INTERNATIONAL STANDARD

ISO 5270

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Pulps — Laboratory sheets — Determination of physical properties

Pâtes — Feuilles de laboratoire — Détermination des propriétés physiques

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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 5270 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 5, *Test methods and quality specifications for pulps*.

This third edition cancels and replaces the second edition (ISO 5270:1998), which has been technically revised. The list of relevant International Standards for paper and board, to be used for testing the physical properties of laboratory sheets, has been updated and new standards, such as ISO 1924-3 and ISO 15754, have been included. The option to determine air permeance, using the Bendtsen method (ISO 5636-3) or the Sheffield method (ISO 5636-4) has been inserted, as well as the option to measure optical properties.

Introduction

This International Standard includes the determination of physical properties of both “low grammage” sheets and “high grammage” sheets, prepared in accordance with ISO 5269-1, ISO 5269-2 or ISO 5269-3. The oven-dry grammage of the “low grammage” sheets is (60 ± 2) g/m^2 using the conventional sheet former, as described in ISO 5269-1 and ISO 5269-3, or (75 ± 2) g/m^2 using the Rapid-Köthen sheet former, as described in ISO 5269-2 and ISO 5269-3. The oven-dry grammage of the “high grammage” sheets is 140 g/m^2, with a tolerance of 3 % using the conventional and the Rapid Köthen sheet formers, except for the z-directional tensile strength where the grammage is ≥ 90 g/m^2.

For determination of physical properties, ISO 5270 refers to the relevant International Standards for paper and board for the description and calibration of the required equipment, and for the calculation and reporting of results. This International Standard, however, specifies the procedures for testing laboratory sheets where the amount of material is limited, compared to testing of paper and board to which the relevant International Standards referred to are applicable, and for that reason there may be a discrepancy.

Pulps — Laboratory sheets — Determination of physical properties

1 Scope

This International Standard specifies the relevant International Standards to be used for the determination of physical properties of laboratory sheets made of all kind of pulps. It is applicable to laboratory sheets prepared in accordance with ISO 5269-1, ISO 5269-2 or ISO 5269-3.

In this International Standard, it is left to the pulp producer and the pulp user to agree upon which properties are relevant to be tested. The results are, if applicable, reported in index form.

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 187:1990, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 534, *Paper and board — Determination of thickness, density and specific volume*

ISO 536, *Paper and board — Determination of grammage*

ISO 1924-2, *Paper and board — Determination of tensile properties — Part 2: Constant rate of elongation method (20 mm/min)*

ISO 1924-3, *Paper and board — Determination of tensile properties — Part 3: Constant rate of elongation method (100 mm/min)*

ISO 1974, *Paper — Determination of tearing resistance — Elmendorf method*

ISO 2493-1, *Paper and board — Determination of bending resistance — Part 1: Constant rate of deflection*

ISO 2493-2, *Paper and board — Determination of bending resistance — Part 2: Taber-type tester*

ISO 2758, *Paper — Determination of bursting strength*

ISO 5269-1, *Pulps — Preparation of laboratory sheets for physical testing — Part 1: Conventional sheet-former method*

ISO 5269-2, *Pulps — Preparation of laboratory sheets for physical testing — Part 2: Rapid-Köthen method*

ISO 5269-3, *Pulps — Preparation of laboratory sheets for physical testing — Part 3: Conventional and Rapid-Köthen sheet formers using a closed water system*

ISO 5626, *Paper — Determination of folding endurance*

ISO 5636-3, *Paper and board — Determination of air permeance (medium range) — Part 3: Bendtsen method*

ISO 5636-4, *Paper and board — Determination of air permeance (medium range) — Part 4: Sheffield method*

ISO 5636-5, *Paper and board — Determination of air permeance (medium range) — Part 5: Gurley method*

ISO 7263, *Corrugating medium — Determination of the flat crush resistance after laboratory fluting*

ISO 9895, *Paper and board — Compressive strength — Short-span test*

ISO 12192, *Paper and board — Determination of compressive strength — Ring crush method*

ISO 15754, *Paper and board — Determination of z-directional tensile strength*

NOTE A separate International Standard, ISO 15361[1], has been published for pulps describing the determination of zero-span tensile strength, wet or dry.

