INTERNATIONAL STANDARD

ISO 5631-3

First edition
2008-12-15

Paper and board — Determination of colour by diffuse reflectance —

Part 3: Indoor illumination conditions (D50/2°)

Papier et carton — Détermination de la couleur par réflectance diffuse —

Partie 3: Conditions d'éclairage intérieur (D50/2°)

Reference number
ISO 5631-3:2008(E)

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 ... iv
Introduction ... v
1 Scope ... 1
2 Normative references ... 1
3 Terms and definitions ... 1
4 Principle ... 3
5 Apparatus ... 3
6 Sampling and conditioning ... 4
7 Preparation of test pieces ... 4
8 Procedure ... 4
9 Calculation ... 4
9.1 CIE tristimulus values ... 4
9.2 CIELAB coordinates ... 4
9.3 Dispersion of the results ... 5
10 Expression of results ... 6
11 Precision ... 6
12 Test report ... 6
Annex A (normative) Calculation of tristimulus values ... 7
Bibliography ... 10

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 5631-3 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*.

ISO 5631 consists of the following parts, under the general title *Paper and board — Determination of colour by diffuse reflectance*:

— *Part 1: Indoor daylight conditions (C/2°)*

— *Part 2: Outdoor daylight conditions (D65/10°)*

— *Part 3: Indoor illumination conditions (D50/2°)*

Introduction

The colour of an object can be uniquely characterized by means of a triplet of colour coordinates such as the CIE tristimulus values or the CIELAB 1976 L^*, a^*, b^* coordinates.

Apart from the optical properties of the sample, the values of such coordinates depend upon the conditions of measurement, particularly the spectral and geometric characteristics of the instrument used. This part of ISO 5631 should therefore be read in conjunction with ISO 2469.

This part of ISO 5631 describes the measurement and description of colour in terms of the CIE illuminant D50 and the CIE 1931 (2°) standard observer. The method is especially applicable to graphic arts situations since these illuminant/observer conditions are used within the graphic arts industry. It is, however, emphasized that this is only a partial approach to the graphic arts conditions, since ISO 13655 also specifies measurement with a 45:0 or 0:45 geometry of a single sheet over a specified black backing. It is intended particularly for use in situations where papers are to be compared in a light booth adjusted to match the CIE illuminant D50.

The other parts of this International Standard describe measurements and calculations carried out in an analogous manner using either the CIE illuminant C and the CIE 1931 (2°) standard observer (ISO 5631-1) or the CIE standard illuminant D65 and the CIE 1964 (10°) standard observer (ISO 5631-2). The choice of illuminant conditions is important when determining the colour coordinates of white papers containing a fluorescent whitening agent. In ISO 5631-2, the UV content of the illumination is much higher, approximating UV levels encountered in outdoor viewing conditions.

Paper and board — Determination of colour by diffuse reflectance —

Part 3: Indoor illumination conditions (D50/2°)

1 Scope

This part of ISO 5631 specifies a method for measuring the colour of paper and board by the diffuse reflectance method with the elimination of specular gloss.

This part of ISO 5631 is primarily intended for measuring the colour of paper and board to be used in the graphic arts industry where that industry specifies the measurement of colour under D50/2° conditions in accordance with ISO 13655.

The method may be used to determine the colour of papers or boards that contain fluorescent whitening agents, provided the UV content of the illumination on the test piece has been adjusted to conform to that in the CIE illuminant C, using a fluorescent reference standard provided by an authorized laboratory, as described in ISO 2470-1.

This part of ISO 5631 is not applicable to coloured papers or boards that incorporate fluorescent dyes or pigments.

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 2469, *Paper, board and pulps — Measurement of diffuse radiance factor*

ISO 2470-1, *Paper, board and pulps — Measurement of diffuse blue reflectance factor — Part 1: Indoor daylight conditions (ISO brightness)*

CIE Publication 15:2004, *Colorimetry*, 3rd ed.

