INTERNATIONAL STANDARD

ISO 22891

Second edition
2013-03-01

Paper — Determination of transmittance by diffuse reflectance measurement

Papier — Détermination de la transmittance par le mesurage de la réflectance diffuse

Reference number
ISO 22891:2013(E)

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Published in Switzerland

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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.

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 22891 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*.

This second edition cancels and replaces the first edition (ISO 22891:2007), of which it constitutes a minor revision.

Introduction

This International Standard presents a method of determining the transmittance indirectly from reflectance factor data obtained by measurement under specified conditions. The equation used to calculate the transmittance is based on the Kubelka-Munk theory of light scattering and light absorption, and the equation can therefore only be strictly applied if measurements are made on materials which scatter light sufficiently to justify the application of this theory.

The reflectance factor depends on the conditions of measurement, and particularly on the spectral and geometric characteristics of the instrument used for its determination. This International Standard should therefore be read in conjunction with ISO 2469 and ISO 2471.

The transmittance value obtained by this method is a single value compatible with the opacity value determined according to ISO 2471, since all measurements are related to the luminance factor calculated with respect to the CIE illuminant C.

The method described in this International Standard gives only the total transmittance and does not distinguish between regular transmittance and diffuse transmittance. It does not provide a direct measure of the ability to distinguish, for example, written text through a transparent medium. This can be assessed only if the ratio of the regular to the diffuse transmittance is known.

It is emphasized that this method is for the determination not of the transmittance by direct measurement but of the transmittance obtained indirectly from reflectance factor measurements. Under ideal conditions, they are the same, but in practice, it can be necessary to emphasize the difference.

Paper — Determination of transmittance by diffuse reflectance measurement

1 Scope

This International Standard specifies a method for the calculation of transmittance based upon diffuse reflectance measurements.

The use of the method is restricted to white and near-white translucent papers (see 3.9). If it is necessary to determine the transmittance of papers which contain fluorescent whitening agents, the fluorescence emission is eliminated using the prescribed UV cut-off filter.

NOTE This means that, although this International Standard refers to ISO 2469, which permits the use of both filter colourimeters and abridged spectrophotometers, a filter colourimeter with no means of eliminating the emission of fluorescence is not suitable for this type of measurement if fluorescent whitening agents are present.

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

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

ASTM E308-06, *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
reflectance factor
R
ratio of the radiation reflected by a body to that reflected by the perfect reflecting diffuser under the same conditions of illumination and detection

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

3.2
luminance factor (C)
R_y
reflectance factor weighted with reference to the colour matching function $\bar{y}(\lambda)$ of the CIE 1931(2°) Standard Observer and the CIE illuminant C

Note 1 to entry: This property corresponds to the attribute of visual perception of the luminance of the reflecting surface. The strict definition refers to the luminous efficiency function (for photopic vision) $V(\lambda)$. Since this function is identical with the $\bar{y}(\lambda)$ function, the latter is preferred here, since it is more familiar in a paper technology context and it is this function which is indicated in connection with the ASTM E308 tables necessary for the computations.

Note 2 to entry: Since the concept of "luminance" in this International Standard is strictly for small fields of view, it only embodies the $\bar{y}(\lambda)$ function of the CIE 1931(2°) Standard Observer. Thus, it is sufficient to only add the qualification (C) to indicate the CIE illuminant C, and not the full designation (C/2°).

3.3
single-sheet luminance factor (C)
R_0
luminance factor (C) of a single sheet of paper over a black cavity

3.4
white backing luminance factor (C)
R_w
luminance factor (C) of a white backing

3.5
intrinsic luminance factor (C)
R_∞
luminance factor (C) 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 luminance factor

3.6
transmittance
τ
ratio of the transmitted radiant or luminous flux to the incident flux under given conditions

[CIE Publication 17.4:1987, 845-04-59]

3.7
regular transmittance
τ_r
ratio of the regularly transmitted part of the (whole) transmitted flux to the incident flux

[CIE Publication 17.4:1987, 845-04-61]

3.8
diffuse transmittance
τ_d
ratio of the diffusely transmitted part of the (whole) transmitted flux to the incident flux

[CIE Publication 17.4:1987, 845-04-63]

Note 1 to entry: $\tau = \tau_r + \tau_d$.

3.9
transparent medium
medium in which the transmission is mainly regular and which usually has a high regular transmittance in the spectral range of interest

[CIE Publication 17.4:1987, 845-04-108]

Note 1 to entry: Objects may be seen distinctly through a medium, which is transparent in the visible region, if the geometric form of the medium is suitable.

3.10
translucent medium
medium which transmits visible radiation largely by diffuse transmission

[CIE Publication 17.4:1987, 845-04-109]

Note 1 to entry: Objects are not seen distinctly through a translucent medium.

3.11
transmittance from reflectance factor measurements
T
transmittance obtained by direct measurement of luminance factor (C) (filter reflectometer) or determination of luminance factor (C) from measured reflectance factors (abridged spectrophotometer) and subsequent calculation as defined in this method

4 Principle

The luminance factors of a single sheet of paper over a black cavity and over a white backing are determined by measurement according to standard procedures. The transmittance is calculated from the luminance factors.

5 Apparatus

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

5.2 Filter-function: in the case of a filter reflectometer, a filter that, in conjunction with the optical characteristics of the basic instrument, gives an overall response equivalent to the CIE tristimulus value Y of the CIE 1931 standard colourimetric system of the test piece evaluated for the CIE illuminant C.

In the case of an abridged spectrophotometer, a function that permits calculation of the CIE tristimulus value Y of the CIE 1931 standard colourimetric system of the test piece evaluated for the CIE illuminant C using the weighting functions given in Annex A. The spectrophotometer should be fitted with a 420 nm UV cut-off filter for fluorescence elimination, as described in ISO 2469.

5.3 Reference standards, issued by an ISO/TC 6 authorized laboratory in accordance with the provisions of ISO 2469 for calibration of the instrument and the working standards. For maximum accuracy, reference standards having assigned values within the maximum range expected for the particular product to be tested should be selected.

If there is reason to suspect that the instrument has poor linearity or that the deviations from the true colour matching and observer functions are greater than can be tolerated, the use of product-specific reference standards should be considered.

Use new reference standards sufficiently frequently to ensure that the reflectometer is maintained in agreement with the reference instrument.

5.4 Two working standards, calibrated in the apparatus concerned against ISO reference standards of level 3 supplied by an authorized laboratory (see ISO 2469). Calibrate the working standards sufficiently frequently to ensure that satisfactory calibration is maintained.

5.5 Black cavity, for calibration or validation of the low end of the photometric scale, and also for use as a black backing for some of the measurements. This black cavity shall have a radiance factor which does not differ from its nominal value by more than 0,2 percentage points at all wavelengths. The black cavity should be stored upside-down in a dust-free environment or with a protective cover. During calibration, the instrument shall be adjusted to the nominal value of the black cavity.

It is not yet possible to institute a system of reference standards to enable testing laboratories to check the reflectance factor of the black cavity. At the time of delivery, the level should be guaranteed by the instrument maker. Questions concerning the use and condition of the black cavity should be resolved by contacting the instrument maker.

5.6 White backing, consisting of an opaque non-fluorescent white material with a flat, matt surface.