INTERNATIONAL STANDARD

ISO 11341

Second edition
2004-09-01

Paints and varnishes — Artificial weathering and exposure to artificial radiation — Exposure to filtered xenon-arc radiation

Peintures et vernis — Vieillissement artificiel et exposition au rayonnement artificiel — Exposition au rayonnement filtré d'une lampe à arc au xénon

Reference number
ISO 11341:2004(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 11341 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This second edition cancels and replaces the first edition (ISO 11341:1994), which has been revised both technically and editorially. It also replaces ISO 2809:1976.

The main technical changes compared to ISO 11341:1994 are:

a) Tables 1 and 2: The spectral irradiance distribution tables have been recalculated from the previous wavelength range of 300 nm to 800 nm to a wavelength range of 300 nm to 400 nm. New tolerances have been introduced based on spectral irradiance measurements made with typical xenon-arc instruments. In Table 2, the central values have been corrected using Table B.1 and B.2.

b) Subclause 6.2: The required irradiance values have been recalculated from the previous wavelength range of 300 nm to 800 nm to a wavelength range of 300 nm to 400 nm. Additionally, narrow-band spectral irradiance values at 320 nm and 420 nm have been included.

c) Subclause 6.2: An option for using high irradiance levels (up to about three times that of the sun) has been included.

d) Subclauses 6.6 and 9.2: Both black-standard and black-panel thermometers are now included.

e) Subclause 9.3: The test-chamber air temperature is now specified.

f) Table 3: The values of the relative humidity in cycles A and B have been harmonized with those in cycles C and D.

g) Clause 9.5: An additional wetting/drying cycle has been included for special applications.

Introduction

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

In contrast to natural weathering, artificial weathering involves a limited number of variables which can be controlled more readily and which can be intensified to produce accelerated ageing.

The ageing processes which occur during artificial and natural weathering cannot be expected to correlate with each other because of the large number of factors which influence these processes. Definite relationships can only be expected if the important parameters (distribution of the irradiance over the photochemically relevant part of the spectrum, temperature of the specimen, type of wetting and wetting cycle, and relative humidity) are the same in each case or if their effect on the coatings is known.

Paints and varnishes — Artificial weathering and exposure to artificial radiation — Exposure to filtered xenon-arc radiation

1 Scope

This International Standard specifies a procedure for exposing paint coatings to artificial weathering in xenon-arc lamp apparatus, including the action of liquid water and water vapour. The effects of this weathering are evaluated separately by comparative determination of selected parameters before, during and after weathering.

The standard describes the most important parameters and specifies the conditions to be used in the exposure apparatus.

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 1513, *Paints and varnishes — Examination and preparation of samples for testing*

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

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

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

CIE Publication No. 85:1989, *Solar spectral irradiance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
ageing behaviour
change in the properties of a coating during weathering or exposure to radiation

NOTE One measure of ageing is the radiant exposure H in the wavelength range below 400 nm or at a specified wavelength, e.g. 340 nm. The ageing behaviour of coatings exposed to artificial weathering, or to artificial radiation, depends on the type of coating, the conditions of exposure of the coating, the property selected for monitoring the progress of the ageing process and the degree of change of this property.

3.2
radiant exposure
H
amount of radiant energy to which a test panel has been exposed, given by the equation

$$H = \int E \, \mathrm{d}t$$

where

E is the irradiance, in watts per square metre;

t is the exposure time, in seconds

NOTE 1 H is therefore expressed in joules per square metre.

NOTE 2 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.

3.3
ageing criterion
given degree of change in a selected property of the coating under test

NOTE The ageing criterion is specified or agreed upon.

4 Principle

Artificial weathering of coatings or exposure of coatings to filtered xenon-arc radiation is carried out in order to obtain the degree of change in a selected property after a certain radiant exposure H, and/or the radiant exposure which is required to produce a certain degree of ageing. The properties selected for monitoring should preferably be those which are important for the practical use of the coatings. The properties of the coatings exposed are compared with those of unexposed coatings prepared from the same coating materials at the same time and in the same way (control specimens) or with those of coatings exposed at the same time whose behaviour during testing in exposure apparatus is already known (reference specimens).

During natural weathering, solar radiation is considered to be the essential cause for the ageing of coatings. The same is valid for exposure to radiation under glass. Therefore, in artificial weathering and exposure to artificial radiation, particular importance is attached to the simulation of this parameter. The xenon-arc radiation source used is therefore fitted with one of two different filter systems, designed to modify the spectral distribution of the radiation produced so that, with one of the filters, it matches the spectral distribution, in the ultraviolet and visible regions, of global solar radiation (method 1) and, with the other filter, it matches the spectral distribution, in the ultraviolet and visible regions, of global solar radiation filtered by 3-mm-thick window glass (method 2).

