MINIMUM IGNITION ENERGY TEST (MIE)

INTRODUCTION

The processing of powders and bulk solids requires a consideration of the dust explosion risk. A part of this consideration must be the ignition characteristics of the dust, as the relative susceptibility to ignition determines the required prevention measures for a given process. Determination of the minimum ignition energy (MIE) is achieved in a MIKE3 apparatus according to ASTM E2019. This standard provides guidelines to finding the lowest electrostatic discharge spark energy at which a flame can be observed.

BACKGROUND

The MIE of a dust is defined as the lowest amount of energy at which the dust cloud will ignite. It is influenced by the following dust characteristics:

A. physical and chemical properties of the dust (particle size distribution and chemical composition);
B. concentration of dust in the dust/air mixture;
C. homogeneity and turbulence of the dust/air mixture;
D. geometry of the vessel in which the explosion is occurring;

Determination of MIE must be made over a range of dust concentrations. At a given dust concentration, varying the energy will result in energy levels above which the dust cloud will ignite and below which the cloud will not ignite. As the median particle size of a dust decreases, the minimum ignition energy of the dust decreases. The minimum ignition energy of a dust also decreases with decreasing moisture content in the dust, and with increasing initial temperature. A dust becomes increasingly more susceptible to ignition by electrostatic discharges as the MIE decreases. Therefore, more efficient preventive measures would be necessary for dusts with lower minimum ignition energies.

Typically the lowest value for the MIE occurs at an optimum dust concentration. The optimum concentration is the concentration at which the dust cloud is most easily ignitable. Conducting ignition energy tests on dust clouds with concentrations lower or higher than the optimum concentration will provide MIE's that are higher. To determine the absolute minimum ignition energy, a series of tests are conducted at a broad range of concentrations.

EXPERIMENTAL

The apparatus used to measure the minimum ignition energy consists of a cylindrical vessel using a MIKE 3 apparatus by Kuhner AG. A weighed amount of dust is placed at the bottom of the apparatus and pneumatically dispersed into the cylinder. After a predetermined time delay has elapsed, a spark is generated across two electrodes at the center of the cylinder. The energy discharged across the spark electrodes is varied until the minimum ignition energy has been determined.

For the first test, a dust concentration is chosen at which ignition of the dust cloud occurs. Ignition of the dust cloud is observable by emission of light (caused by flame), opening of the diaphragm on top of the cylinder and/or generation of sound. During subsequent tests, concentration is varied such that the optimum concentration is identified and a search for the minimum ignition energy is conducted. A sufficient number of tests are conducted until at least ten non-ignitions are observed below the

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minimum ignition energy. The minimum ignition energy is the average of the lowest energy at which ignition of the dust cloud is observed and the highest energy at which ignition is not observed.

Calculating the MIE by averaging the lowest ignition energy and highest non-ignition energy is sufficient. However, EN 13821 "Determination of Minimum Ignition Energy of Dust / Air Mixtures" contains an equation for calculating the MIE based on ignition probability. The equation for the calculation of E_S is shown below.

$$E_s = 10^{\log E_2 - \frac{I[E_2] \times (\log E_2 - \log E_1)}{(NI+I) \times [E_2] + 1}}$$

Where:
E_2 is the lowest energy where an ignition was observed
E_1 is the highest energy where no ignition was observed for same dust concentration
$I[E_2]$ is the number of dust concentrations at E_2 where ignitions were observed
$(NI+1)[E_2]$ is the total number of concentrations tested at E_2

The following procedure is used to conduct a test:

A. Customer and sample information is input into the software.
B. A weighed amount of sample is placed in the dispersion bowl.
C. The apparatus door is shut and locked.
D. Testing software is initiated.
E. Observations are used to determine if the sample did ignite and that determination is input into the software.
F. Apparatus is opened and cleaned.

Tests conducted with similar apparatus indicate; dusts with MIE's of less than 25mJ are very easily ignitable, dusts with MIE's between 25mJ and 100mJ are easily ignitable, dusts with MIE's between 100mJ to 1000mJ are normally ignitable dusts and dusts with MIE's greater than 1000mJ are hard to ignite dusts.

The MIKE3 apparatus provides the option of testing a sample with or without inductance. Testing with inductance provides a longer duration of the discharge spark, more closely resembling discharges from circuitry or other control equipment. Testing without inductance provides a shorter duration of the discharge spark with better simulates a pure static electricity spark. After a hazard analysis or a self-review of the process, it can be determined what method best suits the application. A test without inductance should be performed if a concern for static electricity only is determined. A test with inductance should be performed if there is a possibility of any other ignition sources (other than pure static electricity) or if the information provided from the test is to be published on a Safety Data Sheet for the product. Testing with inductance is the more conservative approach and should be chosen if unsure which method to choose.

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MIKE 3 Apparatus

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