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Paints and varnishes — Methods of exposure to laboratory light sources —

Part 2:
Xenon-arc lamps

Peintures et vernis — Méthodes d'exposition à des sources lumineuses de laboratoire —

Partie 2: Lampes à arc au xénon

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This first edition of ISO 16474-2, together with ISO 16474-1, cancels and replaces ISO 11341:2004 which has been technically revised.

ISO 16474 consists of the following parts, under the general title *Paints and varnishes — Methods of exposure to laboratory light sources*:

— *Part 1: General guidance*

— *Part 2: Xenon-arc lamps*

— *Part 3: Fluorescent UV lamps*

— *Part 4: Open-flame carbon-arc lamps*

Introduction

Coatings of paints, varnishes and similar materials (subsequently referred to simply as coatings) are exposed to laboratory light sources, in order to simulate in the laboratory the ageing processes which occur during natural weathering or during exposure tests under glass cover.

Paints and varnishes — Methods of exposure to laboratory light sources —

Part 2:
Xenon-arc lamps

1 Scope

This part of ISO 16474 specifies methods for exposing specimens to xenon-arc light in the presence of moisture to reproduce the weathering effects that occur when materials are exposed in actual end-use environments to daylight or to daylight filtered through window glass.

The specimens are exposed to filtered xenon-arc light under controlled conditions (temperature, humidity and/or wetting). Various types of xenon-arc lamps and various filter combinations may be used to meet all the requirements for testing different materials.

Specimen preparation and evaluation of the results are covered in other International Standards for specific materials.

General guidance is given in ISO 16474-1.

NOTE Xenon-arc exposures for plastics are described in ISO 4892-2.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4618, *Paints and varnishes — Terms and definitions*

ISO 9370, *Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method*

ISO 16474-1, *Paints and varnishes — Methods of exposure to laboratory light sources — Part 1: General guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and the following apply.

3.1
radiant exposure
H
amount of radiant energy to which a test panel has been exposed

Note 1 to entry: Radiant exposure is given by the equation $H = \int E \cdot \mathrm{d}t$.

where

H is the radiant exposure, in joules per square metre;

E is the irradiance, in watts per square metre;

t is the exposure time, in seconds.

Note 2 to entry: If the irradiance E is constant throughout the whole exposure time, the radiant exposure H is given simply by the product of E and t.

4 Principle

4.1 A xenon arc, fitted with suitable filters and properly maintained, is used to simulate the spectral power distribution of daylight in the ultraviolet (UV) and visible regions of the spectrum.

4.2 Specimens are exposed to various levels of irradiance (radiant exposure), heat, relative humidity and water (see 4.4) under controlled environmental conditions.

4.3 The exposure conditions may be varied by selection of

a) the light filter(s);

b) the irradiance level;

c) the temperature during light exposure;

d) the relative humidity of the chamber air during light and dark exposures, when test conditions requiring control of humidity are used;

e) the type of wetting (see 4.4);

f) the water temperature and wetting cycle;

g) the timing of the light/dark cycle.

4.4 Wetting is usually produced by spraying the test specimens with demineralized/deionized water, by immersion in water or by condensation of water vapour onto the surfaces of the specimens.

4.5 The procedure shall include measurements of the irradiance and radiant exposure in the plane of the specimens.

4.6 It is recommended that a similar material of known performance (a control) be exposed simultaneously with the test specimens to provide a standard for comparative purposes.

4.7 Intercomparison of results obtained from specimens exposed in different equipments should not be made unless an appropriate statistical relationship has been established between the equipments for the particular material to be tested.

5 Apparatus

5.1 Laboratory light source

5.1.1 General

The light source shall comprise one or more quartz-jacketed xenon-arc lamps which emit radiation from below 270 nm in the ultraviolet through the visible spectrum and into the infrared. In order to simulate daylight, filters shall be used to remove short-wavelength UV radiation (method A, see Table 1). Filters to minimize irradiance at wavelengths shorter than 310 nm shall be used to simulate daylight through window glass (method B, see Table 2). In addition, filters to remove infrared radiation may be used to prevent unrealistic heating of the test specimens, which can cause thermal degradation not experienced during outdoor exposures.

NOTE Solar spectral irradiance for a number of different atmospheric conditions is described in CIE No. 85. The benchmark daylight used in this part of ISO 16474 is that defined in CIE No. 85:1989, Table 4.

5.1.2 Spectral irradiance of xenon-arc lamps with daylight filters

Filters are used to filter xenon-arc emissions in order to simulate daylight (CIE No. 85:1989, Table 4[2]). The minimum and maximum levels of the relative spectral irradiance in the UV wavelength range are given in Table 1 (see also Annex A).