3 Principle

Determination of physical properties of laboratory sheets using the procedure and equipment described in the relevant International Standards given in Tables 1 and 2. The results are, if applicable, reported in index form.

NOTE The properties to be measured are jointly determined by the pulp producer and the pulp user.

4 Apparatus

The equipment is specified in the respective International Standards given in Tables 1 and 2 to which this International Standard refers. The equipment shall be calibrated in accordance with the instructions in the relevant International Standards given in Tables 1 and 2.

5 Trimmed laboratory sheets

5.1 Selection of laboratory sheets

Depending on the properties to be tested, determine the number of laboratory sheets required (see Table 1 and/or Table 2). The specification of the number of test pieces needed for each property defines the area required for testing and thus the number of sheets.

Each sheet shall be free of visible defects.

5.2 Conditioning of laboratory sheets

Condition the laboratory sheets in the standard atmosphere (23 ± 1) °C and (50 ± 2) % relative humidity, or in the atmosphere allowed in tropical countries, according to ISO 187.

ISO 187 states in its Introduction that “Unless otherwise specified, the equilibrium condition should be attained by the sorptive process”. For tests in which the hysterisis of the equilibrium moisture content may lead to important errors, the sample shall be pre-conditioned before conditioning (see ISO 187:1990, 6.1). If it is known that conditioning will result in an equilibrium moisture content equivalent to that achieved by sorption, the pre-conditioning may be omitted.

If the laboratory sheets have been prepared using the conventional sheet former, according to ISO 5269-1 or ISO 5269-3, the sheets may reach equilibrium by desorption. If the laboratory sheets have been prepared using the Rapid-Köthen sheet former, according to ISO 5269-2 or ISO 5269-3, the sheets may reach equilibrium by sorption of moisture.

Whenever the test atmosphere is known to have been outside the limits and there is any chance that the moisture content of the sheets has been changed by such excursions, all sheets must be reconditioned before any further testing (see ISO 187).

Keep the laboratory sheets in the conditioning atmosphere until testing is completed.

NOTE 1 Pre-conditioning using heat may change the optical properties and is, for that reason, not recommended for the sheets to be used for measuring optical properties.

NOTE 2 It is not recommended to use the Rapid-Köthen sheet former, described in ISO 5269-2 and ISO 5269-3, for preparation of laboratory sheets intended for determination of optical properties, since the high temperature used when drying the sheets may change the optical properties.

NOTE 3 The moisture content and thus physical properties of laboratory sheets at a given relative humidity (e.g. at. 50 % RH) depend on the moisture history of the sheets. The moisture content of sheets dried from high relative humidity to low relative humidity follows a different, higher moisture content, path in comparison with sheets taken from low to high relative humidity, an effect called hysteresis. For laboratory sheets prepared using the Rapid-Köthen sheet former (ISO 5269-2 and ISO 5269-3), the 50 % RH is reached from a lower relative humidity by sorption of moisture, whereas for laboratory sheets prepared using the conventional sheet former (ISO 5269-1 and ISO 5269-3), the 50 % RH is reached by desorption of moisture. Thus sheets prepared using the conventional sheet former will have higher moisture content at equilibrium than those prepared using the Rapid-Köthen sheet former. If laboratory sheets are pre-conditioned, moisture content differences caused by this effect can be eliminated.

5.3 Optical properties

For certain purposes, it may be desirable to measure optical properties of laboratory sheets prepared using the conventional sheet former (ISO 5269-1 or ISO 5269-3). Depending on the purpose, light scattering and light absorption coefficients, opacity, ISO brightness and CIE whiteness can be measured.

Optical properties for sheets prepared using the conventional sheet former (ISO 5269-1, ISO 5269-3) should be tested without pre-conditioning and no optical tests should be performed on sheets prepared using the Rapid-Köthen sheet former (ISO 5269-2, ISO 5269-3).

