INTERNATIONAL STANDARD

ISO 2469

Third edition
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Paper, board and pulps — Measurement of diffuse reflectance factor

Papier, carton et pâtes — Mesurage du facteur de réflectance diffuse

Reference number
ISO 2469:1994(E)

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.

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.

International Standard ISO 2469 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*.

This third edition cancels and replaces the second edition (ISO 2469:1977), of which it constitutes a technical revision.

Annexes A and B form an integral part of this International Standard.

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Introduction

The reflectance factor depends on the conditions of measurement, particularly the spectral and geometric characteristics of the instrument used. The diffuse reflectance factor is determined using instruments having the characteristics given in annex A.

Measurements of reflectance factor need to be made to a high degree of accuracy. The only practical means of achieving this is by calibration using ISO reference standards of level 3 (see 3.6). It is, therefore, essential that a number of laboratories be appointed as standardizing laboratories for the issue of ISO reference standards of level 2 and that a number of laboratories be appointed as authorized laboratories for the issue of ISO reference standards of level 3. These laboratories shall, by the interchange of ISO reference standards of level 2 and level 3 respectively, check their results and agree upon the value to be assigned to these reference standards with respect to the ISO reference standard of level 1. This method is entirely dependent on these arrangements being established and maintained within and between countries.

Since the publication of the first edition of ISO 2469 (ISO 2469:1973), experience has indicated that greater interlaboratory precision can be achieved if this calibration system is more rigorously defined. Such amendments are included in this third edition of ISO 2469.

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Paper, board and pulps — Measurement of diffuse reflectance factor

1 Scope

This International Standard specifies the equipment for measuring the diffuse reflectance factor of pulp, paper and board and the procedures for calibrating that equipment.

Measurements of diffuse reflectance factor are used for the evaluation of optical properties such as diffuse blue reflectance factor (ISO brightness), the scattering coefficient of pulp, opacity, whiteness, luminous reflectance factor, the chromaticity coordinates of paper and the intrinsic reflectance factor of non-fibrous materials. Numerical values optically characterizing the materials are calculated specifically for each property determined.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 186:1994, *Paper and board — Sampling to determine average quality.*

ISO 2470:1977, *Paper and board — Measurement of diffuse blue reflectance factor (ISO brightness).*

ISO 2471:1977, *Paper and board — Determination of opacity (paper backing) — Diffuse reflectance method.*

ISO 3688:1977, *Pulps — Measurement of diffuse blue reflectance factor (ISO brightness).*

ISO 4094:1991, *Paper, board and pulps — International calibration of testing apparatus — Nomination and acceptance of standardizing and authorized laboratories.*

IEC 50(845):1987, *International electrotechnical vocabulary — Chapter 845: Lighting.*

ASTM E 308:1990, *Standard Test Method for Computing the Colors of Objects by Using the CIE System.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 reflectance factor: The ratio, expressed as a percentage, of the radiation reflected by a body to that reflected by the perfect reflecting diffuser under the same conditions.

3.2 diffuse reflectance factor, R: The ratio, expressed as a percentage, of the radiation reflected by a body to that reflected by the perfect reflecting diffuser under the same conditions of diffuse illumination and normal viewing described in this International Standard in an instrument calibrated in accordance with the provisions of this standard.

3.3 intrinsic reflectance factor, R_∞: The reflectance factor 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 reflectance factor.

3.4 ISO reference standard of level 1; IR 1: The perfect reflecting diffuser [see IEC 50(845):1987, term No. 845-04-54]. Ideal spectrally uniform isotropic

Lambertian diffuser with a reflectance equal to 1 at all wavelengths.

3.5 ISO reference standard of level 2; IR 2: Standard whose reflectance factors have been determined by a standardizing laboratory in relation to the IR 1. (IR 2's are used by the authorized laboratories for the calibration of their reference instruments.)

3.6 ISO reference standard of level 3; IR 3: Standard whose reflectance factors have been determined by an authorized laboratory in relation to an IR 2. (IR 3's are used by the working laboratories for the calibration of their instruments.)

NOTE 1 Definitions 3.4 to 3.6 are consistent with ISO 4094:1991.

