International Standard 6184/4

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Explosion protection systems — Part 4: Determination of efficacy of explosion suppression systems

Systèmes de protection contre les explosions — Partie 4: Détermination de l'efficacité des systèmes de suppression des explosions

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 6184/4 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Explosion protection systems — Part 4: Determination of efficacy of explosion suppression systems

0 Introduction

0.1 Explosion suppression is a technique by which a developing explosion in a confined, or essentially confined, volume is detected and arrested during its incipient stage, thus limiting pressure development to a safe or predetermined value and preventing or minimizing damage.

The performance of an explosion suppression system is a function of the following:

a) the nature and explosibility of the combustible material;

b) the environmental conditions of temperature, pressure, turbulence, product flow, etc.;

c) the size and geometry of the container;

d) the effectiveness of the explosion suppressant;

e) the performance characteristics of the explosion suppression hardware;

f) the deployment and choice of hardware for the system.

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

Part 1: Determination of explosion indices of combustible dusts in air.

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.

0.3 It should be recognized that the results obtained from the use of the methods specified in the other parts of ISO 6184, either by measurement, interpolation or extrapolation, refer to defined test conditions representing a generalization of typical operational conditions.

The validation of the application of an explosion suppression system for a particular hazard may require further test work and/or theoretical evaluation. Such interpretation and application shall be undertaken by those who are experienced in this field of explosion protection.

The design of explosion suppression systems for hazards which have explosion parameters significantly different from those realised in the standard test procedures should be left to specialists in this field of explosion protection. Examples of such hazards are those characterized by one or more of the following parameters:

a) vessel aspect ratio greater than 2 : 1;

b) partially vented vessels;

c) container fitted with fixed or mobile apparatus which could impede the distribution of suppressant;

d) operating pressures and temperatures substantially higher or lower than normal atmospheric conditions;

e) high levels of turbulence and/or product throughput;

f) vessel volumes substantially greater or lower than those used in the efficacy test.

1 Scope

This part of ISO 6184 specifies a method for evaluating the effectiveness of explosion suppression systems against defined explosions in an enclosed volume. It gives the criteria for alternative test apparatus used to undertake explosion suppression efficacy tests and criteria to be applied in defining the safe operating regime of an explosion suppression system.

2 Field of application

This part of ISO 6184 is applicable only to explosion suppression systems intended for the protection of closed, or essentially closed, vessels in which an explosion may result as a consequence of ignition of an explosive mixture. It does not apply to:

a) systems which render explosive and pyrotechnic materials insensitive to ignition, explosion and/or detonation;

b) systems or devices designed to protect against overpressure of vessels containing steam, compressed gases, liquified gases or unstable reactants;

c) systems or devices designed to protect against exothermic dissociation or polymerization reactions;

d) explosion suppression systems for use in ducts or mine galleries;

e) systems or devices designed specifically for the purpose of prevention of ignition of explosive mixtures.

The deployment of fire protection measures, which are outside the scope of this part of ISO 6184, may be necessary after the suppression of the explosion to prevent reignition in the part of the plant concerned.

3 Definitions

For the purpose of this International Standard, the definitions given in parts 1, 2 and 3 of ISO 6184 and the following definitions apply.

3.1 suppressor: Appliance containing an explosion suppressant which can be expelled by the action of internal pressure. This pressure may be stored pressure, or may be obtained by a chemical reaction such as the activation of an explosive or pyrotechnic device.

3.2 suppressant: Substance contained in the suppressor which, when dispersed into a container, can arrest a developing explosion in that container. Three categories of suppressants are in general use, separately or in combination (powder, water, halon).

3.2.1 powder suppressant: Powder with recognized flame extinguishing properties such as products based on monoammonium phosphate, potassium bicarbonate or sodium bicarbonate. Such suppressants may contain additives to improve their flow properties and their effectiveness.

3.2.2 water suppressant: Water used as an explosion suppressant. Additives may be included to provide frost protection, and/or to improve the suppressant dispersion properties.

3.2.3 halon suppressant: Halogenated hydrocarbon with recognized flame extinguishing properties such as:

a) bromochloromethane — halon 1011;

b) bromochlorodifluoromethane — halon 1211;

c) bromotrifluoromethane — halon 1301;

d) dibromotetrafluorethane — halon 2402.

