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

Part 3: Fluorescent UV lamps

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

Partie 3: Lampes fluorescentes UV

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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 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 139, *Paints and varnishes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16474-3:2013) which has been technically revised. The main changes compared to the previous edition are as follows:

— in 7.2 the difference between the temperature of a black panel sensor and a black standard sensor has been corrected;

— in Table 4 it has been changed that the black-panel temperature is not controlled during water spray;

— the text has been editorially revised and the normative references have been updated.

A list of all parts in the ISO 16474 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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 behind window glass.

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

Part 3:
Fluorescent UV lamps

1 Scope

This document specifies methods for exposing coatings to fluorescent UV lamps, heat and water in apparatus designed to reproduce the weathering effects that occur when materials are exposed in actual end-use environments to daylight, or to daylight through window glass.

The coatings are exposed to different types of fluorescent UV lamps under controlled environmental conditions (temperature, humidity and/or water). Different types of fluorescent UV lamp can be used to meet all the requirements for testing different materials.

Specimen preparation and evaluation of the results are covered in other ISO documents for specific materials.

General guidance is given in ISO 16474-1.

NOTE Fluorescent UV lamp exposures for plastics are described in ISO 4892-3.

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.

ISO 1514, *Paints and varnishes — Standard panels for testing*

ISO 2808, *Paints and varnishes — Determination of film thickness*

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 16474-1:2013, *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.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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 (J/m^2);

E is the irradiance, in watts per square metre (W/m^2);

t is the exposure time, in seconds (s).

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 Fluorescent UV lamps, when properly maintained, can be used to simulate the spectral irradiance of daylight in the ultraviolet (UV) region of the spectrum.

4.2 Specimens are exposed to various levels of UV radiation, heat and moisture (see 4.4) under controlled environmental conditions.

4.3 The exposure conditions may be varied by selection of:

a) the type of fluorescent lamp (spectral power distribution);

b) the irradiance level;

c) the temperature during the UV exposure;

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

NOTE Commercial fluorescent UV lamp devices generally do not provide means of relative humidity control.

e) the type of wetting (see 4.4);

f) the wetting temperature and cycle;

g) the timing of the UV/dark cycle.

4.4 Wetting is usually produced by condensation of water vapour onto the exposed specimen surface or by spraying the test specimens with demineralized/deionized water.

4.5 The procedure(s) may include measurement of the irradiance and the radiant exposure in the plane of the specimen.

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 apparatus or to different types of lamp should not be made unless an appropriate statistical relationship has been established between the different types of equipment for the material to be tested.

5 Apparatus

5.1 Laboratory light source

5.1.1 Fluorescent UV lamps are fluorescent lamps in which radiant emission in the ultraviolet region of the spectrum, i.e. below 400 nm, makes up at least 80 % of the total light output. There are three types of fluorescent UV lamp used in this document:

— The spectral distribution of radiation for typical fluorescent lamps is described in Annex A. Type 1A (UVA-340) fluorescent UV lamp: These lamps have a radiant emission below 300 nm of less than 1 % of the total light output and a peak emission at 343 nm. They are more commonly identified as UVA-340 for simulation of daylight from 300 nm to 340 nm (see Table 1, Spectral pass-band column). Figure A.1 is a graph of spectral irradiance from 250 nm to 400 nm of a typical type 1A (UVA-340) fluorescent UV lamp compared to daylight.

— Type 1B (UVA-351) fluorescent UV lamp: These lamps have a radiant emission below 310 nm of less than 1 % of the total light output and a peak emission at 353 nm. They are more commonly identified as UVA-351 for simulation of the UV portion of daylight behind window glass (see Table 2). Figure A.2 is a graph of spectral irradiance from 250 nm to 400 nm of a typical type 1B (UVA-351) fluorescent UV lamp compared to daylight filtered by window glass.

— Type 2 (UVB-313) fluorescent UV lamp: These lamps have a radiant emission below 300 nm of more than 10 % of the total light output, and a peak emission at 313 nm. They are more commonly identified as UVB-313 (see Table 3). Figure A.3 is a graph of the spectral irradiance from 250 nm to 400 nm of two typical type 2 (UVB-313) fluorescent UV lamps compared to daylight. Type 2 (UVB-313) fluorescent UV lamps may be used only by agreement between the parties concerned. Such agreement shall be stated in the test report.

NOTE 1 Type 2 (UVB-313) fluorescent UV lamps have a spectral distribution of radiation which peaks near the 313 nm mercury line and might emit radiation down to $\lambda = 254$ nm, which can initiate ageing processes that never occur in end-use environments.

NOTE 2 The solar spectral irradiance for a number of different atmospheric conditions is described in CIE 85[7]. The benchmark daylight value used in this document is from CIE 85:1989, Table 4[7].

5.1.2 Unless otherwise specified, type 1A (UVA-340) fluorescent UV lamps or corresponding type 1A fluorescent UV lamp combinations shall be used to simulate the UV part of daylight (see Table 4, method A). Unless otherwise specified, type 1B (UVA-351) fluorescent UV lamps shall be used to simulate the UV part of daylight through window glass (see Table 4, method B).

5.1.3 Fluorescent UV lamps age significantly with extended use. If an automatic irradiance control system is not used, follow the apparatus manufacturer's instructions on the procedure necessary to maintain the desired irradiance.

