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Fire tests — Method of measurement of gases using Fourier transform infrared spectroscopy (FTIR) in cumulative smoke test

Essais au feu — Méthode de mesure des gaz par spectroscopie infrarouge à transformée de Fourier des essais cumulatifs de fumée

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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

ISO 21489 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

Introduction

In recent years, there has been an increased demand to specify methods of analysis of fire gases for use in toxic hazard assessment. Although scientific consideration on such toxic hazard assessment should be conducted based upon the international standards of ISO TR 9122 series and ISO TR 13387 series, a simplified and practicable gas measurement technique has been anticipated, because such toxic threat has been a great concern to the public.

International Maritime Organization (IMO) has developed international regulations applied to ships within the framework of the International Convention of Safety of Life at Sea (SOLAS Convention) by which the use, in ships, of interior finish materials/products which give off extensive heat, smoke and toxic gases/vapours in fire is prohibited. The evaluation method of characteristics of heat release, flame spread, smoke and toxicity produced from such materials/products is provided in the International Code for the Application of Fire Test Procedures (FTP Code) of IMO, which is a mandatory instrument under SOLAS. The evaluation method for smoke and toxicity uses ISO 5659-2 *Plastics - Smoke generation - Part 2: Determination of optical density by a single-chamber test* as heating and burning method for specimen and specifies additional fire effluent gas measurement requirements to be applied during the smoke tests. However, it does not specify any gas measurement method. Therefore, there is also a need to specify such gas measurement method.

ISO 5659-2 is currently under revision and changes introduced in the second edition concerning the heating methods for test specimens will also apply to ISO 21489.

WARNING -- So that suitable precautions can be taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases can be evolved during combustion of test specimens.

Fire tests — Method of measurement of gases using Fourier transform infrared spectroscopy (FTIR) in cumulative smoke test

1 Scope

This draft International Standard specifies methods of measurement of gases developed in cumulative smoke/fire tests, using Fourier transform infrared spectroscopy (FTIR) . Particular attention is given to the gas sampling systems and conditions of gas measurement.

It should be noted that there are fire effluents other than gases, such as particles, smoke or vapours which may be toxic and that some gases such as hydrogen halides may be trapped by moisture in sampling lines or by filters designed to remove only smoke particles.

Gas measurement using FTIR in cumulative smoke/fire tests is useful in providing information for qualitative and quantitative hazard analysis in a fire safety engineering approach. Gas measurement by FTIR can be carried out in a short time interval, and will give a set of time-base data of gas concentration. Measurement of gas concentration by FTIR can be carried out in a regular short intervals throughout the test.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 5659-2:1999, *Plastics — Smoke generation — Part 2: Determination of optical density by a single-chamber test*

ISO 13943 2000, *Fire safety — Vocabulary*

ISO 19702, *Toxicity testing of fire effluents — Analysis of gases and vapours in fire effluents using FTIR technology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 and ISO 19702 apply.

4 Principle

Fire effluents are sampled from a cumulative smoke chamber of a smoke test (ISO 5659-2) where the volume of the chamber is known. The fire conditions in these tests shall be established for the application of data from gas measurement to fire hazard analysis using fire safety engineering. Gas sampling shall be such that the sample represents the gas, the fire effluent, in quality and quantity, in the chamber, and that any affect of gas sampling systems (probes, pipes, tubes and pumps) is

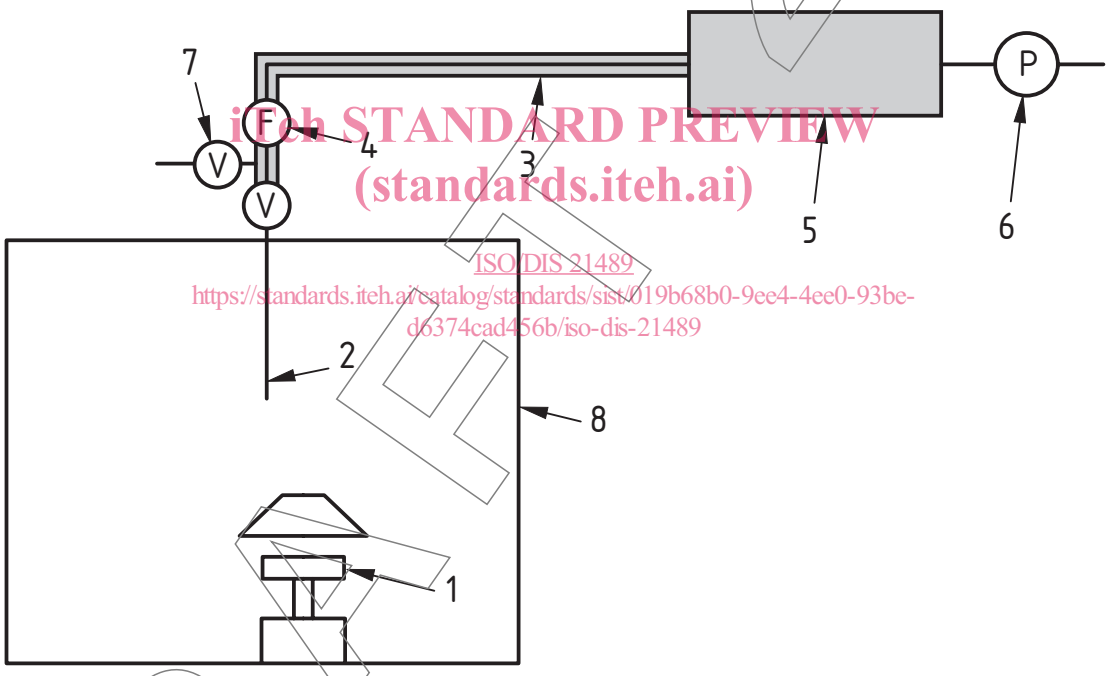
minimized. It is also recommended to minimize the travelling time and distance of fire effluent through the gas sampling system. A filtering system for fire effluent shall be installed within the gas sampling system to prevent smoke particles from entering the gas analyser. FTIR shall be used to analyse the sampled gas.

