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Third edition
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Tissue paper and tissue products —

Part 7: Determination of optical properties — Measurement of brightness and colour with D65/10° (outdoor daylight)

Papier tissue et produits tissue —

Partie 7: Détermination des propriétés optiques — Mesurage du degré de blancheur et de la couleur en D65/10° (lumière du jour extérieure)

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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 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 172, *Pulp, paper and board,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 12625-7:2014), which has been technically revised.

The main changes compared to the previous edition are as follows:

— alternative formulae in 11.2.1 have been removed because they were not relevant for tissue paper.

A list of all parts in the ISO 12625 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

Brightness and colour measurement can be performed under various illumination and observation conditions. This document deals with D65/10° conditions, which refer to an outdoor daylight.

C/2° conditions (indoor daylight) are considered in ISO 12625-15. Although both International Standards deal with brightness and colour, results obtained are usually different and do not correlate.

Optical measurement is affected by the geometry of the instruments used and by the texture of the material. The design of the instrument to use according to this document and the routine to adopt for its calibration are specified in ISO 2469 and ISO 11475.

The optical properties are related to the visual appearance of the material. Therefore, although optical properties are intrinsic properties of tissue paper, they are not functional properties.

Brightness should not be confused with the optical property called CIE whiteness, which is based on reflectance data obtained over the full visible spectral range (VIS) in contrast to the measurement of brightness, which is limited to the blue region of VIS.

Due to its importance for some countries, three different test methods for the determination of optical properties were developed:

— this document, i.e. ISO 12625-7;

— ISO 12625-15;

— ISO 12625-16.

Tissue paper and tissue products —

Part 7:
Determination of optical properties — Measurement of brightness and colour with D65/10° (outdoor daylight)

1 Scope

This document specifies testing procedures for the instrumental determination of brightness and colour of tissue paper and tissue products viewed under outdoor daylight conditions. It also gives specific instructions for the preparation of test pieces (single-ply, multi-ply products) and for the optical measurements of products, where special precautions can be necessary.

NOTE The properties called ISO brightness and colour with C/2° (indoor daylight) are measured with an instrument adjusted to a much lower UV content than that specified in this document. The measurements of ISO brightness and colour with C/2° (indoor daylight) are described in ISO 12625-15.

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 186, *Paper and board — Sampling to determine average quality*

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 2469, *Paper, board and pulps — Measurement of diffuse radiance factor (diffuse reflectance factor)*

ISO 4094, *Paper, board and pulps — General requirements for the competence of laboratories authorized for the issue of optical reference transfer standards of level 3*

ISO 11475:2017, *Paper and board — Determination of CIE whiteness, D65/10 degrees (outdoor daylight)*

ISO/CIE 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b* colour space*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
diffuse radiance factor
R
ratio of the radiation reflected and emitted from a body to that reflected from the perfect reflecting diffuser under the same conditions of diffuse illumination and normal detection

Note 1 to entry: The ratio is often expressed as a percentage.

[SOURCE: ISO 2469:2014, 3.2]

3.2
intrinsic diffuse radiance factor
R_∞
diffuse radiance factor (3.1) of a layer or pad of material thick enough to be opaque, i.e. such that increasing the thickness of the pad by doubling the number of sheets results in no change in the measured radiance factor

Note 1 to entry: The radiance factor of a single non-opaque sheet is dependent on the background and is not a material property.

Note 2 to entry: The ratio is often expressed as a percentage.

[SOURCE: ISO 2469:2014, 3.3]

3.3
reflectance factor
quotient of the flux reflected in the directions by a given cone with apex at a surface element and the flux reflected in the same directions by a perfect reflecting diffuser identically irradiated or illuminated

Note 1 to entry: The ratio is often expressed as a percentage.

Note 2 to entry: This term shall be used only when it is known that the test material exhibits no luminescence (fluorescence).

[SOURCE: CIE S 017 ILV:2020, 17-24-070]

3.4
D65 brightness
intrinsic diffuse radiance factor (3.2) measured with a reflectometer having the characteristics described in ISO 2469, equipped with a filter or corresponding function having an effective wavelength of 457 nm (and a half bandwidth of 44 nm), and adjusted so that the UV content of the irradiation incident upon the test piece corresponds to that of the CIE standard illuminant D65

Note 1 to entry: The filter function is described more fully by the weighting factors given in ISO 2470-2.

