International Standard

ISO 105-B04

Textiles — Tests for colour fastness —

Part B04: Colour fastness to artificial weathering: Xenon arc fading lamp test

Textiles — Essais de solidité des coloris —

Partie B04: Solidité des coloris aux intempéries artificielles : Lampe à arc au xénon

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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.

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 document 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 38, *Textiles*, Subcommittee SC 1, *Tests for coloured textiles and colorants*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 248, *Textiles and textile products,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fifth edition cancels and replaces the fourth edition (ISO 105-B04:1994), which has been technically revised.

The main changes are as follows:

— the Scope has been refined to differentiate this document from ISO 105-B10;

— the description of the test apparatus has been harmonized with ISO 105-B10. This takes into account current technology, but does not discredit the test procedure described in this document;

— Type I and Type II daylight filters for xenon-arc lamps have been introduced.

A list of all parts in the ISO 105 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

ISO 105 was previously published in thirteen “parts”, each designated by a letter (e.g. “Part A”), with publication dates between 1978 and 1985. Each part contained a series of “sections”, each designated by the respective part letter and by a two-digit serial number (e.g. “Section A01”). These sections are now being republished as separate documents, themselves designated “parts” but retaining their earlier alphanumeric designations.

Textiles — Tests for colour fastness —

Part B04:
Colour fastness to artificial weathering: Xenon arc fading lamp test

1 Scope

This document specifies a method intended for determining the effect on the colour of textiles of all kinds, except loose fibres, to the action of weather as determined by exposure to simulated weathering conditions in a test chamber equipped with a xenon arc lamp. This document focuses on textiles (such as apparel) where the main evaluation criterium is the colour fastness.

This method can be used to determine if a textile is sensitive to the combined effect of light and water.

NOTE 1 General information on colour fastness to light is given in Annex A.

NOTE 2 ISO 105-B10 provides guidance on testing textiles or technical textiles, which are permanently exposed to an outdoor environment and/or require mechanical testing (such as tensile strength determination).

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 105-A01, *Textiles — Tests for colour fastness — Part A01: General principles of testing*

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 105-A05, *Textiles — Tests for colour fastness — Part A05: Instrumental assessment of change in colour for determination of grey scale rating*

ISO 105-B01, *Textiles — Tests for colour fastness — Part B01: Colour fastness to light: Daylight*

ISO 105-B02:2014, *Textiles — Tests for colour fastness — Part B02: Colour fastness to artificial light: Xenon arc fading lamp test*

ISO 105-B08, *Textiles — Tests for colour fastness — Part B08: Quality control of blue wool reference materials 1 to 7*

ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 105-B02 apply.

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

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

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

4 Principle

Test specimens of the textile are exposed under specified conditions to light from a xenon arc lamp and to water spray. At the same time, eight dyed blue wool references are exposed to light but are protected from water spray by a sheet of window glass. The fastness is assessed by comparing the change in colour of the test specimen with that of the references.

If the method is used to determine if a textile is sensitive to the combined effect of light and water (see 7.2), the simultaneous exposure of references is unnecessary. In this case, the assessment shall be performed by comparison with the grey scale in accordance with ISO 105-A02 or by colour measurement in accordance with ISO 105-A05.

5 Materials

5.1 Blue wool references

The reference materials used in this test shall be those blue wool references specified in ISO 105-A01 and ISO 105-B01. The blue wool references 1 to 8 used in this test shall meet the quality requirements specified in ISO 105-B08.

5.2 Glass case for blue wool references

The blue wool references shall be protected from water spray by a shield of glass. The transmission of the glass used shall be at least 90 % in the wavelength range from 380 nm and 750 nm, falling to 0 % between 310 nm and 320 nm. The glass case shall be well ventilated, i.e. there shall be an opening at the top and another at the bottom to allow good circulation of air.

5.3 Specimen mounting cards

For mounting the blue wool references, mounting cards from cardboard free of optical or fluorescent brightening agent shall be used.

