International Standard 6184/1

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Explosion protection systems — Part 1 : Determination of explosion indices of combustible dusts in air

Systèmes de protection contre les explosions — Partie 1 : Détermination des indices d'explosion des poussières combustibles dans l'air

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Explosion protection systems — Part 1 : Determination of explosion indices of combustible dusts in air

0 Introduction

0.1 The assessment of measures required to provide protection against explosion hazards involving combustible dust/air mixtures requires prior determination of the potential explosion severity of such mixtures, by the measurement of explosion indices. Conversely, the measurement of the effectiveness and performance of explosion protection systems requires that they should be tested against explosions of known severity.

The severity of a dust explosion is a function of the following:

a) the physical and chemical properties of the dust;

b) the concentration of dust in the dust/air mixture;

c) the homogeneity and turbulence of the dust/air mixture;

d) the type, energy, and location of the ignition source;

e) the geometry of the container;

f) the temperature, pressure and humidity of the explosive dust/air mixture.

0.2 This part of ISO 6184 is one of a series dealing with explosion protection systems. The other parts are as follows:

Part 2: Determination of explosion indices of combustible gases in air.

Part 3: Determination of explosion indices of fuel/air mixtures other than dust/air and gas/air mixtures.

Part 4: Determination of efficacy of explosion suppression systems.

0.3 The interpretation of explosion indices determined by the method specified in this part of ISO 6184 and their relation to the development of explosions in commonly encountered explosion hazards should be recognized. In particular, the degree of turbulence can influence the hazard significantly. In practice, the link between a given degree of turbulence and a specific type of hazard is the responsibility of specialists in the fields of explosions and explosion protection.

Two extremes of turbulence commonly encountered in industrial plants are:

a) low turbulence conditions prevailing in a gravity-fed silo;

b) high turbulence conditions prevailing in a grinder or micronizer.

It should be realized that turbulence can arise in two ways:

a) turbulence intrinsic to the plant, under normal operating conditions, as a consequence of perturbations to the air-flow;

b) turbulence induced by obstructions within an installation on a gas which expands as the result of an explosion.

1 Scope

This part of ISO 6184 specifies a method for the determination of the explosion indices of combustible dusts suspended in air in an enclosed space. It gives the criteria by which results obtained using other test procedures can be correlated to yield explosion indices as determined by the method specified in this part of ISO 6184.

2 Field of application

This part of ISO 6184 is applicable only to the determination of explosion indices pertaining to the development of contained dust/air explosions after ignition of the reactants. It does not apply to indices pertaining to the conditions necessary to cause ignition of the reactants. If the specified experimental procedure for the determination of explosion indices does not result in ignition of the dust/air mixture, it should not be concluded that the dust in question cannot explode. The interpretation of such cases should be left to specialists in the field of explosions and explosion protection.

4 Test method

4.1 General

The apparatus described in this part of ISO 6184 has been chosen as the reference apparatus and is suitable for the evaluation of explosion indices of combustible dusts which have a particle size not exceeding 63 µm and a moisture content not exceeding 10 % (m/m).

NOTES

1 In practice, dust with larger particle sizes and/or higher moisture contents can be characterized in this standard apparatus, provided that such dust can be dispersed effectively in the explosion chamber.

2 The sample tested should be representative of the material in use in respect to particle size distribution and moisture content.

4.2 Apparatus

The apparatus consists essentially of a cylindrical explosion chamber with a volume of 1 m^3 and an aspect ratio nominally of 1 : 1, as shown in figure 2.

A container of approximately 5 l capacity is attached to the explosion chamber and is capable of being pressurized with air to 20 bar. This container is fitted with a 19 mm (3/4 in) quick-opening valve which allows injection of the contents of the container within 10 ms of opening the valve. The container is connected to the explosion chamber by means of a 19 mm (3/4 in) internal diameter tube which is formed into a perforated (4 to 6 mm hole diameter) semicircular spray pipe. The number of holes in the pipe shall be chosen such that their total cross-sectional area is approximately 300 mm^2.

The ignition source comprises two pyrotechnic igniters with a total energy of 10 kJ and arranged to ignite after a fixed ignition delay, corresponding to a turbulence index, t_v, of 0,6 s. The total mass of the ignition source is 2,4 g, and consists of 40 % zirconium metal, 30 % barium nitrate, and 30 % barium peroxide. It is ignited by an electric fuse head. The igniter is located at the geometric centre of the explosion chamber. A pressure transducer is fitted to measure explosion chamber pressure, this being linked to a recorder.