5.1.4 Irradiance uniformity shall be in accordance with the requirements specified in ISO 16474-1. Requirements for periodic repositioning of specimens when irradiance within the exposure area is less than 90 % of the peak irradiance are described in ISO 16474-1.

Table 1 — Relative ultraviolet spectral irradiance for type 1A (UVA-340) fluorescent UV lamps for daylight UV (method A)[a, b]

Spectral passband	Minimum[c]	CIE 85:1989, Table 4[d, e]	Maximum[c]
(λ = wavelength in nm)	%	%	%
$\lambda < 290$	—	0	0,1
$290 \leq \lambda \leq 320$	5,9	5,4	9,3
$320 < \lambda \leq 360$	60,9	38,2	65,5
$360 < \lambda \leq 400$	26,5	56,4	32,8

[a] This table gives the relative values for irradiance in the given passband, expressed as a percentage of the total irradiance between 290 nm and 400 nm. To determine whether a specific type 1A (UVA-340) fluorescent UV lamp meets the requirements of this table, the spectral irradiance from 250 nm to 400 nm shall be measured. 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 for type 1A (UVA-340) fluorescent UV lamps in this table are based on more than 60 spectral irradiance measurements with type 1A (UVA-340) fluorescent UV lamps from different production lots and of various ages[8]. The spectral irradiance data are for lamps within the ageing recommendations of the apparatus 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. The range of the relative irradiance of fluorescent UV lamp combinations is determined by radiation measurements at about 50 locations within the exposure area recommended by the apparatus manufacturer.

[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 distribution, the percentages calculated for the passbands in this table will sum up to 100 %. For any individual type 1A (UVA-340) fluorescent UV lamp, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Test results can be expected to differ between exposures using type 1A (UVA-340) fluorescent UV lamps in which the spectral irradiance differs by as much as that allowed by the tolerances. Contact the manufacturer of the fluorescent UV apparatus for specific spectral irradiance data for the type 1A (UVA-340) fluorescent UV lamp used.

[d] The data from CIE 85:1989, Table 4[7], is the global solar irradiance on a horizontal surface for an air mass of 1,0, an ozone column of 0,34 cm at standard temperature and pressure (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 provided for reference purposes only and are intended to serve as a target.

[e] For the solar spectrum represented by CIE 85:1989, Table 4[7], the UV irradiance (290 nm to 400 nm) is 11 % and the visible irradiance (400 nm to 800 nm) is 89 %, expressed as a percentage of the total irradiance from 290 nm to 800 nm. Because the primary emission of fluorescent UV lamps is concentrated in the 300 nm to 400 nm passband, there are limited data available for the visible light emission of fluorescent UV lamps. The percentages of UV irradiance and visible irradiance on specimens exposed in fluorescent UV apparatus might vary due to the number of specimens being exposed and their reflectance properties.

Table 2 — Relative ultraviolet spectral irradiance for type 1B (UVA-351) fluorescent UV lamps for daylight behind window glass (method B)[a, b]

Spectral passband	Minimum[c]	CIE 85:1989, Table 4, plus effect of window glass[d, e]	Maximum[c]
(λ = wavelength in nm)	%	%	%
$\lambda < 300$	—	0	0,2
$300 \leq \lambda \leq 320$	1,1	≤1	3,3
$320 < \lambda \leq 360$	60,5	33,1	66,8
$360 < \lambda \leq 400$	30,0	66,0	38,0

[a] This table gives the relative values for irradiance in the given passband, expressed as a percentage of the total irradiance between 290 nm and 400 nm. To determine whether a specific type 1B (UVA-351) fluorescent UV lamp meets the requirements of this table, the spectral irradiance from 250 nm to 400 nm shall be measured. 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 given in this table are based on 21 spectral irradiance measurements with type 1B (UVA-351) fluorescent UV lamps from different production lots and of various ages[8]. The spectral irradiance data are for lamps within the ageing recommendations of the apparatus 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 distribution, the percentages calculated for the passbands in this table will sum to 100 %. For any individual type 1B (UVA-351) fluorescent UV lamp, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Test results can be expected to differ between exposures using type 1B (UVA-351) fluorescent UV lamps in which the spectral irradiance differs by as much as that allowed by the tolerances. Contact the manufacturer of the fluorescent UV apparatus for specific spectral irradiance data for the type 1B (UVA-351) fluorescent UV lamp used.

[d] The data from CIE 85:1989, Table 4[7], plus the effect of window glass was determined by multiplying the CIE 85:1989, Table 4[7] data by the spectral transmittance of typical 3-mm-thick window glass (see ISO 16474-2:2013, Annex A). These data are provided for reference purposes only and are intended to serve as a target.

[e] For the solar spectrum represented by CIE 85:1989, Table 4[7], plus window glass data, the UV irradiance from 300 nm to 400 nm is typically about 9 % and the visible irradiance (400 nm to 800 nm) is typically about 91 %, expressed as a percentage of the total irradiance from 300 nm to 800 nm. Because the primary emission of fluorescent UV lamps is concentrated in the 300 nm to 400 nm passband, there are limited data available for the visible light emission of fluorescent UV lamps. The percentages of UV irradiance and visible irradiance on specimens exposed in fluorescent UV apparatus might vary due to the number of specimens being exposed and their reflectance properties.