For exposure cycles with specimen wetting, specimen mounting cards shall be water resistant. Mounting cards shall be made from material resistant to the exposure conditions, such as stainless steel or inert plastic.

5.4 Specimen covers

Specimen covers to partly cover the front of the test specimens shall be made from opaque cardboard, or other thin opaque material, for example stainless steel or thin sheet aluminium. The cover material shall be inert to the test conditions and not react with the test specimen.

If specimen covers are used for the test specimen, these shall be water resistant.

5.5 Specimen holders

Specimen holders shall be used to hold the test specimen on the specimen mounting card and the specimen covers, if used, during the exposure. Specimen holders shall be made of inert materials that will not affect the test results. They are preferably made in the form of an open frame. If required, a metal plate can be used to close the specimen holders from the rear.

5.6 Grey scale for assessing change in colour

Grey scale for assessing change in colour shall be in accordance with ISO 105-A02.

6 Apparatus

6.1 Laboratory light source

6.1.1 General

The light source shall be one or more quartz-jacketed xenon-arc lamps, which emit radiation from about 270 nm in the ultraviolet through the visible spectrum and into the infrared. In order to simulate global solar radiation at the earth's surface as described in CIE 241[1], CIE-H1, so-called daylight filters shall be used to remove short wavelength UV radiation shorter than 290 nm. In addition, filters to remove infrared radiation may be used to prevent unrealistic heating of test specimens that can cause thermal degradation not experienced during outdoor exposures.

Solar spectral irradiance for a number of different atmospheric conditions is described in CIE 241. Like other International Standards, this document uses CIE 241 as a benchmark for solar spectral irradiance.

The xenon-arc light source may be either air-cooled or water-cooled. The size, form and number of xenon-arc lamps depend on the type of apparatus. When available, an irradiance-controlled light source should be used.

The variation in irradiance over the area covered by the test specimens shall not exceed ±10 % of the mean. If this cannot be achieved, test specimens shall be periodically repositioned to provide equivalent exposure periods in each location. Periodic repositioning of the test specimens in the test chamber is recommended to ensure the most consistent results.

The characteristics of xenon-arc lamps and filters are subject to change during use due to ageing, and lamps and filters shall be replaced at suitable intervals. Furthermore, they are subject to change due to the accumulation of dirt and shall therefore be cleaned at suitable intervals. Follow the manufacturer's recommendations for replacement and cleaning of lamps and filters.

6.1.2 Spectral irradiance

Optical filters are used to reduce the xenon-arc emission in order to simulate daylight (CIE 241, CIE-H1[1]). The minimum and maximum levels for the relative spectral irradiance in the UV wavelength range of radiation are given in Table 1.

Table 1 allows a range of different spectral irradiance distributions in the UV, referred to as general daylight. Depending on the spectral irradiance distribution within the specifications of Table 1, the test results can vary. It is recommended to agree on selection of the filter system according to the Type I or the Type II specification in Table 1 between the interested parties. Background information on the different types of daylight filters can be found in ISO 4892-2[2] and ISO 4892-2:2013/Amd 1:2021, Annex C[3].

Table 1 — Relative spectral irradiance of xenon-arc lamps with daylight filters[a]

Spectral bandpass (λ = wavelength in nm)	General[b]		Type I[f]		Type II[g]		CIE 241, CIE-H1[d,e] %
	Min[c] %	Max[c] %	Min[c] %	Max[c] %	Min[c] %	Max[c] %	
λ < 300	2,60	8,05	0,00	0,20	0,20	1,05	5,86
300 ≤ λ ≤ 320			2,60	6,00	3,50	7,00	
320 < λ ≤ 340	28,2	39,8	10,0	17,0	10,0	17,0	40,4
340 < λ ≤ 360			18,3	23,2	18,3	23,2	
360 < λ ≤ 380	54,2	67,5	25,0	30,5	25,0	30,5	53,8
380 < λ ≤ 400			29,2	37,0	29,2	37,0	

[a] This table gives the irradiance in the given passband, expressed as a percentage of the total irradiance from 290 nm to 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 shall be measured from 250 nm to 400 nm. The total irradiance in each wavelength passband is then summed and divided by the total irradiance from 290 nm to 400 nm. There shall be no irradiance below 290 nm.