4.3 Procedure

Place the dust sample, the mass of which shall be that required to obtain the appropriate concentration, in the 5 l container and pressurize it with air to 20 bar. Ensure that the explosion chamber is at atmospheric pressure. Start the pressure recorder and then activate the sample container valve followed by the igniter. After each test, clean the explosion chamber by purging with air.

Repeat this procedure for a wide range of dust concentrations to obtain curves of p_m, in bars, and K, in bar metres per

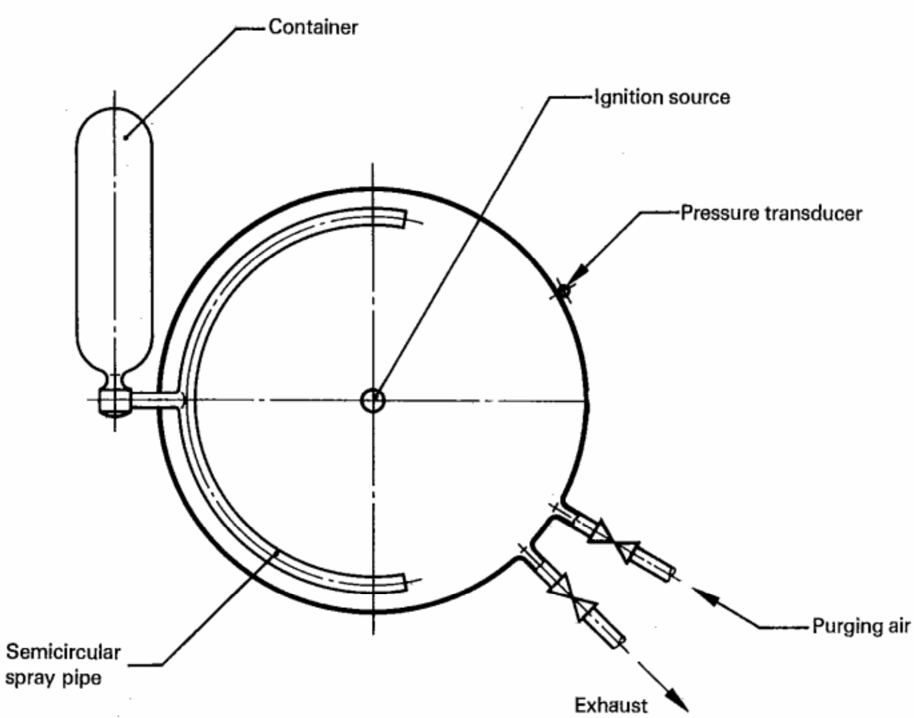

Figure 2

second, versus dust concentration, in kilograms per cubic metre, to determine p_{max} and K_{max} respectively (see figure 3).

NOTE — The explosion pressures attain their maximum values if ignition occurs as soon as all of the dust is effectively dispersed in the explosion chamber. For this apparatus, this is achieved with an ignition delay (t_v) of 0,6 s. The ignition delay (t_v) corresponds to a specific level of turbulence determined by the turbulence index (T_u) and hence has an influence on the measured value of K_{max}. Since some turbulence always exists in a dust/air suspension, T_u is necessarily greater than 1. The effect of increasing t_v is to lower the K_{max} value and vice-versa. (See figure 4.)

4.4 Alternative test methods

The explosion indices of combustible dust/air mixtures can be determined using alternative test equipment and/or test procedures providing that it has been proven that such methodology gives results directly, or by calculation, that are commensurate (±20 %) with the results obtained using the 1 m^3 apparatus for at least 5 dusts from each of the following explosibility ranges:

K_{max} < 200 bar·m/s

K_{max} < 300 bar·m/s

K_{max} > 300 bar·m/s

NOTE — In cases where the test apparatus is not to be used to determine the explosion indices of dusts in certain explosibility ranges, it is possible to reduce the number of dusts tested in these ranges.