4 Prerequisites

4.1 Reference instruments

To obtain reproducible values of the reflectance factor it is essential that the reference instruments used by the authorized laboratories be maintained in perfect working order. The characteristics are given in annex A . It is vital that these reference instruments be kept in calibration with respect to the perfect reflecting diffuser, IR 1, by use of a calibrated IR 2. The calibration shall be renewed with a freshly calibrated IR 2 as often as is necessary to maintain the level of the reference instrument.

4.2 ISO reference standards of level 2

To set the upper end of the scale of the reference instruments, ISO reference standards of level 2 with known intrinsic reflectance factors are required. For these reference standards, materials such as tablets of barium sulfate, tablets of pressed PTFE powder or plates of high reflectance, high opacity opal glass, may be used. Such reference standards shall be assigned absolute reflectance factors by direct calibration of the tablets or plates by a standardizing laboratory.

4.3 ISO reference standards of level 3

ISO reference standards of level 3 are distributed by authorized laboratories (see annex B) to enable the working instruments to be calibrated against a reference instrument. Materials such as opal glass, ceramic or paper may be used (see annex B). These reference standards may cover various working ranges and spectral conditions of the instruments.

4.4 Working standards

Working standards are plates of flat opal glass or ceramic material that can be used for the routine recalibration of working instruments.

5 Apparatus

5.1 Reflectometer, having the geometric, spectral and photometric characteristics described in annex A.

5.2 Two working standards, of opal glass or ceramic material with flat surfaces (see 4.4).

5.2.1 Calibration of the working standards

The working standards shall be calibrated with ISO reference standards of level 3 in the instrument with which they will be used.

NOTE 2 Although barium sulfate powders for pressing tablets are commercially available for which the absolute spectral reflectance factors are given on the container, these values are valid only if the procedure of pressing the tablets is very close to that of the laboratory which determined these values.

The use of home-made tablets based on barium sulfate powder is not recommended unless the barium sulfate has values properly assigned and certified by a standardizing or authorized laboratory, and the working laboratory demonstrates its competence in its ability to prepare the tablets.

All calibrations are thus related to the IR 1 through the medium of an IR 2 and IR 3 to which absolute values have been assigned by a standardizing laboratory and an authorized laboratory respectively.

Using the procedure appropriate to the instrument, calibrate the instrument with an IR 3 and read off and record the reflectance factors of the cleaned working standards to the nearest 0,1 %.

Use new reference standards of level 3 sufficiently frequently to ensure satisfactory calibration.

Handle each IR 3 carefully and protect the test area from contamination. Keep it in darkness.

In order to achieve agreement with the reference instrument, a working standard may be assigned different values depending upon the working level and the purpose of the measurement.

5.2.2 Use of working standards

Use one plate as a primary working standard and the other as a control plate for the working standard. The

frequency with which the working instrument needs to be calibrated depends on the type of instrument. Check the primary working standard periodically against the control plate. If any change in the reflectance factor is noticed, clean the primary working standard by the procedure described in 5.2.3. If the change persists, clean and recalibrate both working standards against an appropriate IR 3 reference standard.

NOTE 3 The primary working standard should be checked against the control plate sufficiently often to ensure that any change in the primary working standard is discovered before an error is introduced into the calibration.

5.2.3 Cleaning the working standards

Rinse with distilled water, rubbing with a soft brush (with synthetic fibre bristles) and detergent free from fluorescent ingredients. Rinse thoroughly in distilled water and dry in the air in a dust-free environment without allowing anything to touch the surface. Leave in a desiccator until stable.

5.3 Black cavity, for calibration of the zero point of the photometric scale. This black body shall have a reflectance factor which does not differ from its nominal value by more than 0,2 % at all wavelengths. The nominal value is usually zero.

6 Sampling

Sample in accordance with ISO 186 unless otherwise agreed between the parties concerned.

7 Preparation of test pieces

Instructions for the preparation of test pieces are given in the relevant test methods for determining optical properties based on measurements of reflectance factor.

8 Procedure

Determine the reflectance factor as specified in the relevant test methods for the determination of optical properties based on measurements of reflectance factor.

9 Expression of results

Calculate and report the results as stated in the relevant test methods for optical properties based on measurement of reflectance factor, for example

ISO 2470;

ISO 2471;

ISO 3688.