[b] The minimum and maximum data in this table are based on more than 100 spectral irradiance measurements for water-cooled and air-cooled xenon-arc instruments with daylight filters from different production lots and various ages (see ISO 4892-2), in accordance with the recommendations of the manufacturer. The minimum and maximum data are at least three sigma limits from the mean of all measurements.

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

[d] The data from CIE 241, CIE-H1 represent global solar spectral irradiance on a horizontal surface with an air mass of 1,0, column ozone of 0,34 cm at standard temperature and pressure (STP), 1,42 cm precipitable water vapour, and spectral optical depth of aerosol extinction of 0,1 at 500 nm. These data serve as target values for xenon-arc lamps with daylight filters.

[e] For the solar spectrum represented by CIE 241, CIE-H1, the UV irradiance (290 nm to 400 nm) is 10,5 % and the visible irradiance (400 nm to 800 nm) is 89,5 %, expressed as a percentage of the total irradiance from 290 nm to 800 nm. These percentages of UV irradiance and visible irradiance on test specimen exposed in xenon-arc devices may vary due to the number and reflectance properties of specimens being exposed.

[f] Daylight filter systems as described in ASTM D7869[4] fall under the definition of Type I Daylight filters.

[g] Daylight filter spectral requirements as described in SAE J2527[5] have been historically achieved using Type II Daylight filters.

6.2 Test chamber

The design of the test chamber may vary, but it shall be constructed from inert material. The test chamber shall provide means for measurement and control of irradiance, black standard or black panel temperature (as described in 6.4.3), chamber air temperature and relative humidity. It shall also provide a system to provide humidification, a device for wetting the surface of the test specimens and a frame to carry specimen holders.

Relative humidity sensors have to be shielded from direct radiation. They can either be electronic humidity sensors, or of the “wet bulb” type, where the humidity is defined by the difference in the air temperature within the test chamber. The location of sensors used to measure humidity shall be according to ISO 4892-1.

The water used for humidification and for wetting the specimen shall comply with the requirements in ISO 4892-1. Unless otherwise specified, water used for specimen spray shall contain a maximum of 1 µg/g of solids and a maximum of 0,2 µg/g of silica. For spraying the test specimens, only completely ion-free water shall be used. Tubing, tanks, and spray jets shall be of corrosion-resistant material.

If equipment is used with irradiance control by adjusting lamp power manually, this shall be noted in the test report.

6.3 Radiometer

An integrated (or on-board) radiometer shall be used for measuring irradiance either in the wavelength range from 300 nm to 400 nm, or at 340 nm, depending on the type of apparatus used (see Annex B). The radiometer shall conform with the requirements outlined in ISO 9370 and ISO 4892-1.

6.4 Temperature sensors

6.4.1 General

Temperature sensors shall be used for measurement of the air temperature within the test chamber, and for the measurement of a black surface to control the surface temperatures of the test specimens during exposure.

6.4.2 Chamber air temperature thermometer

The sensor for measuring the air temperature in the test chamber may either be a thermometer, a thermocouple or a thermal resistor. It shall be fixed in a position where the air temperature is similar to that in front of the test specimens but shielded from the direct radiation from the xenon-arc lamp.

6.4.3 Black-standard thermometer (BST) and black-panel thermometer (BPT)

Two types of black surface thermometers may be used: black-standard thermometer (BST) and black-panel thermometer (BPT). Black surface thermometers are exposed to direct irradiance in a similar way as the test specimens.

Black-standard and black-panel thermometer shall conform with the requirements outlined in ISO 4892-1 (see also ISO 105-B02). Generally, BST and BPT do not give the same readings and the test results may not be comparable.