NOTE 1 Preparation of laboratory sheets for the measurement of diffuse blue reflectance factor (ISO brightness) of pulp is specified in ISO 3688[2]. The sheets having a grammage of 200 g/m^2 are prepared in a sheet former (ISO 5269) or in a Büchner funnel. The measurement of ISO brightness is described in ISO 2470-1[3] .

NOTE 2 For the determination of light scattering and light absorption coefficients of the low-grammage laboratory sheets ISO 9416[4] is recommended, and for the determination of opacity ISO 2471[5] is recommended.

NOTE 3 For the determination of CIE whiteness, it is recommended to use either ISO 14475[6] or ISO 14476[7] .

5.4 Determination of grammage, bulking thickness and apparent bulk density

Trim the laboratory sheets, using a punch, or a ruler and a pair of scissors, to obtain a defined size so that the area can be determined to an accuracy of 0,5 %. For “low grammage” sheets, consult Table 1 in 5.5 to establish a suitable size for the trimmed sheets that allows them to be used for cutting test pieces.

Before cutting test pieces, determine the grammage of the conditioned trimmed sheets using ISO 536. The mass of the trimmed sheets shall be determined to an accuracy of 0,2 % and the grammage shall be reported to three significant figures.

NOTE If a circular sheet having a diameter of 158 mm is used, only two test pieces for the determination of flat crush resistance or ring crush resistance can be cut from each sheet. These test pieces may be used for the determination of grammage.

Measure the bulking thickness of a pack of four trimmed sheets, with the same sides up, using ISO 534. Take measurements at five different places of the pack, taking care that the sheets are not displaced when changing the position of the pack for each measurement. Calculate and report the mean bulking thickness of a single sheet to three significant figures.

Calculate and report the apparent bulk density ρ, in kilograms per cubic metre, to three significant figures.

5.5 Preparation of test pieces

From the conditioned trimmed sheets, cut a sufficient number of test pieces depending on the property to be determined. The minimum number of test pieces for “low grammage” sheets is given in Table 1 and for “high grammage” sheets in Table 2.

Table 1 — Test piece dimensions and minimum number of test pieces recommended for "low grammage" sheets

Property	ISO Standard	Target grammage (oven-dry basis) g/m^2		Test piece dimensions mm		Minimum number of test pieces
		Conventional	Rapid-Köthen	Length	Width	
Tensile properties	ISO 1924-2 ISO 1924-3	60	75	At least 100 ± 2 between clamps + extra length for complete clamping	15 ± 0,1	8 from at least 4 sheets
Tear index	ISO 1974	60	75	According to the testing apparatus		2[a] from at least 4 sheets
Burst index	ISO 2758	60	75	Wide enough to be securely clamped		8 from at least 4 sheets
Air permeance	ISO 5636-3 ISO 5636-4 ISO 5636-5	60	75	50 × 50		8 from at least 2 sheets
Folding endurance	ISO 5626	60	75	According to the testing apparatus	15,0 ± 0,1	6 from at least 3 sheets

[a] Each test piece consists of four pieces.

Table 2 — Test piece dimensions and minimum number of test pieces recommended for "high grammage" sheets

Property	ISO Standard	Target grammage (oven-dry basis) g/m^2		Test piece dimensions mm		Minimum number of test pieces
		Conventional	Rapid-Köthen	Length	Width	
Bending resistance index	ISO 2493-1 ISO 2493-2	140	140	> 70	38,0 ± 0,2	6 from at least 2 sheets
Flat crush resistance index	ISO 7263	140	140	> 150	12,7 ± 0,1	6 from at least 2 sheets
Ring crush resistance index	ISO 12192	140	140	150 to 152,5	12,7 ± 0,1	10 from at least 2 sheets
Short span compression index	ISO 9895	140	140	> 70	15,0 ± 0,1	10 from at least 2 sheets
Z-directional tensile strength	ISO 15754	≥ 90	≥ 90	Larger than the tester platens		5 from at least 4 sheets

6 Procedures for physical properties ("low grammage" sheets)

6.1 General

For determination of physical properties, use the equipment stated in the relevant International Standard given in this clause. The equipment shall be maintained and calibrated as stated in the relevant International Standard.

