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Plastics — Smoke generation — Determination of the corrosivity of fire effluents —

Part 2: Static method

*Plastiques — Production de fumées — Détermination de la corrosivité des
effluents du feu*

Partie 2: Méthode statique



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Foreword

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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.

International Standard ISO 11907-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

ISO 11907 consists of the following parts, under the general title *Plastics — Smoke generation — Determination of the corrosivity of fire effluents*:

- *Part 1: Guidance*
- *Part 2: Static test*
- *Part 3: Dynamic decomposition method using a travelling furnace*
- *Part 4: Dynamic decomposition method using a conical radiant heater*

At the time of publication of this part of ISO 11907, the other parts were at various stages of preparation.

Annexes A and B of this part of ISO 11907 are for information only.

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Plastics — Smoke generation — Determination of the corrosivity of fire effluents —

Part 2: Static method

1 Scope

1.1 This part of ISO 11907 specifies a test method using a small-scale laboratory apparatus for the determination of the corrosive effects of combustion products liberated by burning plastics. Although the method is applicable to all combustible materials which might constitute a corrosion risk in the event of their burning, the size and nature of the test specimen is such that the test is not directly applicable to end-use assessment of corrosion hazard.

1.2 The test method makes it possible to produce a ranking of materials in the order of the corrosivity of their combustion products under specific test conditions with regard to combustion temperature, available oxygen, ventilation and different humidity levels.

NOTE 1 In order to assess the risk of corrosion when materials burn, the ranking of materials by corrosivity should be combined with their heat and flame response characteristics (e.g. ignitability, surface spread of flame, rate of heat release). The assessment of risk of corrosion in the event of fire requires consideration of many factors including fuel load, intensity of burning, ventilation conditions, humidity levels and the nature of the exposed surfaces.

Although the method described in this part of ISO 11907 refers only to copper corrosion, the test can be applied to other metallic and non-metallic materials in a variety of detector forms.

NOTE 2 Additives and fillers have been shown to influence the test results.

1.3 It is emphasized that this standard method of test is intended to be used to evaluate the relative degree of possible corrosive effects of fire gases to exposed materials and products under controlled laboratory conditions, and should not be considered, or used, for describing or appraising the corrosion risk of materials, products or systems under actual fire conditions.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11907. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11907 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC Guide 52:1990, *Glossary of fire terms and definitions*.

IEC 695-5-1:1993, *Fire hazard testing — Part 5: Assessment of potential corrosion damage by fire effluent — Section 1: General guidance*.

3 Definitions

For the purposes of this part of ISO 11907, the definitions given by ISO/IEC Guide 52 apply, together with the following definitions.

3.1 corrosion: The reaction of a metallic material with its environment, resulting in a measurable change of the material and possibly in an impairment of the functioning of a metal part or of an entire system.

NOTE 3 In most cases, the reaction is electrochemical. In others, however, it may be chemical (non-electrochemical) or physical.

3.2 corrosion damage: The extent of the physical damage or impaired function caused by the chemical action of fire effluents.

3.3 fire effluent decay characteristics: The chemical and physical changes in fire effluents with time and during transport.

3.4 fire model: Means for the decomposition and/or combustion of test specimens under defined conditions to represent (a) known stage(s) of fire in order to generate fire effluents for corrosivity assessments. (This term is also used by the fire science community in the mathematical simulation of fire characteristics.)

3.5 corrosion detector: A standardized test piece made up to represent an electrical circuit or other material which can fail by corrosive effects.

4 Principles

4.1 One of the basic principles of the test is expressed by the sequence: combustion — condensation — corrosion, which is observed in real fires when humid effluents condense out on to cooler structures and components which may have escaped direct thermal damage. This may produce conditions conducive to corrosion. The test chamber for measuring the corrosiveness of effluents has been designed in order to reproduce the above conditions in a small-scale test.

The method primarily measures corrosion under conditions such that the sample is subject to condensation of water from the atmosphere and from the combustion products. It is also able to measure corrosion produced under conditions of low relative humidity, or where the detector temperature is above the dew point.

4.2 Under high relative humidity conditions, the combustion products are made to condense out on to a target substrate. This corrosion detector is a printed wiring board (PWB) (see 5.3), which is typically kept at constant temperature below the dew point of the effluents in the chamber.

4.3 In order to induce condensation, it is necessary to have a certain minimum relative humidity within the test chamber. Moreover, for a given atmosphere at a given temperature and relative humidity, condensation on a surface will occur only if its temperature lies at or below the dew point for that atmospheric condition.

NOTE 4 Moisture may be adsorbed on to the detector surface at temperatures above the dew point if hygroscopic chemical species have been deposited on to the surface of the corrosion detector.

4.4 If the desired temperature and relative humidity are known, it is possible to calculate the absolute humidity, i.e. the number of grams of water per cubic metre, necessary to produce condensation on the corrosion detector.

4.5 Constant temperature and relative humidity in the test chamber are established at the time of ignition (although the combustion of the specimen produces a temporary increase in the temperature of the test atmosphere). Once ignition has taken place, the repeatability of the test results depends on having a constant temperature of condensation at the detector. The detector temperature determines the residual relative humidity in the test chamber and also the reliability of the measurements of the electrical resistance of the detector, since this varies with temperature.

5 Apparatus

5.1 Test chamber

The test chamber shall consist of a cylindrical sealed enclosure with a total volume of approximately 20 litres and a diameter of approximately 300 mm (a typical test apparatus is described in annex A). The chamber shall be maintained at a constant temperature, e.g. by heating elements around its external surface.

The test chamber doors shall be designed to provide a gas-tight seal adequate for the purpose of maintaining a constant relative humidity within the test chamber for the duration of the test.

