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Paper and board — Determination of thickness, density and specific volume

Papier et carton — Détermination de l'épaisseur, de la masse volumique et du volume spécifique

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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 534 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

This third edition cancels and replaces the second edition (ISO 534:1988), which has been technically revised and where the major revision is the introduction of the concept of specific volume.

Paper and board — Determination of thickness, density and specific volume

1 Scope

This International Standard specifies two methods for measuring the thickness of paper and board:

a) the measurement of a single sheet of paper or board as a single sheet thickness;

b) the measurement of a pack of sheets of paper as a bulking thickness.

It also specifies calculation methods

— for the apparent sheet density and for the apparent bulk density, and

— for the apparent specific sheet volume and for the apparent specific bulk volume

from the thickness determinations.

This International Standard is not applicable to corrugated fibreboard. In addition, method a) is not suitable for materials with a grammage higher than 225 g/m^2.

NOTE 1 The two methods generally lead to different results.

NOTE 2 For tissue paper and tissue products, ISO 12625-3 should be used.

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

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

3 Terms and definitions

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

3.1
single sheet thickness
distance between one surface of a paper or board and the other, measured under an applied static load, using the standard test method

3.2
bulking thickness
thickness of a single sheet of paper, calculated from the thickness of several superimposed sheets in a pack, and measured under an applied static load, using the standard test method

3.3
apparent sheet density
mass per unit volume, expressed in grams per cubic centimetre, and calculated from the **single sheet thickness** (3.1)

NOTE This term is normally applicable to paper or board.

3.4
apparent bulk density
mass per unit volume, expressed in grams per cubic centimetre, and calculated from the **bulking thickness** (3.2)

NOTE This term is normally applicable to paper.

3.5
apparent specific sheet volume
volume per unit mass, expressed in cubic centimetres per gram, and calculated from the **single sheet thickness** (3.1)

NOTE This term is normally applicable to paper or board.

3.6
apparent specific bulk volume
volume per unit mass, expressed in cubic centimetres per gram, and calculated from the **bulking thickness** (3.2)

NOTE This term is normally applicable to paper.

4 Principle

4.1 Measurement of the **single sheet thickness** (3.1) or of the **bulking thickness** (3.2), according to the test requirements, by means of a high-precision micrometer.

4.2 Calculation of the **apparent sheet density** (3.3) or **apparent bulk density** (3.4) of the paper or board, from a knowledge of its grammage and thickness.

4.3 Calculation of the **apparent specific sheet volume** (3.5) or **apparent specific bulk volume** (3.6) of the paper or board, from a knowledge of its grammage and thickness.

5 Apparatus

5.1 Dead-weight micrometer, provided with two plane, parallel, circular pressure faces, between which the paper or board is placed for measurement.

The preferred pressure exerted between the pressure faces during the thickness measurement shall be (100 ± 10) kPa. As an alternative pressure, (50 ± 5) kPa is also permitted.

The two pressure faces shall form an integral part of the micrometer, such that one face is fixed (the anvil) and the other is movable in a direction perpendicular to the plane of the fixed face.

One face shall be (16,0 ± 0,5) mm in diameter and the second face shall be of such a size that it is in contact with the whole area of the other face when the micrometer reads zero. Thus, a circular region of a test piece, nominally 200 mm^2 in area, is subjected during the thickness measurement to the pressure exerted between the faces.

The performance requirements of the micrometer shall be such that, when calibrated according to the method given in Annex A, the micrometer complies with the required pressure of (100 ± 10) kPa, alternatively (50 ± 5) kPa, and the performance requirements as shown in Table 1 (see also 9.1).

Table 1 — Micrometer performance requirements

Micrometer characteristics	Maximum permitted value[a]
Indication error	± 2,5 µm or ± 0,5 % of the reading
Error of parallelism between pressure faces	5 µm or 1 %
Repeatability of measurement (as standard deviation)	1,2 µm or 0,5 %

NOTE Where a tolerance is expressed in the form of a percentage, it is based upon the thickness of the test piece under test. Thus, it is possible for a given micrometer to comply with the requirements of this table for some materials, but not for others.

[a] The maximum permitted value of a micrometer characteristic is the greater of the two values.

5.2 Thickness gauges, corresponding to approximately 10 %, 30 %, 50 %, 70 % and 90 % of the full-scale reading of the micrometer. The thickness of each gauge shall be known to an accuracy of 0,3 µm.

6 Sampling

If the tests are made to evaluate a lot, select the sample in accordance with ISO 186. If the tests are made on another type of sample, make sure that the test pieces taken are representative of the sample received.

7 Conditioning

Condition the sample in accordance with ISO 187.

8 Preparations of test pieces

8.1 General

Prepare the test pieces in the same standard atmospheric conditions as used to condition the sample. Avoid areas with folds, creases, cracks or other defects which could influence the results.

