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Reaction to fire tests — Measurement of material properties using a fire propagation apparatus

Essais de réaction au feu — Mesurage des propriétés des matériaux au moyen d'un appareillage de propagation du feu

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 12136 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

Introduction

This International Standard contains four separate test methods[3][4][5][12], which are conducted using a fire propagation apparatus (FPA). The ignition, combustion and pyrolysis test methods involve the use of horizontal specimens subjected to a controlled, external radiant heat flux, which can be set from 0 kW/m^2 to 65 kW/m^2. The fire propagation test method involves the use of vertical specimens subjected to ignition near the base of the specimen from an external radiant heat flux and a pilot flame. The combustion, pyrolysis and fire propagation test methods can be performed using an inlet air supply that is either normal air or other gaseous mixtures, such as air with added nitrogen, 100 % nitrogen or air enriched with up to 40 % oxygen.

The ignition test method is used to determine the time required for ignition, t_{ign}, of horizontal specimens by a pilot flame as a function of the magnitude of a constant, externally applied radiant heat flux. Measurements also are made of time required until initial fuel vaporization. The surface of these specimens is coated with a thin layer of black paint to ensure complete absorption of the radiant heat flux from the infrared heating system (note that the coating does not itself undergo sustained flaming).

The combustion test method is used to determine the chemical and convective heat release rates, and smoke generation rate when the horizontal test specimen is exposed to an external radiant heat flux.

The pyrolysis test method with a flow of 100 % nitrogen and no ignition can be used to measure the mass loss rate as a function of externally applied radiant heat flux for a horizontal specimen. From these measurements, the heat of gasification of the material can be determined.

The fire propagation test method using 40 % oxygen is used to determine the chemical heat release rate of a burning, vertical specimen during upward fire propagation and burning initiated by a heat flux near the base of the specimen. Chemical heat release rate is derived from the release rates of carbon dioxide and carbon monoxide. Observations also are made of the flame height on the vertical specimen during fire propagation. As discussed in B.5 and B.6, the use of enhanced oxygen in small-scale fire tests can better simulate the flame heat flux occurring in large-scale fires[16][18][19][20][21]. Correlation has been developed between the results from small-scale tests with 40 % oxygen and the results from large-scale tests for a class of materials (see B.6).

Distinguishing features of the FPA include:

— tungsten-quartz external, isolated heaters to provide a radiant flux of up to 65 kW/m^2 to the test specimen, which remains constant whether the surface regresses or expands;

— provision for combustion or upward fire propagation in prescribed flows of normal air, air enriched with up to 40 % oxygen, air oxygen vitiated, pure nitrogen or mixtures of gaseous suppression agents with the preceding air mixtures;

— the capability of measuring heat release rates and exhaust product flows generated during upward fire propagation on a vertical test specimen 0,305 m high.

The original FPA uses a vertical exhaust duct configuration[6], which requires laboratories to have available a sufficient ceiling height to accommodate all the system components. Also, the original FPA has the gas sampling and analysis system completely separate from the main apparatus. To reduce this ceiling height constraint and to allow for a more compact arrangement, a horizontal exhaust configuration has been developed as shown in Figures 1 and 2. The FPA with horizontal duct provides equivalent results to those measured using the FPA with vertical duct, as described in Annex C.

The FPA is used to evaluate the flammability of materials and products. It is also designed to obtain the transient response of such materials and products to prescribed heat fluxes in specified inert or oxidizing environments and to obtain laboratory measurements of generation rates of fire products (CO_2, CO, and, if desired, gaseous hydrocarbons) for use in fire safety engineering.

Ignition of the specimen is by means of a pilot flame at a prescribed location with respect to the specimen surface [described in 11.1 e)].

The Fire Propagation test of vertical specimens is not suitable for materials that, on heating, melt sufficiently to form a liquid pool.

This International Standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this International Standard to establish appropriate health and safety practices and to determine the applicability of regulatory limitations prior to use. For specific hazard statements, see Clause 7.

This International Standard specifies small-scale test methods for determining the performance of materials when exposed to fire, which are based on decades of research published in the fire science literature. Parts of this International Standard are based on information contained in ASTM E2058 and NFPA 287.

The following test methods, capable of being performed separately and independently, are included:

1) Ignition test, to determine t_{ign} for a horizontal specimen;

2) Combustion test, to determine Q_{chem}, Q_c, $\dot{m}$, ΔH_{eff}, and Y_s from burning of a horizontal specimen;

3) Pyrolysis test, to determine $\dot{m}$ and ΔH_g; and,

4) Fire propagation test, to determine Q_{chem} from burning of a vertical specimen.