INTERNATIONAL STANDARD ISO 2471

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Paper and board — Determination of opacity (paper backing) — Diffuse reflectance method

Papier et carton — Détermination de l'opacité sur fond papier — Méthode de réflexion en lumière diffuse

Second edition — 1977-02-15

Pag 3

UDC 676.017

Ref. No. ISO 2471-1977 (E)

Descriptors : paper, paperboards, tests, optical tests, opacity.

Price based on 4 pages

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2471 was developed by Technical Committee ISO/TC 6, *Paper, board and pulps*, and circulated to the member bodies in September 1971.

It has been approved by the member bodies of the following countries :

Australia	Hungary	Romania
Austria	India	South Africa, Rep. of
Belgium	Iran	Spain
Bulgaria	Israel	Sweden
Canada	Italy	Switzerland
Czechoslovakia	Netherlands	Thailand
Egypt, Arab Rep. of	New Zealand	Turkey
Finland	Norway	United Kingdom
France	Poland	U.S.A.
Germany	Portugal	

No member body expressed disapproval of the document.

This second edition, incorporating an annex which was submitted directly to the ISO Council in accordance with clause 6.12.1 of the Directives for the technical work of ISO, cancels and replaces the first edition (ISO 2471-1973).

Printed in Switzerland

Paper and board – Determination of opacity (paper backing) – Diffuse reflectance method

0 INTRODUCTION

The opacity value depends on the principle used for its evaluation, and a method should be chosen which most closely relates to the interpretation to be placed upon the results. This method is applicable when that property of a paper is involved that governs the extent to which one sheet visually obscures printed matter on underlying sheets of similar paper. It should not be confused with methods based on the reduction in a standard contrast by interposition of the paper – opacity (white backing), formerly known as contrast ratio – nor with the assessment of the amount and condition of light penetrating a sheet (transparency or translucency).

Luminous reflectance factors of the paper are needed for calculating the opacity, that is, measurements of reflectance factor made under specified spectral conditions. The reflectance factor depends on the conditions of measurement and particularly the spectral and geometric characteristics of the instrument used for its determination. This International Standard should therefore be read in conjunction with ISO 2469, *Paper, board and pulps – Measurement of diffuse reflectance factor.*

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method for the measurement of the opacity (paper backing) of paper by diffuse reflectance.

It is restricted to white and near-white papers (and boards). Paper or board that has been treated with a fluorescent dyestuff or exhibits significant fluorescence may be measured, but the agreement between values obtained with different instruments may be unsatisfactory and there may be difficulty in assessing the meaning of results.

2 DEFINITIONS

For the purpose of this International Standard the following definitions apply :

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

2.2 luminous reflectance factor, R_0 : The reflectance factor that corresponds to the attribute of visual sensation by which a single sheet of the paper with a black backing is judged to reflect incident light.

The reflectometer shall have the characteristics given in ISO 2469.

2.3 intrinsic luminous reflectance factor, R_∞ : The luminous reflectance factor of a layer or pad of material thick enough to be opaque.

2.4 opacity (paper backing) : The ratio, expressed as a percentage, of the luminous reflectance factor of a single sheet of the paper with a black backing to the intrinsic luminous reflectance factor of the same sample.

3 APPARATUS

3.1 Reflectometer, in calibration with the reference instrument described in ISO 2469, and equipped for the measurement of luminous reflectance factor.

3.2 Filter that in conjunction with the optical characteristics of the basic instrument gives an overall response equivalent to the CIE tristimulus value Y (CIE 45-15-060)[1] of the CIE 1931 standard colorimetric system (CIE 45-15-040)[1] of the test piece evaluated for the CIE standard illuminant C (CIE 45-15-145)[1].

3.3 Two working standards calibrated against ISO reference standards of level 3 supplied by the authorized laboratory for the purpose of luminous reflectance factor standardization.

Details of the calibration of the working standards together with cleaning precautions and use are given in ISO 2469. Calibrate the working standards by using ISO reference standards of level 3. In each case recently calibrated reference standards intended for the calibration of the instrument for luminous reflectance factor measurements shall be used at suitable intervals to ensure agreement with the reference instrument.