Two spectral energy distributions are used to describe the irradiance values and permitted deviations of the filtered test radiation in the ultraviolet range below 400 nm. In addition, CIE Publication No. 85 is used for the specification of the irradiance in the range up to 800 nm because only in that range can the xenon-arc radiation be adapted to match solar radiation sufficiently well.

During testing in exposure apparatus, the spectral irradiance E may change due to ageing of the xenon-arc lamp and the optical-filter system. This occurs particularly in the ultraviolet region which is photochemically important for polymeric materials. Therefore, measurements are made not only of the duration of the exposure, but also of the radiant exposure H in the wavelength range below 400 nm, or at a specific wavelength, e.g. 340 nm, and used as reference values for the ageing of coatings.

It is impossible to simulate accurately every aspect of the way in which the weather acts on coatings. Therefore, in this International Standard, the term artificial weathering is used as distinct from natural weathering. Testing using simulated solar radiation filtered by window glass is referred to in this International Standard as exposure to artificial radiation.

5 Required supplementary information

For any particular application, the test method specified in this International Standard shall be completed by supplementary information. The items of supplementary information are given in Annex A.

6 Apparatus

6.1 Test chamber

The test chamber shall consist of a conditioned enclosure made from corrosion-resistant material, capable of housing the radiation source, including its filter system, and the test-panel holders.

6.2 Radiation source and filter system

One or more xenon-arc lamps shall be used as the optical radiation source. The radiation emitted by them shall be filtered by a system of optical radiation filters so that the relative spectral distribution of the irradiance (relative spectral energy distribution) in the plane of the test-panel holders is sufficiently similar either to global solar ultraviolet and visible radiation (method 1) or to global solar ultraviolet and visible radiation filtered by 3-mm-thick window glass (method 2).

Tables 1 and 2 give the spectral irradiance distribution, as a percentage of the total irradiance between 290 nm and 400 nm, required when using xenon-arc lamps with daylight filters (Table 1) and when using xenon-arc lamps with window-glass filters (Table 2).

Table 1 — Required spectral irradiance distribution for xenon-arc lamps with daylight filters [method 1 (artificial weathering)]

Wavelength, λ nm	Minimum[a,b] %	CIE No. 85:1989, Table 4[c,d] %	Maximum[a,b] %
$\lambda \leqslant 290$			0,15
$290 < \lambda \leqslant 320$	2,6	5,4	7,9
$320 < \lambda \leqslant 360$	28,2	38,2	38,6
$360 < \lambda \leqslant 400$	55,8	56,4	67,5

[a] The minimum and maximum limits in this table are based on 113 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. The minimum and maximum limits are at least at three sigma from the mean of all the measurements.

[b] 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 lamp with daylight filters, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Test results can be expected to differ if obtained using xenon-arc apparatus in which the spectral irradiances differed 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 and filters used.

[c] The global solar radiation data from Table 4 of CIE Publication No. 85:1989 are given in Annex B. These data shall always serve as target values for xenon-arc lamps with daylight filters.

[d] For the solar spectrum represented by Table 4 in CIE Publication No. 85:1989 (see Annex B), 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. These percentages of UV irradiance and visible irradiance for actual specimens exposed in xenon-arc apparatus may vary, however, due to the number of specimens being exposed and their reflectance properties.

Table 2 — Required spectral irradiance distribution for xenon-arc lamps with window-glass filters (method 2)

Wavelength, λ nm	Minimum[a,b] %	CIE No. 85, Table 4, plus effect of window glass[c,d] %	Maximum[a,b] %
$\lambda \leqslant 300$			0,29
$300 < \lambda \leqslant 320$	0,1	$\leqslant 1$	2,8
$320 < \lambda \leqslant 360$	23,8	33,1	35,5
$360 < \lambda \leqslant 400$	62,4	66,0	76,2

[a] The minimum and maximum limits in this table are based on 35 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. The minimum and maximum limits are at least at three sigma from the mean of all the measurements.

[b] 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 window glass filters, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Test results can be expected to differ if obtained using xenon-arc apparatus in which the spectral irradiances differed 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 and filters used.

[c] The data in this column was determined by multiplying the CIE No. 85:1989 Table 4 data by the spectral transmittance of 3-mm-thick window glass (see Annex B). These data shall always serve as target values for xenon-arc lamps with window-glass filters.

[d] For the CIE No. 85:1989 Table 4 plus window glass data, the UV irradiance (300 nm to 400 nm) is typically about 9 % and the visible irradiance (400 nm to 800 nm) typically about 91 %, expressed as a percentage of the total irradiance from 300 nm to 800 nm. The percentages of UV irradiance and visible irradiance for actual specimens exposed in xenon-arc apparatus may vary, however, due to the number of specimens being exposed and their reflectance properties.