As the physical properties in general will increase with increasing grammage, they shall be reported in index form, i.e. the result shall be divided by the conditioned grammage, in grams per square metre, of the trimmed sheets, determined in accordance with 5.4.

6.2 Tensile properties

Using ISO 1924-2 with a constant rate of elongation of 20 mm/min (for paper and board), or ISO 1924-3 with a constant rate of elongation of 100 mm/min (for paper, board or laboratory sheets), determine the tensile properties. If ISO 1924-2 is used for testing the “low grammage” sheets, the distance between the clamps shall be (100 ± 2) mm (not 180 mm as stated for paper and board). Since the clamping length is shorter for laboratory sheets when using ISO 1924-2, the rate of elongation shall be (10 ± 2,5) mm/min (20 × 100/180 = 11,1 mm/min) to maintain a similar rate of strain.

Test a minimum of eight test pieces from at least four sheets (see Table 1). If the length of a test piece is not sufficient to allow the test piece to be securely clamped, a test length of 90 mm may be used. This deviation shall be stated in the test report.

For some pulp qualities, the test piece may fail quickly, for example when using ISO 1924-2 in less than 5 s, or take some time, for example more than 30 s. In such cases, a different constant rate of elongation may be used, but this rate shall be stated in the test report.

Calculate and report, where appropriate, the results in index form, to three significant figures.

WARNING — Parts 2 and 3 of ISO 1924 do not give the same results and it is not possible to predict any relationship between results obtained using the two parts. For that reason, the procedure for determination of tensile properties shall always be reported when reporting tensile properties using this International Standard.

6.3 Tear index

Using ISO 1974, determine the tearing resistance of a minimum of two test pieces from at least four sheets where each test piece consists of four pieces (see Table 1). Clamp the test pieces so that their non-glazed sides face the shaft of the pendulum. Carry out at least two such tests.

Calculate and report the tear index, in millinewton square metres per gram, to three significant figures.

6.4 Burst index

Using ISO 2758, determine the bursting strength of a minimum of eight test pieces from at least four sheets (see Table 1). Carry out at least one burst test on each side of each of at least four sheets. Test pieces less than 70 mm x 70 mm in area may be used, provided that they are wide enough to be securely clamped.

Report the burst index, in kilopascal square metres per gram, to three significant figures.

6.5 Air permeance

Using ISO 5636-3, ISO 5636-4 or ISO 5636-5, determine the air permeance with the air pressure applied to the non-glossy side of the sheets, of a minimum of eight test pieces from at least two sheets (see Table 1).

Using ISO 5636-3, calculate and report the air permeance, in micrometres per pascal second, to three significant figures.

Using ISO 5636-4, calculate and report the air permeance, in micrometres per pascal second, to three significant figures.

Using ISO 5636-5, calculate the mean time, in seconds, for the passage of 100 ml of air. Calculate and report air permeance, in micrometres per pascal second, to two significant figures.

6.6 Folding endurance

Using one of the procedures specified in ISO 5626, determine the logarithm (to the base 10) of the number of double folds obtained for each test piece. Test a minimum of six test pieces from at least three sheets (see Table 1).

Report the folding endurance as the mean of the logarithms, to the second decimal place. Also state the type of tester used.

7 Procedures for physical properties (“high grammage” sheets)

7.1 General

For determination of physical properties, use the equipment stated in the relevant International Standard given in this clause. The equipment shall be maintained and calibrated as stated in the relevant International Standard.

As physical properties in general will increase with increasing grammage, they shall be reported in index form, i.e. the result shall be divided by the conditioned grammage, in grams per square metre, of the trimmed sheets, determined in accordance with 5.4.

7.2 Bending resistance index

Using ISO 2493-1 or ISO 2493-2, determine the bending resistance of a minimum of six test pieces from at least two sheets (see Table 2). If the instrument is designed so that deflection is possible only to one side of the unstressed position, test equal numbers of test pieces with opposing surfaces towards the direction of deflection.

Using ISO 2493-1, calculate (as a force) and report the bending resistance index, in N m^6/g^3, to three significant figures.