3.3 propelling agent pressure: Pressure of stored gas (typically nitrogen) in a stored pressure-type suppressor measured in bar[1].

3.4 suppressant charge: Mass or volume of the suppressant contained within the suppressor measured in kilograms or litres.

3.5 explosion sensor: Device which is responsive to the changes caused by a developing explosion, in one or more of the environmental parameters such as pressure, temperature and/or radiation.

3.6 explosion detector: Device or arrangement of apparatus, containing one or more explosion sensors, that responds to a developing explosion by providing an explosion suppressor actuation signal.

3.7 detection pressure p_A: That pressure threshold, above the pressure at ignition of the reactants (p_i), at which a firing signal is applied to the explosion suppressors (see figure 1).

3.8 suppressed explosion pressure p_{RED}: Maximum overpressure, above the pressure at ignition of the reactants (p_i), recorded in a suppressed explosion event (see figure 2).

4 Test methods

4.1 General

In general, the apparatus described in this part of ISO 6148 is suitable for the evaluation of the efficacy of explosion suppression systems against gas and dust explosions.

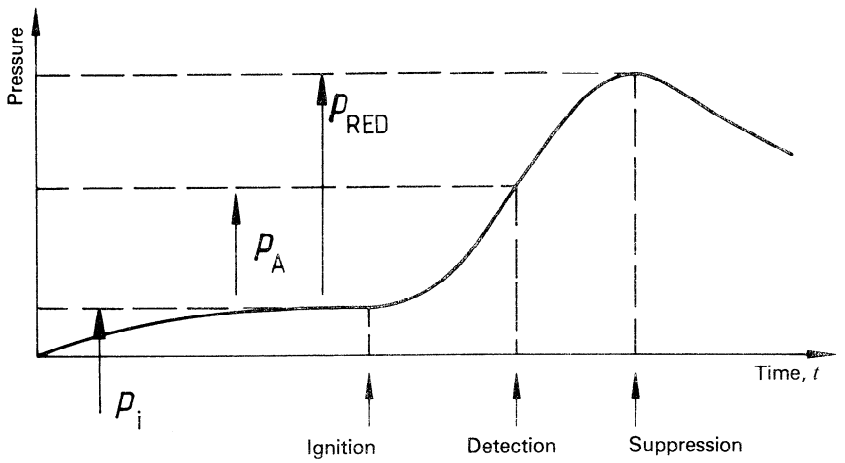

Figure 1

1) 1 bar = 10^5 Pa

4.2 Test apparatus

4.2.1 A test to establish the efficacy of an explosion suppression system shall be undertaken in a test apparatus which gives unsuppressed explosibility results commensurate with those obtained in the standard 1 m^3 apparatus for the test combustible material.

4.2.2 The 1 m^3 test apparatus described in parts 1, 2 and 3 of ISO 6184 is suitable for suppression system efficacy tests with the following reservation:

a) the test volume is only appropriate for the smaller explosion suppressors;

b) the pyrotechnic igniters (total energy 10 kJ) used to initiate dust explosions can trigger very sensitive detectors and/or can mask the effectiveness of low detection pressure systems.

4.2.3 The volume of the test apparatus shall be sufficiently large, such that one or more fully charged explosion suppressor(s) are required in order to attain a minimum design concentration of suppressant. Spherical or cylindrical vessels with a length to diameter ratio less than 2 : 1 are preferred designs.

4.3 Test procedures

4.3.1 To determine the efficacy of a particular explosion suppression system against a defined explosive material in a chosen test volume, a single test is required. The suppression system shall be installed on the test apparatus in accordance with the manufacturer's recommendations. The suppressed explosion pressure p_{RED} shall be determined from the test.

4.3.2 To determine the range of application of a particular explosion suppression system against explosion hazards in a chosen test volume, a series of evaluations shall be undertaken against gas and dust explosions of increasing severity by varying K (see figure 2).

NOTE — The detection pressure p_A and the number of suppressors are constant.

4.3.3 To determine the range of application of particular explosion suppressors fitted to a chosen test volume, the performance shall be evaluated against explosions of defined severity, using a range of detection pressures p_A (or equivalent sensor response; see figure 3).

NOTE — The explosion index K and the number of suppressors are constant.