The materials of construction of the test chamber shall have sufficiently low permeability to water vapour to permit the maintenance of a constant relative humidity of $(65 \pm 2) \%$ at the test temperature of $50 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$ for the duration of the test.

All materials within the chamber, with the exception of the corrosion target, shall be chemically inert to the combustion products or shall be protected from contact with the combustion products by means of a surface coating or other device.

The interior surfaces of the chamber are thermostated uniformly at $50 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$ to avoid formation of cold spots.

5.2 Ignition source

5.2.1 The ignition source consists of an inert crucible containing a resistance wire heater: a typical arrangement is shown in figure A.4.

5.2.2 A dispensing device shall be provided, capable of placing the specimen in the crucible after the required ignition temperature has been reached.

5.3 Corrosion detector

The corrosion detector shall be a resistance etched on a copper-plated laminated base. The detector shall be constructed of 36 conductor tracks each 52 mm $\pm$

1 mm long, $0,3 \text{ mm} \pm 0,02 \text{ mm}$ wide and $17 \text{ } \mu\text{m} \pm 1 \text{ } \mu\text{m}$ thick, on a laminated epoxy-resin base-plate (see figure A.5).

Dimensions: PWB $(40 \pm 1) \text{ mm} \times (80 \pm 1) \text{ mm}$

Base-plate $(70 \pm 2) \text{ mm} \times (140 \pm 2) \text{ mm}$

Resistance: $8,0 \text{ } \Omega \pm 0,5 \text{ } \Omega$

Condensed products react with the copper if they are corrosive and the corrosivity shall be assessed by measurement of the resistance variation due to attack on the copper circuit.

6 Test specimens

A minimum sample quantity of 3 g shall be provided to allow five tests to be carried out on individual specimens of $600 \text{ mg} \pm 2 \text{ mg}$ of material. The specimens shall be in the form of granules or chips to ensure intimate contact with the ignition source.

Prior to use, new equipment shall be calibrated for relative humidity and temperature within the exposure chamber, and for the temperature of the ignition source, in accordance with the procedures recommended by the equipment manufacturer. These calibrations shall be carried out for maintenance purposes after every 50 runs at least.

7 Procedure

7.1 Condensing mode

7.1.1 Place a test specimen in the dispensing device (5.2.2).

7.1.2 Prepare the PWB by cleaning with a pumice-based acidic powder formulation. Rub the PWB with a piece of moist cotton wool containing the cleaning powder. Thoroughly wash the PWB with excess deionized water and carefully wipe it dry.

NOTE 5 By this method, copper surfaces are cleaned chemically as well as physically. The acidic chemical cleaning action removes oxides and wets the PWB surface. No residual film remains after rinsing and drying. Circuits which have been subjected to this treatment show no sign of corrosion in simple condensation tests.

7.1.3 Ensure that the internal surface of the test chamber (5.1) as well as other parts which might have been in contact with combustion products have been suitably cleaned as described in clause 8.

7.1.4 Connect up the PWB corrosion detector (5.3) and position it on the holder (see figure A.5).

7.1.5 Adjust the temperature in the chamber to $50 \text{ } ^\circ\text{C} \pm 2 \text{ } ^\circ\text{C}$ and the relative humidity to $(65 \pm 2) \%$ (see A.5).

7.1.6 Circulate water to the corrosion detector holder to maintain it at $40 \text{ } ^\circ\text{C} \pm 2 \text{ } ^\circ\text{C}$ and measure the initial resistance R_i to $\pm 0,02 \text{ } \Omega$.

7.1.7 Heat the ignition source to $800 \text{ } ^\circ\text{C} \pm 5 \text{ } ^\circ\text{C}$.

7.1.8 Place the specimen in the crucible and maintain at $800 \text{ } ^\circ\text{C} \pm 5 \text{ } ^\circ\text{C}$ for 3 min.

7.1.9 60 min after the specimen was placed in the crucible, measure the final resistance R_f to $\pm 0,02 \text{ } \Omega$.

In order to avoid electrochemical corrosion of the PWB, the resistance shall not be measured continuously over the 60 min interval.

7.1.10 If required, remove the corrosion detector from the test chamber and post-condition for a specified time (see clause 10).

7.2 Non-condensing mode

7.2.1 Place a test specimen in the dispensing device (5.2.2).

7.2.2 Prepare the PWB as described in 7.1.2.

7.2.3 Ensure that the internal surface of the test chamber (5.1) as well as other parts which might have been in contact with combustion products have been suitably cleaned as described in clause 8.

7.2.4 Connect up the PWB corrosion detector (5.3) and position it on the holder (see figure A.5).

7.2.5 Adjust the temperature in the chamber to $50 \text{ } ^\circ\text{C} \pm 2 \text{ } ^\circ\text{C}$ and the relative humidity to $(65 \pm 2) \%$.

7.2.6 Measure the initial resistance R_i of the corrosion detector to $\pm 0,02 \text{ } \Omega$.

7.2.7 Heat the ignition source to $800 \text{ } ^\circ\text{C} \pm 5 \text{ } ^\circ\text{C}$.

7.2.8 Place the specimen in the crucible and maintain at $800 \text{ } ^\circ\text{C} \pm 5 \text{ } ^\circ\text{C}$ for 3 min.

7.2.9 60 min after the specimen was placed in the crucible, measure the final resistance R_f to $\pm 0,2 \text{ } \Omega$.

In order to avoid electrochemical corrosion of the PWB, the resistance shall not be measured continuously over the 60 min interval.

7.2.10 If required, remove the corrosion detector from the test chamber and post-condition for a specified time (see clause 10).

8 Cleaning procedure

Evacuate the combustion products from the chamber by purging with air before opening the chamber doors. Carry out this operation in a fume cupboard or using a filter at the chamber exit in order to remove combustion products.