Annex A
(normative)

Instruments for the measurement of reflectance factor

The geometric, photometric and spectral characteristics of the instruments[1] to which this International Standard applies are defined as follows.

A.1 Geometric characteristics

The test piece and reference shall be subjected to diffuse illumination effected by means of an integrating sphere [see IEC 50(845):1987, term No. 845-05-24] with an internal diameter of 150 mm and coated internally with a spectrally non-selective white diffusing paint. The sphere shall be constructed so that a measurement can be made on a test piece and a reference measurement can be made on a small region of the inner surface of the sphere with visual or physical photometers. The sphere shall be equipped with screens to eliminate direct illumination of the test piece or reference area by the light source.

The total area of the apertures and other non-reflecting areas in the sphere shall not exceed 13 % of the area of the inner surface of the sphere.

The receptor aperture shall be surrounded by a black annulus having an external diameter of 80,2 mm ± 1 mm (subtending a half-angle of 15,5° ± 0,5° at the centre of the test piece aperture). This black annulus serves as a "gloss trap" so that specularly reflected light from the test piece does not reach the receptor.

The test piece aperture shall be designed so that the piece itself is essentially a continuation of the internal wall of the sphere. The rim of the test piece aperture shall not exceed 1,5 mm in thickness.

The measured test area on the test piece shall be circular with a diameter of 30 mm ± 1 mm.

The diameter of the aperture shall be larger than that of the test area (~ 34 mm) to ensure that no light reflected from the rim of the test piece aperture or from the test piece within a distance of 1 mm from the rim of the aperture shall reach the receptor.

The test piece shall be viewed normally. Only reflected rays within a cone the vertex of which is in the test piece aperture and the half-angle of which is not greater than 4° shall fall on the receptor.

A.2 Photometric characteristics

The photometric accuracy of the instrument shall be such that the residual departure from photometric linearity after calibration does not give rise to systematic errors exceeding 0,3 % reflectance factor.

To minimize linearity errors, the instrument may be calibrated in the region in which measurements are to be made, using an appropriate IR 3 reference standard (see B.2).

A.3 Spectral characteristics

In the case of filter colorimeters, the spectral characteristics are determined by the filters inserted into the light beams in combination with the characteristics of the receptor, the sphere lining, the lamps and other optical parts of the instruments. The filters shall be chosen so that the overall characteristics of the instrument agree with the spectral functions specified in the test methods relating to the determination of specific optical properties.

In the case of abridged spectrophotometers, the spectral characteristics are determined by the accuracy to which the individual receptors represent the nominal wavelengths assigned to them, the bandwidth associated with each receptor, and the values given to the mathematical functions used in the subsequent calculations. The instrument shall incorporate

1) At the time of publication of this International Standard, suitable instruments are manufactured by Technidyne Corp., New Albany, USA, under the tradename Technibrite, by Datacolor AG, Zürich, Switzerland, under the tradename Elrepho 2000, by Color Sensors Oy, Helsinki, Finland, under the tradename Autoelrepho, and formerly by Carl Zeiss, Oberkochen, Germany, under the tradename Elrepho.

This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the apparatus named. Equivalent apparatus may be used if they can be shown to lead to the same results.

not less than 16 receptors uniformly spaced over at least the range from 400 nm to 700 nm.

When measuring tristimulus values as specified by the CIE standard observer functions (1931 or 1964), the appropriate tables presented in ASTM E 308 for measurement at for example 10 nm or 20 nm intervals shall be used. The tristimulus values shall be calculated by direct summation using these tabulated values with no attempt at interpolation using for example spline functions. The actual values to be used are given in the relevant test methods for determining optical properties.

No procedure for calibration to eliminate errors in spectral characteristics is currently available. The spectral characteristics can be checked using suitable coloured IR 3 reference standards. For specific purposes where close inter-instrument agreement is required, product-specific IR 3 reference standards may be used to calibrate the instrument in relation to a reference instrument.

For the measurement of materials containing fluorescent dyestuffs or whitening agents, some means of setting and maintaining the spectral power distribution of the radiation incident on the test piece to a specified UV-content is required. The incorporation of a suitable cutoff filter to exclude the UV-portion of the radiation and thus permit measurement with and without the fluorescent component is also desirable.