Dust Ignition Testing Explained

The **Classification** test determines whether the dust is classed as Group A (explosible) or Group B (non-explosible).

The **Layer Ignition test** determines the lowest temperature at which a layer of dust of specific thickness (usually 5mm) ignites on a heated surface, such as a motor or light fitting. The test apparatus and method follow the European Standard EN 50281-2-1:1999 or American Standard ASTM E2021 - 06

The **Minimum Ignition Temperature** is the lowest temperature of a hot surface which will cause a dust cloud to ignite and propagate flame. The value is particularly relevant to problems involving localised hot spots in buildings, such as light fittings or motor surfaces. The test apparatus and method follow the European Standard EN 50281-2-1:1999 or American Standard ASTM E1491 - 06

The **Minimum Explosible Concentration** determines the lowest concentration of a dust that will allow combustion. It may be used as an explosion prevention method in areas where the concentration of the dust can be reliably controlled. The test follows the European Standard EN14034-3 or American Standard ASTM E1515 - 07

The **Minimum Ignition Energy** test measures the ease of ignition of a dust cloud by electrical and electrostatic discharges. The test follows the European Standard EN 13821:2002 or American Standard ASTM E2019 - 03

The **Limiting Oxygen Concentration** test is the minimum concentration of oxygen present in the atmosphere, into which a dust cloud is dispersed, that will sustain flame propagation if ignition occurs. The test is required if inerting is used as a method of explosion prevention and follows the European Standard EN 14034-4:2004.

The **Explosion Indices** test measures the maximum explosion pressure and rate of pressure rise. The Kst value is then calculated which is used to correctly design explosion protection systems. The tests follow EN 14034-1:2004 and EN14034-2:2006 or American Standard ASTM E1226 - 05
**Burning number** (BZ) characterizes whether, and to what extent, a fire started by external ignition can spread to deposited dust. The test follows VDI2263 part 1, test methods for the determination of safety characteristics of dusts 1990.

The **air-over layer** test is designed to simulate conditions in dryers in which hot air circulates above a layer of the material being dried or settled deposits on internal surfaces. The test is described in Abbott, J A, Prevention of Fires and Explosions in Dryers.

The **aerated cell** test simulates conditions in dryers and associated equipment where a hot air stream passes through material. The test may be carried out in a ramped oven for screening purposes or at constant temperature to determine the onset of exotherm. The test is described in details in Abbott, J A, Prevention of Fires and Explosions in Dryers.

The **bulk resistivity and charge decay** are used to determine the conductivity of a dust sample and the time it takes for charge present on the sample to decay. These values are used to assess the potential risk posed by the material from generating/holding static discharges during bulk processing operations. Bulk resistivity tests follow BS 7506 part 1.

The **isothermal bulk powder** test is carried out in the same test cell as the above, but without airflow. It may be carried out in a ramped oven for screening purposes or at constant temperature to determine the onset of exotherm. The test is described in details in Abbott, J A, Prevention of Fires and Explosions in Dryers.

The **Isothermal Basket Test** to EN15188 determines the critical ignition temperature of materials that undergo self-heating. Thermal ignition theory is then used to enable the behaviour of the material to be predicted under specific practical conditions of storage and plant operation.

The test report includes an assessment of the material under the Health & Safety Commission classification and packaging of dangerous goods for carriage.

**Tests required for DSEAR compliance**

Assuming no previous knowledge of the material, the following tests should be undertaken to assess the explosion and ignition potential.

1. Identify whether the material is an explosion hazard through a classification test.

2. Verification of explosion protection through the explosion indices (Kst & Pmax).

The design of any explosion vent or explosion suppression system fitted to the equipment handling biomass should be verified through the explosion indices test (Kst & Pmax).

3. Verification of inert atmosphere through the limiting oxygen concentration test.

This test must be carried out for any plant using inerting (oxygen depletion) as the basis of safety. The test follows BS EN 14034-4 and may be carried out in Carbon Dioxide, Nitrogen or steam to better simulate conditions on plant.

4. Verification of explosion containment through the explosion indices (Kst & Pmax).
This test must be carried out for plant using explosion containment as the basis of safety. It is also essential to consider the effect of explosion propagation in the plant as much higher explosion pressures may be generated by pressure piling. High speed isolation valves, physical or chemical barriers may be need to alleviate pressure piling effects

(5) Selection of appropriate temperature class for equipment through the layer ignition test.

Any equipment intended for use in an explosive atmosphere must not be a potential source of ignition and comply with the Equipment and Protective Systems Regulations (EPS) 1996. Under BS EN 61241-11 Electrical apparatus for use in the presence of combustible dust, the layer ignition test, normally undertaken on a 5mm layer, is required to determine the maximum permissible surface temperature (temperature class T6, T5 etc) for electrical equipment that may be covered in dust. The specification for electrical equipment will include a safety margin, usually taken to be 75°C.

(6) Determining the safe operating temperature for dryers and other equipment operating at elevated temperature – minimum ignition temperature test and air-over layer test required.

Under BS EN 61241-11, Electrical apparatus for use in the presence of combustible dust, the maximum surface temperature of any apparatus exposed to a dust cloud should not exceed two-thirds of the minimum ignition temperature measured in degrees Centigrade.

If material may build up on internal surfaces within a drier (ledges etc), then an air-over layer test will determine the minimum temperature from which combustion may develop. A safety margin of 20°C is usually applied to minimise the risk of decomposition in the drier.

(7) Minimum explosible concentration test to determine hazardous area zoning.

Where the hazardous area zoning of a plant is in doubt, the minimum explosible concentration test may be undertaken to provide clarification.

(8) Minimum ignition energy test

The minimum ignition energy test will establish whether additional precautions are necessary for the elimination of static. In particular, the need for antistatic footwear and clothing for plant personnel and the use of epitropic (earth weave) filter media.

(9) Self-heating – screening for self-heating and/or an isothermal basket test is required for any materials that may have exothermic properties.

An isothermal basket test under EN 15188 Determination of the spontaneous ignition behaviour of dust accumulations will measure the critical ignition temperature for a series of different size baskets containing the test sample. From this data, the appropriate Frank-Kamenetskii parameter (δc) can be calculated and then thermal ignition theory applied to scale-up the results to full size plant. This will predict the onset of spontaneous combustion in any particular storage arrangement – storage temperature and geometry - and help set safe storage limits for the material in question.
Other dust hazard services

- DSEAR risk assessment
- Hazardous area classification for ATEX/DSEAR compliance
- Incident investigation
- In-house training
- Advice on DSEAR legislation and European Union ATEX Directives
- Verification of in-house risk assessments/area classifications