7 Exposure conditions

7.1 General

The test specimens and the blue wool references are exposed simultaneously in the apparatus (6.1), the test specimens to both light and water spray, and the references to light only.

The test specimens shall be mounted on a suitable holder. The test specimens shall completely enclose the holder and the side to be assessed shall not be in contact with metal plates, other test specimens, or backing fabric.

7.2 Exposure of test specimens

The test specimens shall be subjected to the following accurately adjusted, reproducible weathering cycle:

— duration of spraying: 1 min;

— duration of drying: 29 min.

NOTE 1 The quantity of water delivered to test specimens by water spray can be determined using the procedure in ISO 23741[6].

NOTE 2 Typical irradiance setpoints are 42 W/m^2 in the wavelength range from 300 nm to 400 nm or 0,36 W/(m^2·nm) at 340 nm.

The temperature in the test chamber shall not exceed 40 °C during the drying period.

NOTE 3 A typical chamber air temperature setpoint is 37 °C.

The temperature of the black surface thermometer, which is measured in the centre and under the same illumination as the specimens, shall not exceed 60 °C during the drying period. The control surface temperature setpoint shall be reported in the test report.

NOTE 4 Surface temperature setpoints are selected to achieve the desired air temperature. Typical setpoints are 57 °C (black standard thermometer) or 55 °C (black panel thermometer). For temperature-sensitive textiles, lower setpoints may be used.

If the method is used to determine if a textile is sensitive to the combined effect of light and water, the weathering cycle shall be repeated for a total of 16 h testing.

7.3 Exposure of colour fastness references

The blue wool references (5.1) shall be protected from the water spray by a glass case (5.2) whilst being exposed to light from the same xenon arc lamp as the test specimens.

NOTE The published requirements in previous versions of ISO 105-B04 were not clear and can be interpreted as being more restrictive and not achievable. As such, the current requirements have been revised both to clarify and reflect industry practices.

8 Test specimens

8.1 If the textile to be tested is fabric, prepare two test specimens, each of a suitable size, mounted on holders or other equipment which will fit the weathering test equipment.

8.2 If the textile to be tested is yarn, knit or weave it into fabric and treat it as described in 8.1.

8.3 Mount strips of blue wool references on cardboard, (5.3), cover one-third of each as described in ISO 105-B02:2014, 8.3.2.2 and fix the mounted references under glass according to 7.3.

8.4 Unexposed specimens of original fabric identical to those being tested are required as references for comparison with the test specimens during weathering.

9 Procedure

9.1 General

9.1.1 Place the test specimens mounted on the holders in the apparatus and expose them continuously to weathering (see 7.2) following Methods 1, 2 or 3 (see 9.2).

9.1.2 At the same time, expose the mounted and partially covered blue wool references (see 5.1 and 8.3) to light in the glass case of the same apparatus (see 7.3).

9.1.3 Only one side of the test specimen shall be exposed to weathering and light.

9.1.4 Whilst the test specimens are drying, the air in the test chamber shall not be moistened.

NOTE The actual conditions of the weathering test depend on the kind of test apparatus used.

9.1.5 The test specimens shall not be washed after the weathering test.

NOTE Natural outdoor weathering according to ISO 105-B03[8] stipulates specimen washing after the exposure.

9.2 Exposure methods

9.2.1 General

There are three separate methods given (Methods 1, 2 and 3), each of which produce different amounts of information. The user should select the most appropriate method for their application.

9.2.2 Method 1

9.2.2.1 This method is considered most satisfactory and is mandatory in cases of dispute over the numerical rating. The basic feature is the control of the exposure periods by inspection of the test specimen and, therefore, one set of blue wool references is required for each test specimen. It is therefore impractical when large numbers of specimens have to be tested concurrently; in such cases, Method 2 (see 9.2.3) shall be used.

