
**Paper and board — Determination
of moisture content of a lot — Oven-
drying method**

*Papier et carton — Détermination de la teneur en humidité d'un lot
— Méthode par séchage à l'étuve*



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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

This document 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 fourth edition cancels and replaces the third edition (ISO 287:2009), which has been technically revised.

The main changes compared to the previous edition are as follows:

- precision data (previously in [Clause 11](#)) have been moved to [Annex A](#);
- editorial changes have been made for clarification and removal of inconsistencies.

Introduction

The determination of dry matter content and moisture content are carried out for different purposes.

ISO 638 is used in cases where the dry matter content is needed to calculate the result of chemical analysis or physical testing and when the determination of the moisture content of a sample, rather than a lot, is required. As an example, the dry matter content of the sample is needed to express the content of elements, such as cadmium and manganese, in relation to the oven-dry mass of the sample.

This document is used for the purpose of determining the average moisture content and the variation in moisture content (maximum and minimum values) of a lot. In the paper and board trade, the moisture content is important since it influences converting processes, such as printing and copying. The moisture content also has an influence on curl and dimensional stability.

Paper and board — Determination of moisture content of a lot — Oven-drying method

1 Scope

This document specifies an oven-drying method for the determination of the moisture content of a lot of paper and board. The procedure in [Clause 8](#), describing how the test pieces are drawn from the lot, is performed at the time of sampling.

This document is applicable to every type of lot of paper and board, including corrugated board and solid board, provided that the paper or board does not contain any substances, other than water, that are volatile at the temperature specified in this document.

NOTE For determination of the dry matter content of a sample of paper or board, e.g. for calculation of the dry mass of the sample, ISO 638^[1] can be used.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 moisture content

$w_{\text{H}_2\text{O}}$

content of water in paper or board, i.e. the ratio of the loss of mass of a test piece, when dried under specified conditions, to its mass at the time of sampling

Note 1 to entry: The moisture content is normally expressed as a percentage mass fraction.

3.2 constant mass

mass reached by a test piece of paper or board after drying at a temperature of (105 ± 2) °C until the difference between two successive dryings and weighings, separated in time by at least half the initial drying period, does not exceed 0,1 % of the initial mass of the test piece at the time of sampling

4 Principle

At the time of sampling, test pieces taken from a lot are weighed and the test pieces are weighed again after drying to constant mass. From the mass of a test piece before and after drying, the moisture content is calculated.

5 Apparatus

5.1 Balance, having an accuracy of 0,05 % of the mass to be weighed, or better.

5.2 Containers, for the transport and weighing of test pieces, which shall be water-vapour proof and made from a lightweight material that is not subject to change under the conditions of test.

5.3 Oven, capable of maintaining the air temperature at (105 ± 2) °C, and suitably ventilated to maintain a uniform temperature in the usable volume while extracting the moisture driven off the test pieces.

5.4 Desiccator.

6 Preparation of containers

Before sampling, number a sufficient number of clean, dry containers (5.2). Allow the containers to attain temperature equilibrium with the atmosphere. Use a balance (5.1) and weigh each container. Keep the containers closed until the sample is about to be taken.

7 Sampling

Select the units to be sampled in accordance with ISO 186.

Precautions shall be taken when handling the paper or board to avoid contamination and any gain or loss of moisture if the atmosphere at the place of sampling is warm and damp. It is recommended to wear plastic or rubber gloves. To avoid moisture changes due to atmospheric exposure, it is important to enclose all test pieces in their containers immediately after taking them.

8 Selection, preparation and weighing of test pieces

8.1 General

For each unit withdrawn from the lot, proceed as specified in 8.2 or 8.3. Report the procedure that was used (for selection, preparation and weighing) along with other reported results (as described in Clause 11).