ASTM E 308-06, *Standard Practice for Computing the Colors of Objects by Using the CIE System*

3 Terms and definitions

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

3.1
radiance factor
β
ratio of the radiance of a surface element of a body in the direction delimited by a given cone, with its apex at the surface element, to that of the perfect reflecting diffuser under the same conditions of illumination

NOTE For fluorescent (luminescent) materials, the total radiance factor, β, is the sum of two portions, the reflected radiance factor, β_S, and the luminescent radiance factor, β_L, so that $\beta = \beta_S + \beta_L$.

For non-fluorescent materials, the reflected radiance factor, β_S, is numerically equal to the reflectance factor, R.

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

NOTE The ratio is often expressed as a percentage.

3.3
reflectance factor
R
ratio of the radiation reflected by a surface element of a body in the direction delimited by a given cone, with its apex at the surface element, to that of the perfect reflecting diffuser under the same conditions of illumination

NOTE 1 The ratio is often expressed as a percentage.

NOTE 2 The reflectance factor is influenced by the backing if the body is translucent.

3.4
intrinsic reflectance factor
R_∞
reflectance factor of a layer or pad of material thick enough to be opaque, such that increasing the thickness of the pad by doubling the number of sheets results in no change in the measured reflectance factor

NOTE The reflectance factor of a non-opaque sheet is dependent on the background and is not a material property.

3.5
tristimulus values
X_2, Y_2, Z_2
amounts of the three reference colour stimuli, in a given chromatic system, required to match the stimulus considered

NOTE 1 In this part of ISO 5631, the CIE illuminant D50 and the CIE 1931 standard observer are used to define the trichromatic system.

NOTE 2 The subscript 2 is applied to conform to the CIE convention that tristimulus values have the subscript 2 when the CIE 1931 (2°) standard observer is used.

3.6
CIELAB colour space
three-dimensional, approximately uniform colour space, produced by plotting, in rectangular coordinates L^*, a^*, b^*, quantities defined by the equations given in Clause 9

NOTE 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.

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

4 Principle

The light reflected from a sample under specified conditions is analysed either by a tristimulus-filter colorimeter or by an abridged spectrophotometer, and the colour coordinates are then calculated for D50/2° conditions.

5 Apparatus

5.1 Reflectometer.

5.1.1 Reflectometer, having the geometric, spectral and photometric characteristics described in ISO 2469, and calibrated in accordance with the provisions of ISO 2469.

If materials containing fluorescent whitening agents are to be measured, the reflectometer shall be equipped with a radiation source having an adequate UV-content control, adjusted to a UV condition corresponding to the C illuminant by the use of a reference standard, as described in ISO 2470-1.

5.1.2 In the case of a filter reflectometer, a set of filters that, in conjunction with the optical characteristics of the basic instrument, give overall responses equivalent to the CIE tristimulus values X, Y and Z of the CIE 1931 standard colorimetric system of the test piece evaluated for the CIE illuminant D50.

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 illuminant C.

5.1.3 In the case of an abridged spectrophotometer, the instrument shall have a function that permits calculation of the CIE tristimulus values X, Y and Z of the CIE 1931 standard colorimetric system of the test piece evaluated for the CIE illuminant D50, using the weighting functions given in Annex A.

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 equivalent system, and this filter shall be adjusted or the system shall be calibrated with the help of 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 illuminant C.

5.2 Reference standards, for calibration of the instrument and the working standards and used frequently enough to ensure satisfactory calibration and UV adjustment.

5.2.1 Non-fluorescent reference standard, for photometric calibration, issued by an ISO/TC 6 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 an ISO brightness value assigned by an ISO/TC 6 authorized laboratory, as prescribed in ISO 2470-1.

5.3 Working standards, calibrated frequently enough to ensure that satisfactory calibration is maintained.

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

NOTE In some instruments, the function of the primary working standard may be taken over by a built-in internal standard.

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

5.4 Black cavity, having a reflectance factor which 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 1 The condition of the black cavity can be checked by reference to the instrument maker.