5 Apparatus for combustion of specimen

Test apparatus and ancillary equipment specified in ISO 5659-2 (e.g. smoke chamber, specimen support and heating arrangements, fuel gas supply, photometric system and other measurement devices) shall be used.

6 Gas sampling system

Gas sampling system shall consists of a probe, filter, gas transfer line, gas flow indicator, gas temperature monitor, gas pressure indicator and pump. Gas analyser shall be at the end of the sampling line up-stream of the pump. An example of the gas sampling system is shown in Figure 1



Key

(1) cylindrical heater of the chamber and sample
(2) sampling probe of fire effluents
(3) heated gas sampling line
(4) heated soot filter
(5) heated measuring cell of the IRTF spectrometer
(6) pump for gas circulation
(7) valve
(8) smoke chamber

Figure 1 — An example of gas sampling system

6.1 Probe an gas sampling line

A suitable probe for sampling gases in the cumulative smoke chamber is a pipe of inner diameter of (4,0 ± 1,0) mm. The open end shall be directed downwards at the geometric centre of the chamber. The material of the probe shall be of corrosion resistant type and shall not be affected by the temperature in the smoke chamber during the tests.

The sampling line, which transfers the gases from the chamber and filter unit to the analyser, shall be made of corrosion resistant material. The line shall be kept at a constant temperature of (175 ± 5) ^{o}C. The inner diameter of the sampling line shall be (4,0 ± 1,0) mm. The length between the probe and the soot filter shall be as short as possible and in any case no more than 4 m. The presence of bends and joints shall be minimised.

If HF is to be analysed, glass sampling probe shall be prohibited.

6.2 Filter

6.2.1 General

The FTIR and other analysers shall be protected, by a filter unit, from contamination of soot and other solid particles that are often contained in fire effluents. The filter unit shall be such that the filter element can be easily changed. The filter unit shall be placed, as far as practicable, between the chamber and the sampling line.

NOTE 1 Some laboratories use a 'dirty cell' in their FTIR apparatus and this allows small amounts of soot to enter the gas cell. However, this equipment is not recommended for regular use when fire tests are conducted for a wide variety of materials and products. When testing sooty materials in cumulative smoke procedures such as ISO 5659-2, it has been found that the needle valve controlling the pressure in the FTIR apparatus can become blocked within a few minutes.

NOTE 2 Depending on the gases to be analysed, a special care should be taken when choosing the filter. Interaction between the media of filter and gases should be checked.

6.2.2 Filter material

A cylindrical filter of diameter of (20 ± 2) mm with a length of (75 ± 5) mm and porosity of 2 micron should be used.

If a planar filter is used, it should have a porosity of 5 micron and a diameter of approximately 47 mm. Glass wool or glass fibre membranes are suitable for filtering most gas effluents but they should not be used when testing fluorine-containing materials. The filter housing should be made of stainless steel or other corrosion resistant material. The filter and the housing shall not be affected by the temperature, to which the filter unit is heated.

NOTE 1 Filters of different size and porosity may be suitable. The selection of filter porosity in the range 1 to 5 microns is based on compromise between trapping the soot before it reaches the gas cell and avoidance of choking up the filter. For test in which dense soot is produced, clogging of 47 mm diameter planer filter may happen.

NOTE 2 Glass wool filter is not suitable for sampling gas contained HF and/or HBr condition of the filter

6.2.3 Conditions of the filter

The temperature of the filter and sampling line shall be maintained at (175 $\pm$ 5) ^{o}C, which shall be measured at the housing of the filter and the appropriate place(s) of the outer surface of the sampling line.