1) CIE (Commission Internationale de l'Éclairage), *International Lighting Vocabulary*, 3rd Edition, for CIE definitions.

3.4 Black cavity, in the form of a hollow cylinder covered on the inside with black velvet and having a luminous reflectance factor of less than 0,5 %.

The design of the cavity is not critical and any backing giving a measured luminous reflectance factor value of 0,5 % or less may be used. Measurements made using a backing having a luminous reflectance factor greater than 0,5 % will introduce an error that depends on the opacity, and which will be greater for papers of low opacity.

4 SAMPLING

The sampling procedure will differ according to the purposes for which the measurement is required. It shall be agreed between the parties concerned.

5 PREPARATION OF TEST PIECES

Avoiding watermarks, dirt and obvious defects of the paper, cut rectangular test pieces about 75 mm × 150 mm. Assemble not less than ten test pieces top side upwards in a pad using, if necessary, a number greater than ten so that the luminous reflectance factor remains unchanged if the number is increased. Protect the pad by placing an additional test piece on both top and bottom; avoid contamination and unnecessary exposure to light or heat.

Mark the top test piece in one corner to identify the sample and the top side.

6 PROCEDURE

Check that the correct filters are in the light beams. Remove the protecting sheets from the test piece pad. Without touching the test area, use the procedure appropriate to the instrument, and the working standard, to measure the intrinsic luminous reflectance factor R_∞ of the top side of the test piece pad. Read and record the value to the nearest 0,1 %.

Remove the top test piece from the pad and, using the black cavity to back the test piece, measure the luminous reflectance factor R_o, for the same area of the test piece. Read and record the value to the nearest 0,1 % luminous reflectance factor. Move the measured test piece to the bottom of the pad.

Determine R_∞ and R_o for five test pieces. Turn the pad upside down and repeat the procedure for the other side.

7 EXPRESSION OF RESULTS

Calculate the mean of R_∞ and R_o for each side and use these figures to calculate the opacity to three significant figures :

$$\text{Opacity} = 100\,\frac{R_o}{R_\infty}$$

Calculate the mean opacity for each side and report to the nearest 0,5 %. If they differ by more than 0,5 % the sides should be identified. If the difference is equal to, or less than 0,5 %, the overall average shall be reported.

The value(s) so obtained is (are) taken as the opacity (paper backing) for the paper.

NOTE — For most papers the difference in the opacity value obtained when measuring from opposite sides will be small. For extremely two-sided papers the opacities measured from opposite sides may differ significantly, i.e. by more than 0,5 %.

8 TEST REPORT

The test report shall include the following details :

a) precise identification of the sample;

b) a reference to this International Standard;

c) the results and the form which they are expressed;

d) any particular points observed in the course of the test;

e) any departure from this International Standard or any circumstances or influences that may have affected the results.

ANNEX

GENERAL INFORMATION ON ISO BRIGHTNESS AND REFLECTANCE FACTOR STANDARDS FOR PAPERS, BOARDS AND PULPS

(Not part of the standard)

In ISO 2469, ISO 2470, ISO 2471 and ISO 3688, which deal with measurements of diffuse reflectance factors, ISO brightness and opacity and opacity (paper backing), a sequence of reference standards of three different levels is mentioned in which, for diffuse reflectance factor measurements, the ultimate reference standard (the ISO standard of level 1) is the "perfect reflecting diffuser". The use of this ideal uniform diffuser, with a reflectance equal to 1,0, constitutes a deviation from the older practice of using smoked magnesium oxide as ultimate reference. However, the use of the perfect reflecting diffuser as ultimate reference is in full agreement with a recommendation made by the prime authority on optical properties, the Commission Internationale de l'Éclairage (CIE) which replaced smoked magnesium oxide by the perfect reflecting diffuser in 1969.