Normally, the radiant flux shall be chosen so that the time-averaged irradiance E in the plane of the test-panel holders is

— 60 W/m^2 between 300 nm and 400 nm, or 0,51 W/(m^2·nm) at 340 nm (method 1);

— 50 W/m^2 between 300 nm and 400 nm, or 1,1 W/(m^2·nm) at 420 nm (method 2).

If agreed between the interested parties, high-irradiance testing may be used. In this case, the radiant flux shall be chosen so that the time-averaged irradiance E in the plane of the test-panel holders is

— 60 W/m^2 to 180 W/m^2 between 300 nm and 400 nm, or 0,51 W/(m^2·nm) to 1,5 W/(m^2·nm) at 340 nm (method 1);

— 50 W/m^2 to 162 W/m^2 between 300 nm and 400 nm, or 1,1 W/(m^2·nm) to 3,6 W/(m^2·nm) at 420 nm (method 2).

NOTE 1 High-irradiance testing has been shown to be useful for several materials, e.g. automotive interior materials. When using high-irradiance testing, the linearity of the property change with the irradiance has to be checked carefully. Results obtained at different irradiance levels can only be compared if the other test parameters (black-standard or black-panel temperature, chamber air temperature, relative humidity) are similar.

NOTE 2 It is recommended that the actual irradiance E between 300 nm and 800 nm is measured and reported. In the case of discontinuous operation (see 9.4), this value includes the radiation reflected from the inside walls of the test chamber which reaches the plane of the test-panel holders.

NOTE 3 The conversion factors used above to calculate the narrow-band (340 nm or 420 nm) irradiance from the broad-band (300 nm to 400 nm) irradiance are mean values for a variety of filter systems. Details of such conversion factors will normally be provided by the manufacturer.

The irradiance E at any point over the area used for the test panels shall not vary by more than ± 10 % of the arithmetic mean of the total irradiance for the whole area. Any ozone formed by the operation of the xenon-arc lamps shall not enter the test chamber but shall be vented separately. If this is not possible, specimens shall be periodically repositioned to provide equivalent exposure periods in each location.

In order to accelerate ageing further, deviations from the above specifications concerning relative spectral energy distribution and irradiance may be agreed between the interested parties provided that, for the property selected for the particular coating to be tested, the correlation with natural weathering is known. Such further accelerated ageing may be carried out either by increasing the irradiance or by shifting the short-wavelength end of the spectral energy distribution band in a defined manner to shorter wavelengths. Details of any such deviations from the methods specified shall be stated in the test report.

Ageing of the xenon-arc lamps and filters causes the relative spectral energy distribution to change during operation and the irradiance to decrease. Renewal of the lamps and filters will help keep the spectral energy distribution and the irradiance constant. The irradiance may also be kept constant by adjustment of the apparatus. Follow the manufacturer's instructions.

6.3 Test chamber conditioning system

To maintain the test chamber at the black-standard or black-panel temperature specified in 9.2, humidity- and temperature-controlled dust-free air shall be circulated through the test chamber. The temperature and relative humidity of the air in the test chamber shall be monitored using temperature and humidity sensors protected against direct radiation. Only distilled or demineralized water shall be used to maintain the relative humidity at the level specified in 9.5.

NOTE When the test chamber is fed continuously with fresh air, the operating conditions of the apparatus may differ, for example, in the summer from those in the winter, because the moisture content of the air in the summer is generally higher than in the winter. This may influence the test results. The reproducibility of the test may be improved by circulating the air in an essentially closed circuit.

6.4 Device for wetting the test panels (for use in method 1)

NOTE 1 Method 1 includes wetting of the test panels; this is intended to simulate the effects of rain and condensation in an outdoor environment.

The device for wetting the test panels shall be designed so that, during the whole of the wetting period specified in 9.5, the surface under test of all the test panels shall be wetted in one of the following ways:

a) the surface is sprayed with water;

b) the panels in the test chamber are immersed in water.

NOTE 2 Wetting the samples by spraying with water and by immersion in water does not necessarily lead to similar results.

If the test panels rotate around the radiation source, the water-spray nozzles shall be arranged so that the requirements of 9.5 are met for each test panel.

Distilled or demineralized water having a conductivity below 2 µS/cm and a residue on evaporation of less than 1 mg/kg shall be used for wetting.

Recycled water shall not be used unless filtered to give water of the required purity since there is a danger of deposits forming on the test panel surfaces. Such deposits can lead to false results.

The supply tanks, supply pipes and spray nozzles for the water shall be made of corrosion-resistant material.