Table 1 — Relative spectral irradiance of xenon-arc lamps with daylight filter [a,b] (method A)

Spectral passband	Minimum[c]	CIE No. 85:1989, Table 4 [d,e]	Maximum[c]
(λ = wavelength in nm)	%	%	%
$\lambda < 290$			0,15
$290 \le \lambda \le 320$	2,6	5,4	7,9
$320 < \lambda \le 360$	28,2	38,2	39,8
$360 < \lambda \le 400$	54,2	56,4	67,5

[a] This table gives the irradiance in the given passband, expressed as a percentage of the total irradiance between 290 nm and 400 nm. To determine whether a specific filter or set of filters for a xenon-arc lamp meets the requirements of this table, the spectral irradiance has to be measured from 250 nm to 400 nm. Typically, this is done in 2 nm increments. The total irradiance in each wavelength passband is then summed and divided by the total irradiance from 290 nm to 400 nm.

[b] The minimum and maximum limits in this table are based on more than 100 spectral irradiance measurements with water- and air-cooled xenon-arc lamps with daylight filters from different production lots and of various ages, used in accordance with the recommendations of the manufacturer. As more spectral irradiance data become available, minor changes in the limits are possible. The minimum and maximum limits are at least three sigma from the mean for all the measurements.

[c] The minimum and maximum columns will not necessarily sum to 100 % because they represent the minima and maxima for the measurement data used. For any individual spectral irradiance, the percentages calculated for the passbands in this table will sum to 100 %. For any individual xenon-arc lamp with daylight filters, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Exposure results can be expected to differ if obtained using xenon-arc apparatus in which the spectral irradiances differ by as much as that allowed by the tolerances. Contact the manufacturer of the xenon-arc apparatus for specific spectral irradiance data for the xenon-arc lamp and filters used.

[d] The data from CIE Publication No. 85:1989, Table 4 is the global solar irradiance on a horizontal surface for an air mass of 1,0, an ozone column of 0,34 cm at STP, 1,42 cm of precipitable water vapour and a spectral optical depth of aerosol extinction of 0,1 at 500 nm. These data are target values for xenon-arc lamps with daylight filters.

[e] For the solar spectrum represented in CIE No. 85:1989, Table 4, the UV irradiance (between 290 nm and 400 nm) is 11 % and the visible irradiance (between 400 nm and 800 nm) is 89 %, expressed as a percentage of the total irradiance between 290 nm and 800 nm. The percentage of the UV irradiance and that of the visible irradiance incident on specimens exposed in xenon-arc apparatus can vary due to the number of specimens being exposed and their reflectance properties.

5.1.3 Spectral irradiance of xenon-arc lamps with window glass filters

Filters are used to filter the xenon-arc lamp emissions in order to simulate daylight which has passed through window glass. The minimum and maximum levels of the relative spectral irradiance in the UV region are given in Table 2 (see also Annex A).

Table 2 — Relative spectral irradiance for xenon-arc lamps with window glass filters[a,b] (method B)

Spectral passband	Minimum[c]	CIE No. 85:1989, Table 4 plus effect of window glass[d,e]	Maximum[c]
(λ = wavelength in nm)	%	%	%
$\lambda < 300$			0,29
$300 \leq \lambda \leq 320$	0,1	≤ 1	2,8
$320 < \lambda \leq 360$	23,8	33,1	35,5
$360 < \lambda \leq 400$	62,4	66,0	76,2

a This table gives the irradiance in the given passband, expressed as a percentage of the total irradiance between 290 nm and 400 nm. To determine whether a specific filter or set of filters for a xenon-arc lamp meets the requirements of this table, the spectral irradiance has to be measured from 250 nm to 400 nm. Typically, this is done in 2 nm increments. The total irradiance in each passband is then summed and divided by the total irradiance between 290 nm and 400 nm.

b The minimum and maximum limits in this table are based on more than 30 spectral irradiance measurements with water- and air-cooled xenon-arc lamps with window glass filters from different production lots and of various ages, used in accordance with the recommendations of the manufacturer. As more spectral irradiance data become available, minor changes in the limits are possible. The minimum and maximum limits are at least three sigma from the mean for all the measurements.