3.5
tristimulus values
X_{10},Y_{10},Z_{10}
amounts of the reference colour stimuli, in a given trichromatic system, required to match the colour of the stimulus considered

Note 1 to entry: In ISO 5631-2 the CIE standard illuminant D65 and the CIE 1964 (10°) standard observer are used to define the trichromatic system.

Note 2 to entry: The subscript 10 is applied to conform to the CIE convention that tristimulus units have the subscript 10 when the CIE 1964 (10°) standard colorimetric observer is used.

[SOURCE: CIE S 017 ILV:2020, 17-23-038]

3.6
colour (D65/10°)
L^*, a^* and b^* values of the sample according to the CIELAB 1976 system described in ISO/CIE 11664-4, corresponding to the CIE standard illuminant D65 described in ISO 11664-2 and the CIE 1964 standard colorimetric observer described in ISO/CIE 11664-1, determined by measurement under the conditions specified in ISO 5631-2

Note 1 to entry: The quantity L^* is a measure of the lightness of the test piece, where $L^* = 0$ corresponds to black and $L^* = 100$ is defined by the perfect reflecting diffuser. Visually, the quantities a^* and b^* represent respectively the red-green and yellow-blue axes in colour space, such that

— $+a^*$ is a measure of the degree of redness of the test piece,

— $-a^*$ is a measure of the degree of greenness of the test piece,

— $+b^*$ is a measure of the degree of yellowness of the test piece,

— $-b^*$ is a measure of the degree of blueness of the test piece, and

— if both a^* and b^* are equal to zero, the test piece is grey.

4 Principle

A test piece is illuminated diffusely in a standardized instrument and the light reflected normal to the surface is either allowed to pass through a defined optical filter and then measured by a photodetector or measured by an array of photosensitive diodes, where each diode responds to a different effective wavelength. The brightness is then determined directly from the output from the photodetector or by calculation from the photosensitive diode outputs using the appropriate weighting function and colour coordinates are calculated for D65/10° conditions.

Precision data are available in Annex A.

5 Apparatus

5.1 Reflectometer or spectrophotometer, having the geometric, spectral and photometric characteristics described in ISO 2469 and calibrated in accordance with the provisions of ISO 2469, and equipped for the measurement of blue reflectance factor.

5.1.1 In the case of a filter **reflectometer**, the radiation falling upon the test piece shall have a UV content corresponding to that of the CIE standard illuminant D65, adjusted or verified using the fluorescent reference standard (5.2.2).

5.1.2 In the case of an abridged **spectrophotometer**, the instrument shall have an adjustable filter with a cut-off wavelength of 395 nm or some other system for adjustment and control and this filter shall be adjusted or the system shall be calibrated using the fluorescent reference standard (5.2.2), so that the UV content of the illumination falling upon the sample corresponds to that of the CIE standard illuminant D65.

5.2 Reference standard for calibration of the instrument

5.2.1 Non-fluorescent reference standard for photometric calibration, issued by an ISO 4094 authorized laboratory in accordance with the provisions of ISO 2469.

5.2.2 Fluorescent reference standard for use in adjusting the UV content of the radiation incident upon the sample, having a CIE whiteness (D65/10°) unit assigned by an ISO 4094 authorized laboratory as prescribed in ISO 11475:2017, Annex B.

NOTE 1 Greater precision in the D65 brightness measurement would be attained if a fluorescent reference standard having an assigned D65 brightness unit were used. It is, however, important for the industry to have only one UV-filter adjustment for all measurements under CIE illuminant D65 conditions. For this reason, a reference standard having an assigned CIE whiteness (D65/10°) value as prescribed in ISO 11475 is used.

NOTE 2 To use sufficiently frequently to ensure satisfactory calibration and UV adjustment.

5.3 Working standards

5.3.1 Two plates of flat opal glass, ceramic or other suitable non-fluorescent material, cleaned and calibrated as described in ISO 2469.

NOTE In some instruments, the function of the primary working standard is taken over by a built–in internal standard.

5.3.2 Stable plastic or other tablet, incorporating a fluorescent whitening agent.

5.3.3 Black cavity, having a reflectance factor that does not differ from its nominal value by more than 0,2 %, at all wavelengths. The black cavity should be stored upside down in a dust-free environment or with a protective cover.

NOTE The condition of the black cavity can be checked by reference to the instrument maker.