Using ISO 2493-2, calculate (as a moment) and report the bending resistance index, in Nm m^6/g^3, to three significant figures.

NOTE 1 The bending resistance is proportional to the grammage to the third power.

NOTE 2 The determination of bending stiffness is described in ISO 5628[8].

7.3 Flat crush resistance index after laboratory fluting

Using ISO 7263, determine the flat crush resistance, CMT, after laboratory fluting of a minimum of six test pieces from at least two sheets (see Table 2). The non-glossy side of the test piece shall face the adhesive tape.

Calculate and report the flat crush resistance index, in newton square metres per gram, to three significant figures.

7.4 Ring crush resistance index

Using ISO 12192, determine the ring crush resistance, RCT, of a minimum of ten test pieces from at least two sheets (see Table 2). Place the test pieces such that in half the tests the non-glossy side or the wire side faces the centre of the ring and in the other half the glossy side or the top side. Approximately equal numbers from any one sheet should face each way.

Calculate and report the ring crush resistance index, in newton metres per gram, to three significant figures.

7.5 Short span compression index

Using ISO 9895, determine the short span compressive strength of a minimum of ten test pieces from at least two sheets (see Table 2).

Calculate and report the compression index, in newton metres per gram, to three significant figures.

7.6 Z-directional tensile strength

Using ISO 15754, determine the z-directional tensile strength of a minimum of five test pieces from at least four sheets (see Table 2). The size of the test pieces shall be larger than the size of the platens. To avoid the tape from reinforcing the test piece, the grammage of the laboratory sheets shall be ≥ 90 g/m^2.

NOTE In ISO 15754, applicable to paper and board, the minimum grammage permitted is 60 g/m^2. Paper almost always is sized using starch which will prevent the glue of the tape from entering the test piece and reinforcing it, thus a low grammage may be used without any risk of incorrect results. Since laboratory sheets normally are not sized, a higher grammage is recommended, i.e. a grammage of ≥ 90 g/m^2.

Calculate and report the z-directional tensile strength, in kilopascals, to three significant figures.

8 Test report

a) a reference to this International Standard, i.e. ISO 5270:2012;

b) all the indications necessary for complete identification of the sample of pulp;

c) if the laboratory sheets have been prepared from laboratory-beaten pulp, reference to the relevant International Standard and the relevant particulars listed in the test report in that standard;

d) if the sheets have been prepared from unbeaten pulp, or pulp beaten otherwise than by a standard method, reference to the relevant International Standard for the method of disintegration and the relevant particulars listed in the test report in that standard;

e) reference to the International Standard for preparation of laboratory sheets (ISO 5269-1, ISO 5269-2 or ISO 5269-3);

f) the conditioned grammage of the trimmed sheets;

g) the atmosphere for conditioning and testing, i.e. standard or tropical;

h) reference to the test methods used and the part of the standard considered, if appropriate;

i) whether the sheets were pre-conditioned;

j) the results and details stated in the relevant paragraphs in Clauses 6 and 7 of this International Standard;

k) any unusual procedures used or features observed in the course of the test, in particular the rate of elongation for tensile index using ISO 1924-2, if it differ from 10 mm/min ± 2,5 mm/min;

l) any operations not specified in this International Standard, or in the International Standards to which reference is made or regarded as optional, which might have affected the results.

Bibliography

[1] ISO 15361, *Pulps — Determination of zero-span tensile strength, wet or dry*

[2] ISO 3688, *Pulps — Preparation of laboratory sheets for the measurement of diffuse blue reflectance factor (ISO brightness)*

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

[4] ISO 9416, *Paper — Determination of light scattering and absorption coefficients (using Kubelka-Munk theory*)

[5] ISO 2471, *Paper and board — Determination of opacity (paper backing) — Diffuse reflectance method*

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

[7] ISO 11476, *Paper and board — Determination of CIE whiteness, C/2 degrees (indoor illumination conditions)*

[8] ISO 5628, *Paper and board — Determination of bending stiffness — General principles for two-point, three-point and four-point methods*

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