9.2.2.2 Expose the test specimens and the blue wool references following the procedure described in 9.1 until the contrast between the exposed test specimens and a portion of the original fabric (8.4) is equal to grey scale grade 3. Remove one of the test specimens and cover a second one-third of the references with an additional opaque cover.

9.2.2.3 Continue the exposure until the contrast between the remaining test specimen and a portion of the unexposed original fabric is equal to grey scale grade 2. If blue wool reference 7 fades to a contrast equal to grey scale grade 4 before the contrast between the test specimen and the portion of the original fabric is equal to grey scale grade 2, the exposure may be concluded at this stage, and the remaining test specimen and the reference removed.

9.2.2.4 Prepare both test specimens, and a portion of the original fabric (8.4) for assessment (see 9.3 and 9.4).

9.2.2.5 If textiles are to be examined for their sensitivity to the combined effect of light and water, a 16 h testing period shall be used prior to assessment.

9.2.2.6 Assess the colour fastness to weathering in accordance with the method given in 10.1 to 10.3.

9.2.3 Method 2

9.2.3.1 This method should be used when the number of specimens to be tested simultaneously is so large that Method 1 is impractical. The basic feature of this method is the control of the exposure period by inspection of the blue wool references, which allows a number of test specimens differing in weathering fastness to be tested against only one set of references, thus conserving supplies of the latter.

9.2.3.2 Expose the test specimens and the blue wool references following the procedure described in 9.1 until the contrast between the exposed and unexposed portions of reference 6 is equal to grey scale grade 4. At this stage, remove one test specimen from each pair and cover a second one-third of the blue wool references with an additional opaque cover.

9.2.3.3 Continue the exposure until the contrast between the fully exposed and unexposed portions of reference 7 is equal to grey scale grade 4. Remove the remaining test specimens and the references.

9.2.3.4 Prepare the exposed test specimens and a portion of the original fabric (8.4) from each specimen for assessment (see 9.3 and 9.4).

9.2.3.5 Assess the colour fastness to weathering of each test specimen in accordance with the method given in 10.1 to 10.3.

9.2.4 Method 3

Where the test is to be used to check conformity of colour fastness to exposure to agreed-upon radiant energy levels, it is permissible to expose the test specimens alone or with references. The test specimens should undergo weathering for the time required for exposure to the specified level of radiant energy, then removed together with the blue wool references and evaluated in accordance with Clause 10.

9.3 Drying

Before mounting the tested specimens for assessment, dry them in air at a temperature not exceeding 60 °C.

9.4 Mounting for assessment

Trim and mount the tested specimens so that they measure at least 15 mm × 30 mm, one on each side of a portion of the original fabric (8.4) which has been trimmed to the same size and shape as the test specimens. The test specimen exposed for the shorter length of time shall be mounted on the left.

10 Assessment of colour fastness to weathering

10.1 Assess the magnitude of the contrast between the test specimen exposed for the shorter time and the original fabric in terms of the contrasts produced on the blue wool references exposed for the same period: the assessment is the number of the blue wool reference showing the contrast closest to that of the test specimen. If the test specimen shows changes in colour approximately half-way between two blue wool references, an appropriate half-rating, for example 5-6, shall be given.

10.2 Assess the magnitude of the contrast between the test specimen exposed for the longer time and the original fabric in terms of the contrasts produced in the blue wool references exposed for the same period: the assessment is the number of the blue wool reference showing the contrast closest to that of the test specimen. If the test specimen shows changes in colour approximately half-way between two blue wool references, an appropriate half-rating, for example 3-4, shall be given.

10.3 If test specimens larger than the blue wool references are exposed, a mask of a neutral grey colour approximately midway between that illustrating grade 1 and that illustrating grade 2 of the grey scale for assessing change in colour (see 5.6) shall be used in the assessment, the mask covering the surplus area of the test specimens and leaving open an area equal to that of the blue wool references for comparative evaluation.