It appears that with this change a reference standard which is difficult to produce (magnesium oxide) is now replaced by a reference standard which probably can never be physically materialized. However, there are good reasons for this regulation. The preparation of a smoked magnesium oxide surface is a slow and tedious process which produces reference standards of low precision. A survey of the literature shows that the reflectances of magnesium oxide surfaces prepared in different laboratories vary by about 2 %. Such uncertainty in the ultimate reference cannot be tolerated if instruments are available which can measure relative reflectance factors with a precision of the order of 0,1 %. Reference to the perfect reflecting diffuser is equivalent to absolute measurements of reflectance factors and the techniques of such measurements have been improved in recent years to an accuracy which is of the order of ± 0,3 % and better[1]. Consequently it is possible to calibrate material standards in such absolute reflectometers to an accuracy which is far superior to the accuracy of smoked magnesium oxide standards[2].

For the implementation of this ultimate reference standard or "ISO reference standard of level 1" = IR 1 and the reference standards of levels 2 and 3, ISO proposes the following procedure.

Certain laboratories, which are equipped for absolute reflectance factor measurements, are appointed by ISO/TC 6 as "standardizing laboratories". These laboratories issue "ISO reference standards of level 2" = IR 2 to certain "authorized laboratories" for calibrating their "reference instruments". These authorized laboratories, which are also appointed by ISO/TC 6, then issue "ISO reference standards of level 3" = IR 3 on demand to industrial laboratories which are advised to use the IR 3 only for the purpose of calibrating their working standards periodically.*

The standardizing laboratories are requested to exchange samples from time to time so that agreement between their measurements is maintained. The same holds for the authorized laboratories. It is expected that this procedure, which is specified in certain ISO documents, will achieve those accuracies which are suggested in the "Expression of results" clause in the above-mentioned International Standards.

It should be mentioned that barium sulphate powders for pressing tablets are commercially available for which the absolute spectral reflectance factors are given on the container. These values are determined with care but they are valid only if the procedure of pressing the tablets is very close to that of the laboratory which determined these values.

One consequence of this conversion in the ultimate reference is that diffuse reflectance factors, for example the ISO brightness, when referred to the perfect reflecting diffuser, are lower by about 1,0 to 1,5 % than those referred to smoked magnesium oxide. It is very important that this fact be borne in mind, not only in commercial transactions, but in general whenever various measurements on one sample are to be compared. Measurements according to the above International Standards are always referred to the perfect reflecting diffuser. Consequently, "ISO brightness" can only be an absolute value, never relative to smoked magnesium oxide. However, if reflectance factors are given without the ISO prefix, it is advisable to mention the reference by a qualifying "absolute" or "MgO = 100".

Opacity measurements are, of course, almost unaffected by the change in the ultimate reference.

Two aspects of these International Standards must be kept in mind :

1) The term "diffuse" refers to a diffuse illumination on the sample which is achieved by means of an integrating sphere. It is important to recognize that other specifications, such as TAPPI 452, use a different geometry and that, in general, another geometry will yield different values.

2) The instruments described in these International Standards are equipped with a "gloss trap" so that the specularly reflected component is excluded. It is important to observe this condition because, for samples exhibiting gloss, the introduction of the gloss trap may cause an additional decrease of the value of the reflectance factor by up to 1 %.

* The up-to-date lists of standardizing and authorized laboratories are available from the Secretariat of ISO/TC 6 (AFNOR) or from the ISO Central Secretariat.

BIBLIOGRAPHY

[1] KORTE, H. and SCHMIDT, M., Über die Messung des Leuchtdichtefaktors an beliebig reflektierenden Proben. *Lichttechnik* **19**, 135A (1967).

VAN DEN AKKER, J. A., Evaluation of absolute reflectance for standardization purposes. *J. Opt. Soc. Am.* **56**, 252 (1966).

BUDDE, W. and DODD, C. X., Absolute reflectance measurements in the d/O geometry. *Farbe* **19**, 94 (1970).

[2] BUDDE, W. and CHAPMAN, S. M., The calibration of standards for "absolute brightness" measurements with the Elrepho. *Pulp and Paper Magazine of Canada* **69**, nº 7, T206 (1968).