c The minimum and maximum columns will not necessarily sum to 100 % because they represent the minima and maxima for the data used. For any individual spectral irradiance, the percentages calculated for the passbands in this table will sum to 100 %. For any individual xenon-arc lamp with window glass filters, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Exposure results can be expected to differ if obtained using xenon-arc apparatus in which the spectral irradiances differ by as much as that allowed by the tolerances. Contact the manufacturer of the xenon-arc apparatus for specific spectral irradiance data for the xenon-arc lamp and filters used.

d The data from CIE No. 85:1989, Table 4 plus the effect of window glass was determined by multiplying the CIE No. 85:1989, Table 4 data by the spectral transmittance of 3-mm-thick window glass (see Table A.1). These data are target values for xenon-arc lamps with window glass filters.

e For the CIE No. 85:1989 plus window glass data, the UV irradiance between 300 nm and 400 nm is typically about 9 % and the visible irradiance (between 400 nm and 800 nm) is typically about 91 %, expressed as a percentage of the total irradiance between 300 nm and 800 nm. The percentage of the UV irradiance and that of the visible irradiance incident on specimens exposed in xenon-arc apparatus can vary due to the number of specimens being exposed and their reflectance properties.

5.1.4 Irradiance uniformity

The irradiance at any position in the area used for specimen exposure shall be at least 80 % of the maximum irradiance. Requirements for periodic repositioning of specimens when this requirement is not met are described in ISO 16474-1.

For some materials of high reflectivity, or/and high sensitivity to irradiance and temperature, periodic repositioning of specimens is recommended to ensure uniformity of exposures, even when the irradiance uniformity in the exposure area is within the limits so that repositioning is not required.

5.2 Test chamber

The design of the test chamber may vary, but it shall be constructed from inert material. In addition to the controlled irradiance, the test chamber shall provide for control of temperature. For exposures that require control of humidity, the test chamber shall include humidity-control facilities that meet the requirements of ISO 16474-1. When required by the exposure used, the apparatus shall also include facilities for the provision of water spray or the formation of condensate on the surface of the test specimens, or for the immersion of the specimens in water. Water used for water spray shall meet the requirements of ISO 16474-1.

The light source(s) shall be located, with respect to the specimens, such that the irradiance at the specimen surface complies with 5.1.

NOTE If the lamp system (one or more lamps) is centrally positioned in the chamber, the effect of any eccentricity of the lamp(s) on the uniformity of exposure can be reduced by using a rotating frame carrying the specimens or by repositioning or rotating the lamps.

Should any ozone be generated from operation of the lamp(s), the lamp(s) shall be isolated from the test specimens and operating personnel. If the ozone is in an air stream, it shall be vented directly to the outside of the building.

5.3 Radiometer

The radiometer used shall comply with the requirements outlined in ISO 16474-1 and ISO 9370.

5.4 Black-standard/black-panel thermometer

The black-standard or black-panel thermometer used shall comply with the requirements for these devices given in ISO 16474-1.

NOTE The preferred maximum surface temperature device is the black-standard thermometer. The cycles are described in Table 3 and Table B.1.

5.5 Wetting and humidity-control equipment

5.5.1 General

Specimens may be exposed to moisture in the form of water spray or condensation, or by immersion. Specific exposure conditions using water spray are described in Table 3 (see also Table B.1) and Table 4 (see also Table B.2). If condensation, immersion or other methods are used to expose the specimens to moisture, details of the procedures and exposure conditions used shall be included in the exposure report.

Table 3 and Table 4 describe exposure conditions in which the relative humidity is controlled. Table B.1 and Table B.2 describe exposure conditions in which humidity control is not required.

NOTE The relative humidity of the air can have a significant influence on the photodegradation of coatings.

5.5.2 Relative-humidity control equipment

For exposures where relative-humidity control is required, the location of the sensors used to measure the humidity shall be as specified in ISO 16474-1.

5.5.3 Spray system

The test chamber shall be equipped with a means of directing an intermittent water spray onto the fronts or backs of the test specimens under specified conditions. The spray shall be uniformly distributed over the specimens. The spray system shall be made from corrosion-resistant materials that do not contaminate the water employed.

The water sprayed onto the specimen surfaces shall have a conductivity below 5 µS/cm, contain less than 1 µg/g dissolved solids content and leave no observable stains or deposits on the specimens. Care shall be taken to keep silica levels below 0,2 µg/g. A combination of deionization and reverse osmosis may be used to produce water of the desired quality.

5.6 Specimen holders

Specimen holders may be in the form of an open frame, leaving the backs of the specimens exposed, or they may provide the specimens with a solid backing. They shall be made from inert materials that will not affect the results of the exposure, for example non-oxidizing alloys of aluminium or stainless steel.