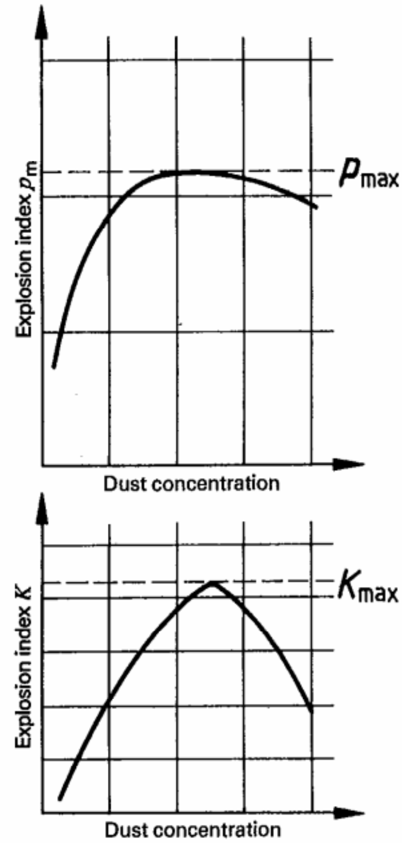

Figure 3

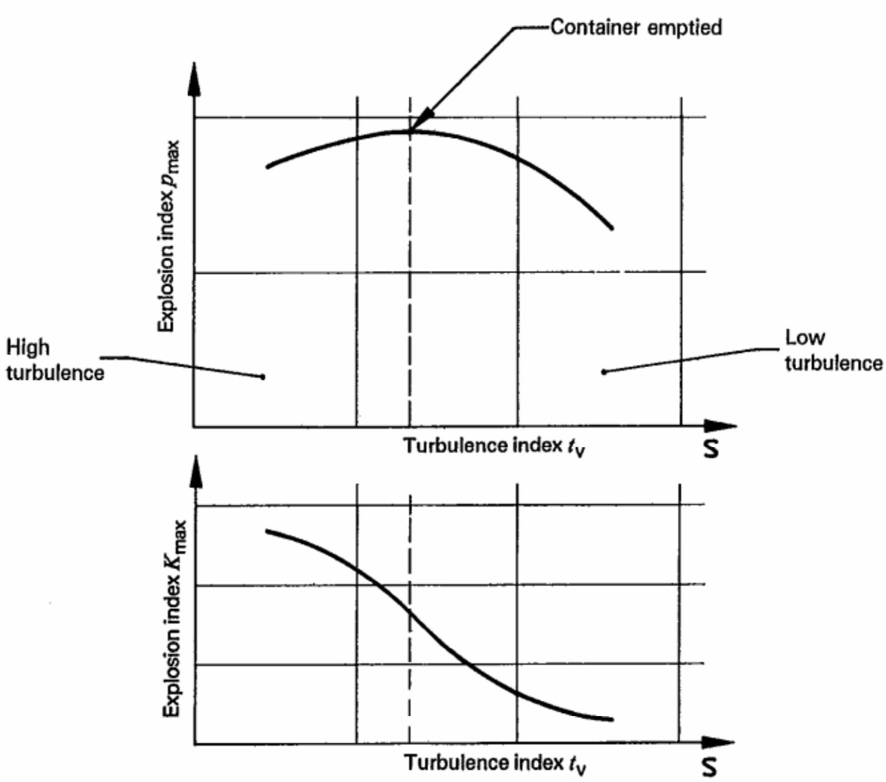

Figure 4

5 Interpretation of test results

The test methods described in clause 4 allow the explosion indices p_{max} and K_{max} of turbulent dust/air mixtures to be determined. It can be stated that, in general, the accuracy of a p_{max} determination is ±4 %. The accuracy of a K_{max} determination is dependent upon the conditions of turbulence of the mixture at the time of ignition (see figure 5).

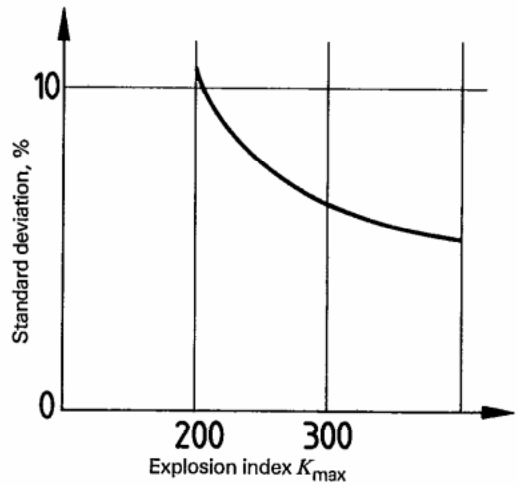

Figure 5

6 Test report

The test report shall include the following information:

a) nature of the dust;

b) particle size distribution, in micrometres;

c) moisture content, as a percentage by mass;

d) explosion index p_{max}, in bars;

e) explosion index K_{max}, in bar metres per second;

f) dust concentration corresponding to p_{max} and K_{max} measurements;

g) any deviations from the test procedure specified in clause 4; such deviations are permissible, provided they are reported exactly;

h) date of test;

j) ambient temperature at the start of the test.