6 Calibration

6.1 Using the values assigned to the non-fluorescent reference standard (5.2.1), calibrate the instrument according to the instrument maker's instruction with the UV-cut-off filters removed from the radiation beams. The setting of the UV-adjustment filter is not important at this stage.

6.2 Using the appropriate measurement procedure, measure the radiance factors of the fluorescent reference standard (5.2.2); calculate the whiteness value and compare the measured whiteness value with the whiteness value assigned to the fluorescent reference standard.

A measured whiteness unit higher than the assigned unit indicates that the relative UV-content is too high and vice versa.

6.3 Using the UV-adjustment filter or other adjustment device, adjust the UV-content of the illumination until measurement gives the correct whiteness value.

6.4 Repeat the calibration as described in 6.1 using the non-fluorescent reference standard (5.2.1) with the UV-adjustment filter in the position that gave the correct whiteness value. Repeat the measurement of the whiteness of the fluorescent reference standard (5.2.2) as described in 6.2. If the measured whiteness value obtained does not agree with the assigned value, adjust the position of the UV-adjustment filter until measurement gives the correct whiteness value as described in 6.3.

6.5 Repeat 6.4 until the correct value for the whiteness of the fluorescent reference standard is obtained with the instrument correctly calibrated to the non-fluorescent reference standard. The UV-content is now correctly adjusted with respect to whiteness to a relative UV-content equivalent to the D65 illuminant. Record the setting of the UV-adjustment.

NOTE 1 This setting is equivalent to the D65 illuminant and CIE 1964 (10°) observer with respect to whiteness. Variations in the green/red tint value can still arise and it cannot be assumed that the tristimulus values and other parameters will also be exactly those applicable to the D65 illuminant.

NOTE 2 In some instruments, the procedure indicated in 6.2 to 6.5 is performed automatically.

6.6 Assign reference values to working standards.

Perform D65 brightness and colour (D65/10°) CIE- L^*, a^* and b^* measurements on the non-fluorescent material (5.3.1). Assign these reference values to the non-fluorescent material as working standard.

Perform D65 brightness and colour (D65/10°) CIE- L^*, a^* and b^* measurements on the fluorescent material (5.3.2). Assign these reference values to the fluorescent material as working standard.

This working standard may only be used in the specific instrument in which its value was assigned and shall only be used to monitor changes in the lamps. A new value shall be assigned with a fluorescent

reference standard of level 3 (5.2.2), if the lamps are changed or the used working standards show significant deviations.

NOTE Instead of using L^*, a^* and b^* values R_x, R_y, R_z can be used as assigned reference values.

7 Sampling

If the tests are being made to evaluate a lot, the sample shall be selected in accordance with ISO 186. If the tests are being made on another type of sample, make sure, the specimens taken are representative of the sample received.

When sampling finished roll products, eliminate at least the first six layers and the last six layers because of the possible presence of adhesive or mechanical damage.

Mark the samples for identification, and make sure that the two sides of the paper or of the product can be distinguished.

8 Conditioning

Condition the samples according to ISO 187, and keep them in the standard atmosphere throughout the test. Preconditioning with elevated temperatures should not be applied since it might change the optical properties.

9 Preparation of test pieces

Cut test pieces of at least 50 mm x 50 mm or 50 mm in diameter that are free from dirt, perforation and any defect. Assemble sufficient test pieces in a pad with their top sides uppermost; the number of test pieces should be such that doubling the number does not alter the reflectance factor.

Protect the pad by placing a protecting sheet on both the top and bottom of the pad. Avoid contamination and unnecessary exposure to light or heat.

If the pads are very voluminous and bulky, steps shall be taken to expel the air. The pads should be carefully compressed between the protecting sheets.

Mark the pad in one corner to identify the sample and the marked side.

10 Procedure

10.1 General

Remove the protecting sheets from the pad of test pieces and measure the optical properties on the top side and if required, on the reverse side of the test pieces, as described in the relevant subclause below.

Steps should be taken, without damaging the material, to ensure that the pad is pressed against the measuring opening under sufficient pressure to give a compact pad that does not intrude into the measurement sphere.

10.2 Measurement of D65 brightness

The UV-content of the illumination shall be adjusted to correspond to the D65 illuminant, as described in Clause 6.

Remove the protecting sheets from the pad of the test pieces and measure the D65 brightness (reflectance factor at an effective wavelength of 457 nm) of the marked side of the test-piece pad. Read and record the value to the nearest 0,05 % reflectance factor or better. Move the uppermost test piece