10.4 To determine if the test specimen is sensitive to the combined effect of light and water, after 16 h weathering assess the magnitude of the contrast between the exposed test specimen and the original fabric by comparison with the grey scale. If a colour change greater than 4-5 on the grey scale was obtained, the textile is judged to be sensitive to the combined effect of light and water; if a colour change of 4-5 or 5 on the grey scale was obtained, the textile is judged not to be sensitive to the combined effect of light and water.

10.5 The term “change in colour” includes not only true “fading”, i.e. destruction of dyes, but also changes in hue, depth, lightness or any combination of these characteristics of colour. If the difference in colour is a change of hue or lightness, this can be indicated by adding abbreviations, as follows, to the numerical colour fastness rating:

— Bl: bluer

— Y: yellower

— G: greener

— R: redder

— D: duller

— Br: brighter

If the change in hue is accompanied by a change in depth, this can also be indicated:

— W: weaker

— Str: stronger

10.6 Exposures based on an agreed-upon radiant energy level (see 9.2.4 Method 3) are assessed either by numerical quantification against the grey scale (5.6) for assessing change in colour, in accordance with ISO 105-A02, or by colour measurement in accordance with ISO 105-A05, or by comparison of the change in colour of the test specimen with that of the blue wool references.

11 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 105-B04:2024;

b) all details necessary for the identification of the test specimen;

c) for Methods 1 and 2, the numerical rating for colour fastness to weathering: xenon lamp. If the two assessments (see 10.1 and 10.2) are different, report only the lower;

d) for Method 3, the numerical rating for colour fastness to weathering together with the specified amount of radiant energy, or if no blue wool references are used, the rating of the colour change assessed by comparison with the grey scale in accordance with ISO 105-A02 or by colour measurement in accordance with ISO 105-A05 and prefixed by the text “grey scale grade”.

e) the type of apparatus used for the test, including the type of filter;

f) optionally, if the textile was sensitive to the combined effect of light and water (see 10.4);

g) the Method (1, 2 or 3);

h) the date of the test;

i) the duration of exposure or the radiant exposure;

j) details on specimen holders and mounting of the test specimens;

k) any deviations from this test method;

l) any unusual features observed.

Annex A
(informative)

General information on colour fastness to light

A.1 When in use, textiles are usually exposed to light. Light tends to destroy colouring matters and the result is the well-known defect of "fading", whereby coloured materials change colour — usually becoming paler and duller. Dyes used in the textile industry vary enormously in their resistance to light. Therefore, there is a need for some method of measuring their fastness. The substrate also influences the colour fastness of a dye to light.

This document cannot completely satisfy all the interested parties (who range from dye manufacturers and the textile industry to wholesale and retail traders and the general public) without becoming technically involved and possibly difficult to understand by many who have a direct interest in its application.

A.2 The following non-technical description of a test for colour fastness to light has been prepared for the benefit of those who find the detailed technicalities of this document difficult to understand. The method is to expose the pattern being tested and to expose also, at the same time and under the same conditions, a series of colour fastness references which are pieces of wool cloth dyed with blue dyes of different degrees of fastness. When the pattern has faded sufficiently, it is compared with the references and if it has behaved, for instance, like reference 4[1)], then its colour fastness is said to be 4.

A.3 The colour fastness references should cover a wide range since some patterns fade noticeably after exposure for 2 h or 3 h to bright summer sunshine, although others can withstand several years' exposure without change, the dyes in fact outliving the material to which they have been applied. Eight references have been chosen, reference 1 being the most fugitive and reference 8 the most resistant. If it takes a certain length of time for reference 4 to fade under certain conditions, then the same amount of fading will occur on reference 3 in approximately half that time, or on reference 5 in approximately twice that time, provided that the conditions are the same.

A.4 It is necessary to ensure that different people testing the same material will fade it to the same extent before assessment against the simultaneously faded reference. The ultimate users of dyed material differ widely in what they consider to be "faded articles" and therefore patterns under test are faded to two different degrees which adequately cover most opinions and make assessment more reliable. These required degrees of fading are defined by reference to a collection of "grey scale" reference contrasts (grey scale 5 equals no contrast, grey scale 1 equals large contrast). Thus, the use of the grey scale enables fading to be taken to defined extents, and the blue wool cloths enable the colour fastness to be rated.

