-1 & BS EN ISO/IEC 80079-20-2: 2016, ASTM 1491-06

The Minimum Ignition Temperature test is conducted to determine the lowest temperature at which a hot surface will ignite a powder when dispersed in air, as a dust cloud.

Layer Ignition Temperature (LIT) – Standards: BS EN 50281-2-1 & BS EN ISO/IEC 80079-20-2: 2016, ASTM 2021-15

The Layer Ignition Temperature test is conducted to determine the lowest temperature at which a hot surface will ignite a powder when settled as a dust layer.

Avoidance of Ignition Sources | Explosion Prevention & Protection | Thermal Stability

Avoidance of Ignition Sources Continued

Electrostatic Testing

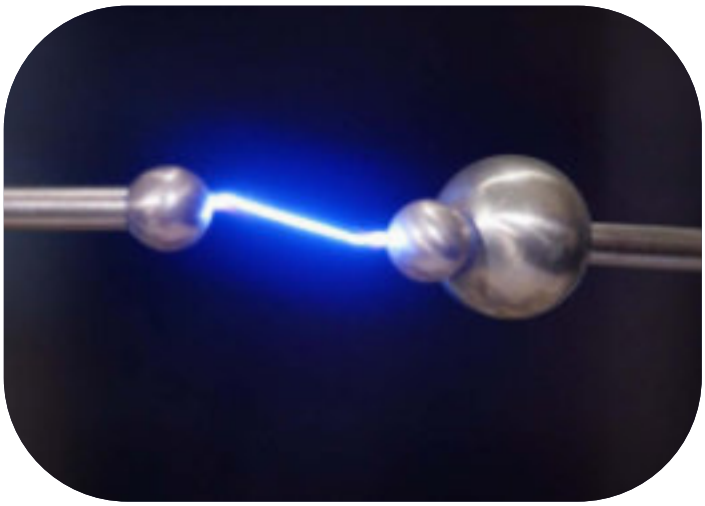
Charge Relaxation Time – Standard: BS 7506: 1996

This test is performed at a controlled relative humidity condition, of 25% and compliments the Powder Volume Resistivity measurement, as it indicates how long a material can retain its electrostatic charge and helps in giving clearer resolution of electrostatic classification, where resistivity testing gives a borderline result. This test can really show which side of the “dissipative fence” the material lays.

Powder Volume Resistivity – Standard: BS EN ISO / IEC 80079-20- 2: 2016, ASTM D257

This test is performed at a controlled relative humidity condition, of 25%. The volume resistivity of a powder dictates how efficiently charges migrate through a material by electrical conduction. The higher the volume resistivity value, the more resistive the powder is. High resistivity powders will accumulate and retain charge presented to it in all situations.

Low and most mid-range resistivity materials (conductive and static dissipative) will dissipate charge, providing it has a good path to earth. This can be achieved by handling these powders in a well earthed environment (earthed conductive or static dissipative containers, silos, hoppers, and plant equipment).



Avoidance of Ignition Sources | **Explosion Prevention & Protection** | Thermal Stability

Explosion Prevention & Protection

20- Litre Sphere

Minimum Explosive Concentration (MEC), Standard: BS EN 14034-1 2006+A1 2011, ASTM E1515-14

The Minimum Explosive Concentration test is conducted to determine the minimum quantity of powder dispersed in air, as a dust cloud that will form an explosive atmosphere. Thus, keeping below this concentration can prevent an explosive atmosphere forming.

Explosion Severity (Pmax & Kst) (20L), Standards: BS EN 14034 1&2 2006+A1 2011, ASTM E1226-19

The explosion severity test is conducted to determine maximum pressure (Pmax), Maximum rate of pressure rise ((dP/dt)max) and Kst of an ignited powder, dispersed in air, as a dust cloud and used to calculate a materials “Dust Constant” or Kst (K for constant and “St” short of Staub – German for dust)

Limiting Oxygen Concentration (LOC), Standard: BS EN 14034- 2006+A1 2004, ASTM E2931

The Limiting Oxygen Concentration test is conducted to determine the minimum quantity of oxygen, within an atmosphere, that will enable a powder dispersed in air, as a dust cloud to ignite. Keeping below this determined oxygen level will prevent an explosion occurring.

This test is performed using nitrogen as the inert gas, but other gases can be used if nitrogen is not the inerting gas of choice.

Thermal Stability Testing

To determine whether safe drying conditions apply, it is necessary to select the correct test and understand how to apply the data. Instead of using 'basic' screening methods such as the Grewer Oven, the following three tests consider the operational conditions that apply to specific drying operations.

Air Over Layer Test

A thin layer of powder, normally to a depth of 15mm is exposed to flowing heated air. Temperature of the surrounding air flow and 3 measurements in the sample are then measured and recorded. It replicates thin layer deposits in any drying situation i.e. drier walls and roof where hot air rushes over its surface

A 30°C factor of safety is applied to the results.

Bulk Powder Test

This test is used to define safe processing conditions where bulk powder is present with limited air availability.

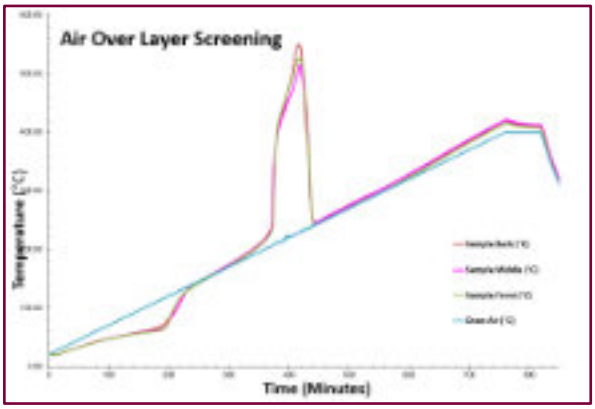
Typical applications for this test would be the base of large spray dryers, fluid bed dryers where the flow through air has stopped or the storage of big bags.

A 50°C factor of safety is applied to the results.

Aerated Cell Test

This test uses the above bulk powder test cell, but a lid is attached with a sintered glass base. Pre-heated air is then pushed through the sample.

This will mimic conditions where there is a bulk of powder with a large amount of air availability such as a fluid bed dryer or a rotating dryer.



Air Over Layer Trace Graph

Benefits of Sigma-HSE's Solutions

The solutions offered by our experienced team at Sigma-HSE, are much more than a standalone test result.

• Combined testing and consulting experience to ensure that our accurate and methodically generated test data is applied to your process safety applications correctly to protect your staff, site and your brand reputation.

• Free technical advice to ensure the correct test package is selected for your needs.

• Complementary post-project support, to ensure you are happy with the data and understand the implications for you project.

Sigma-HSE's testing laboratory has state of the art equipment and is operated by senior laboratory staff with decades of testing knowledge.

Our ISO 17025 Accredited quality systems ensure that all results are accurate with traceable test data. Internationally recognised standards are followed such as those adopted by the EU (BS & EN standards) and also ASTM standards as adopted within the USA.

>>> Data alone is only one part of a process safety plan, it must be used with both caution and expertise for it to be effective.

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