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Determination of the spontaneous ignition behaviour of dust accumulations

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This standard includes the English version of the European Standard.

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English Version

Determination of the spontaneous ignition behaviour of dust accumulations

Détermination de l'aptitude à l'auto-inflammation des accumulations de poussières

Bestimmung des Selbstentzündungsverhaltens von Staubschüttungen

This European Standard was approved by CEN on 18 October 2020.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 15188:2020) has been prepared by Technical Committee CEN/TC 305 “Potentially explosive atmospheres – Explosion prevention and protection”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2021, and conflicting national standards shall be withdrawn at the latest by December 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 15188:2007.

This document has been prepared under a standardization request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2014/34/EU.

For relationship with EU Directive 2014/34 EU, see informative Annex ZA, which is an integral part of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The self-ignition behaviour of dusts and granular materials and their mixtures depends on their chemical composition as well as on related substance and bulk properties. It also depends on the size and geometry of the body of material, and, last but not least on the ambient temperature.

The reason for self-heating (with possible self-ignition) is that the surface molecules of combustible dust or granular materials undergo exothermic reactions with air or other oxidising atmospheres transported into the void volume between the particles even at normal ambient temperatures. Any heat then released will cause the temperature of the reactive system to rise, thus accelerating the reaction of additional molecules with oxygen, etc. A heat balance involving the heat produced inside the bulk (quantity and surface of reactive surface molecules, specific heat producing rate) and the heat loss to the surroundings (heat conductivity and dimension of the bulk, heat transfer coefficient on the outside surface of the bulk and the size of the latter) is decisive as to whether a steady-state temperature is reached at a slightly higher temperature level (the heat loss terms are larger than the heat production term), or whether temperatures in the bulk will continue to rise up to self-ignition of the material, if heat transport away from the system is insufficient (in this case the heat production term is larger than all heat losses).

The experimental basis in this document for describing the self-ignition behaviour of a given dust or granular material is the determination of the self-ignition temperatures (T_{SI}) of differently sized bulk volumes by isoperibolic hot storage experiments (storage at constant oven temperatures) in commercially available ovens. The results thus measured reflect the dependence of self-ignition temperatures upon volume of the accumulation.

Different evaluation procedures – described in Annex A – allow interpolation and extrapolation, to characterize the self-ignition behaviour of deposits of a different scale and of different bulk geometric shapes. Primary method is the evaluation based on the thermal explosion theory according to Frank-Kamenetskii (A.2) and Thomas (A.3).

Interlaboratory tests have shown, that it is necessary to provide prescribed test conditions, e.g. by installation of a mesh wire screen into the oven, surrounding the dust samples and the thermocouples. In this way the spread of results will be minimized. If it is possible based on suitable thermo-analytic test procedures (adiabatic, isothermal or dynamic tests) to derive a reliable formal kinetic model, which describes the heat production of the substance as a function of temperature, then the volume dependency of the self-ignition temperature may be calculated according to the methods described in Annex A.

1 Scope

This document specifies analysis and evaluation procedures for determining self-ignition temperatures (T_{SI}) of combustible dusts or granular materials as a function of volume by hot storage experiments in ovens of constant temperature. The specified test method is applicable to any solid material for which the thermal explosion theory according to A.2 holds (i.e. not limited to only oxidatively unstable materials).

The specified test is applicable to any dust or granular material that reacts primarily with oxygen from the air. For safety reasons, this test is not used with materials mixed with solid/liquid oxidant (e.g. gunpowder, thermites, wood impregnated with liquid oxygen) or materials that could undergo violent non-oxidative reactions (e.g. peroxides, explosives). On a case by case basis, some types of materials undergoing non-oxidative reactions (e.g. non-violent exothermic decomposition reactions) may be however tested provided that additional safety precautions are taken. Where any doubt exists about the existence of hazard due to the properties of the test material (e.g. toxic or explosive), expert advice is sought.

This document is not applicable to the ignition of dust layers or bulk solids under aerated conditions (e.g. as in fluid bed dryer).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1127-1:2019, *Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology*

EN 13237:2012, *Potentially explosive atmospheres - Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*