8.2 Single sheet thickness

Cut not more than two test pieces from each specimen taken at random from the sample available, with minimum dimensions 60 mm × 60 mm. Ensure that the test piece dimensions are not so large that the micrometer reading is affected by the test piece mass that overhangs the lower pressure face while a measurement is being made. When measuring board, do not use test pieces with dimensions exceeding 100 mm × 100 mm. These test piece dimensions are usually satisfactory for making measurements on paper.

Prepare at least 20 test pieces.

8.3 Bulking thickness

Cut sheets at random from the sample available, preferably having dimensions 200 mm × 250 mm, the 200 mm dimension being in the machine direction (see Figure 1). If this is not possible, prepare smaller sheets of at least 150 mm × 150 mm.

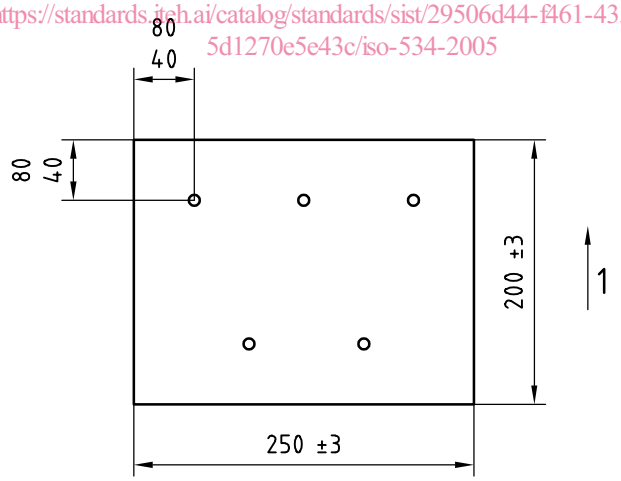
Make up a pack of sheets to form the test piece and make sure that all the sheets are oriented in the same way. Each sheet shall be independent of the rest. For example, it is not permitted to fold one sheet and insert it folded into the test piece to form two or more sheets. The number of sheets in a test piece shall normally be ten.

Prepare at least four test pieces, and make sure that the number of sheets and their sizes in each test piece is the same.

In special circumstances, such as for thick or very thin sheets or when agreed between the parties concerned, a smaller or larger number of sheets, or a smaller or larger sheet may be used.

The number of sheets used and their size shall be reported.

Dimensions in millimetres



Key

1 machine direction (MD)

Figure 1 — Positions of measurements on a test piece for bulking thickness

9 Procedure

9.1 General

Prior to the use of the micrometer or when calibrating it, ensure that the anvil, pressure foot and thickness gauges (5.2) are clean.

NOTE 1 Particularly in the case of the anvil and pressure foot, small pieces of fibre can collect on these surfaces, causing erroneous high values.

When thickness gauges (5.2) are used in calibration, they should be gently wiped with alcohol on a non-linting absorbent material.

NOTE 2 The above requirements do not apply to 9.3.3.

9.2 Verification and calibration of micrometer

At appropriate time intervals, calibrate the micrometer at the temperature of normal use, and verify its performance using the method given in Annex A.

For micrometers in frequent use, determine the indication error and repeatability of measurement daily. Determine the pressure exerted between the pressure faces and their error of parallelism at monthly intervals.

9.3 Determinations

9.3.1 Determination of single sheet thickness

Carry out the test in the standard atmospheric conditions at which the samples were conditioned.

Place the micrometer on a horizontal vibration-free surface and place the test piece between the open pressure faces of the micrometer. Permit the test piece to be held by the pressure face, by very carefully allowing the movable pressure face to move steadily and slowly, at a velocity less than 3 mm/s, towards the anvil so that any punching effect is avoided.

Record the micrometer reading as soon as its value becomes steady, normally within 2 s to 5 s, but before any “bedding down” of the paper can occur. Avoid imposing any manual stress on the test piece or micrometer while a reading is being made.

Make one measurement on each test piece at a position at least 20 mm from any side of the test piece. Make at least 20 independent measurements.

9.3.2 Determination of bulking thickness

Carry out the test in the standard atmospheric conditions at which the samples were conditioned.

Place the micrometer on a horizontal vibration-free surface and place the test piece between the open pressure faces of the micrometer. Permit the test piece to be held by the pressure face, by very carefully allowing the movable pressure face to move steadily and slowly, at a velocity less than 3 mm/s, towards the anvil so that any punching effect is avoided.

Record the micrometer reading as soon as its value becomes steady, normally within 2 s to 5 s, but before any “bedding down” of the paper can occur. Avoid imposing any manual stress on the test piece or micrometer while a reading is being made.

Make one measurement, at each of the five positions on the pack, on the test piece as indicated in Figure 1, situated between 40 mm and 80 mm from the edges of the test piece and distributed along the two edges which are in the cross-direction of the paper.