This general principle of assessing on the basis of moderate and severe fading is complicated, however, by the fact that some patterns on exposure undergo a slight change very rapidly indeed but do not change further for a long time. These slight changes are such that under normal conditions of use they would seldom be observed, but in certain cases they become important, as the following example shows.

A retailer has a length of curtain fabric in his window and on it is a cardboard ticket indicating the price. After a few days the ticket is removed and careful examination reveals the place where it has been resting because the surrounding cloth has changed shade slightly on exposure to light. Some of this curtain material is exposed so as to produce a moderate degree of fading and it is found that reference 7 has faded to the same extent; the general colour fastness of the fabric is therefore 7.

The important factor about this slight change in shade is that it can only be detected when there is a sharp boundary between the exposed and unexposed areas, and these conditions rarely occur during normal use.

1) The designations of the colour fastness references referred to here are those of the European set, but the principles explained are equally valid for the American set (see ISO 105-B01).

The magnitude of this slight change would be given as an additional assessment in brackets. Thus, a rating for a test can be 7(2), indicating a slight initial change equivalent to the first perceptible fade of reference 2, but otherwise a high colour fastness of 7.

A.5 A further unusual colour change is also catered for, namely photochromism. This effect is shown when a dye changes colour rapidly on exposure to strong light but on removal to a dark place the original colour returns more or less completely. The extent of photochromism is determined by the special test described in ISO 105-B05 and is shown in the rating by a number following the letter P within brackets; for example 6(P2) means a photochromic effect equal to a grey scale 2 contrast but permanent fading equal to that of reference 6.

A.6 Finally, there are many patterns which change hue on prolonged exposure to light; for example, a yellow can become brown, or a purple can become blue. In the past there have been many arguments as to whether such patterns could be said to have faded or not. The technique used in ISO 105-B01 to ISO 105-B05 is unambiguous on this point; it is visual contrast on exposure which is being measured, whether it be loss of colour or change in hue; in the latter case, however, the kind of change is included in the assessments. For example, consider two green patterns which, on exposure, change in appearance at the same rate as reference 5; one becomes paler and finally white, while the other becomes first a greenish blue and finally a pure blue. The former would be rated “5” and the latter “5 bluer”. In this instance also, the technique used in ISO 105-B01 to ISO 105-B05 tries to present as complete a picture of the behaviour of a pattern on exposure as is possible without becoming excessively complicated.

Annex B
(informative)

Radiometer for controlling exposure duration

The apparatus for use in this method may be equipped with a monitoring/controlling radiometer for controlling the lengths of exposure time.

A radiometer employing a broad bandpass filter restricting measurement in the wavelength range from 300 nm to 400 nm has been used satisfactorily.

Filter radiometers capable of integrating irradiance with respect to time are satisfactory.

The calibration of the radiometer shall be certified by the manufacturer for a specified time interval when used in the manner described herein.

Bibliography

[1] CIE 241, *Recommended Reference Solar Spectra for Industrial Applications*

[2] ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

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[4] ASTM D7869, *Standard Practice for Xenon Arc Exposure Test with Enhanced Light and Water Exposure for Transportation Coatings*

[5] SAE J2527, *Performance Based Standard for Accelerated Exposure of Automotive Exterior Materials Using a Controlled Irradiance Xenon-Arc Apparatus*

[6] ISO 23741, *Plastics — Determination of spray water delivery during spray cycles when using a xenon arc weathering test apparatus*

[7] ISO 105-B10, *Textiles — Tests for colour fastness — Part B10: Artificial weathering — Exposure to filtered xenon-arc radiation*

[8] ISO 105-B03, *Textiles — Tests for colour fastness — Part B03: Colour fastness to weathering: Outdoor exposure*

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