4.3.4 To determine the range of application of multiple explosion suppressor configurations fitted to large test volumes, their performance shall be evaluated against defined explosion severities in the test volumes (see figure 4).

NOTE — The explosion index K and the detection pressure p_A are constant.

4.4 Alternative methods

Explosion suppression efficacy evaluations can be undertaken using alternative test equipment and/or test procedures provided that it has been proven that such methodology gives results commensurate with those obtained using the test procedures defined in 4.3.

5 Interpretation of test results

The determination of the suppressed explosion pressure, p_{RED}, for a suppression system determines the efficacy of that system, and the minimum design strength of industrial plant to which such a system can be applied. Tests in accordance with the procedures described in section 4.3.2 to 4.3.4 determine the range of application of an explosion suppression system. From such tests it is possible to ascertain

a) the most severe explosion that can be suppressed by the system;

b) the maximum detection pressure that can be used to suppress a defined explosion;

c) the applicability of test results to other volumes;

d) the suppression system effectiveness as correlated to the p_{RED} measurements.

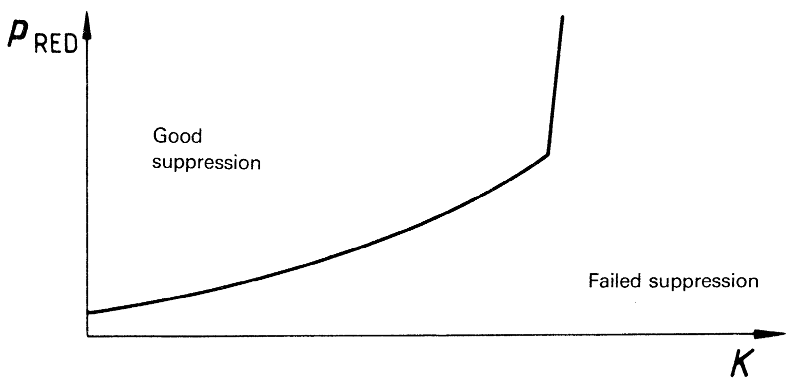

Figure 2

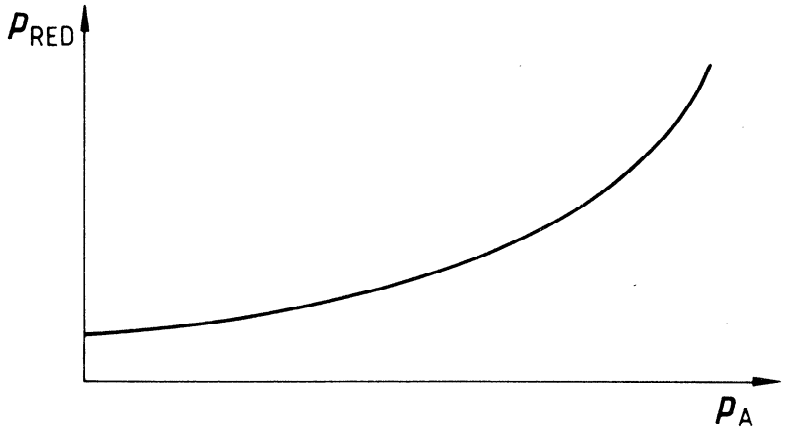

Figure 3

Figure 4

6 Test report

The test report shall include the following information;

a) dimensional sketch of the test apparatus;

b) test volume(s) used;

c) nature of the explosive fuel(s);

d) explosion indices of the fuel(s) as specified in parts 1, 2 and 3 of ISO 6184;

e) the initial pressure p_i;

f) unsuppressed explosion parameters of the fuel(s) in the test volume(s);

g) number, type, and location of explosion suppressors;

h) suppressant(s);

j) detection pressure(s) p_A (or equivalent sensor response);

k) suppressor propelling agent pressure(s);

m) suppressant charge(s) in each of the suppressors;

n) suppressed explosion pressure(s) p_{RED};

p) date of test;

q) turbulence index (ignition delay) t_v.

In addition, the report shall include all pertinent observations and information, which may not be fully described in a) to q) above. Deviations from the defined test procedure are permissible when necessary, provided that such deviations are exactly described in the test report.

Test reports shall be certified on behalf of the testing establishment, numbered and dated.

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