8.2 If the unit is a package that can be and may be unwrapped, or is in an unwrapped form

8.2.1 When the unit is not subdivided and not a reel

8.2.1.1 Average moisture content, grammage < 225 g/m²

Discard the three outermost sheets and all damaged sheets. The number of layers discarded may need to be increased according to the efficiency of wrapping and the influence of storage conditions. Take at least four consecutive sheets; quickly fold or cut them and enclose them together in one of the containers. The contents of a container constitute a test piece, which shall have a mass of at least 50 g. Weigh the container with its contents and calculate the mass of the test piece at the time of sampling, m_0 .

Prepare duplicate test pieces for each unit sampled.

Where the bulk of a 50 g test piece is very large, as for instance for very lightweight papers, a smaller mass of at least 25 g may be used. If a smaller mass is used, state this mass in the test report.

8.2.1.2 Average moisture content, grammage ≥ 225 g/m²

Discard the three outermost sheets and all damaged sheets. The number of layers discarded may need to be increased according to the efficiency of wrapping and influence of storage conditions. Take one or more sheets to provide sufficient strips, of width 50 mm to 75 mm and length not less than 150 mm, to give a total mass of at least 50 g. The strips constitute the test piece. Immediately enclose the test piece in one of the containers. Weigh the container with its contents and calculate the mass of the test piece at the time of sampling, m_0 .

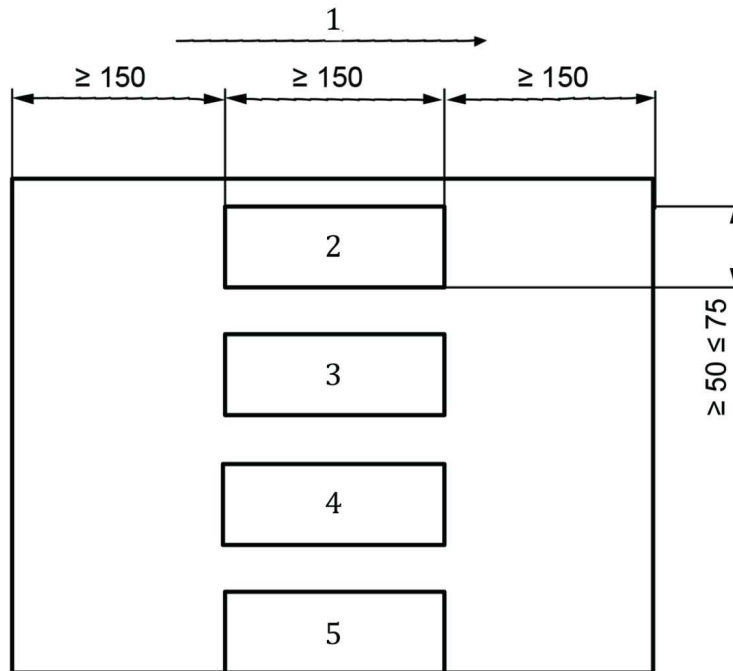
Prepare duplicate test pieces for each unit sampled.

8.2.1.3 Variation in moisture content of the sheets

For the determination of the variation between the centre and edges of the sheets, select a layer of sheets in accordance with [8.2.1.1](#) or [8.2.1.2](#). The layer of sheets shall have dimensions of ≥ 450 mm in cross-direction, and ≥ 200 mm in the MD. Take sufficient consecutive sheets to give one edge test piece and one centre test piece, as described below, each having a mass of at least 50 g.

From the selected layer of sheets, cut four sets of strips of width 50 mm to 75 mm, one strip from each edge and two strips near the centre, as shown in [Figure 1](#), taking care not to separate either the sheets or the strips comprising a set. Cut the strips with their longer dimension in the cross-direction with a length of at least 150 mm. Trim the ends of the strips to remove any paper or board within 150 mm of the edge of the original layer of sheets.

NOTE This direction of cut is chosen because any moisture variation across the width of the machine remaining in the paper from the papermaking operation will then be equally represented on each strip.



Key

- 1 cross-direction of paper
- 2 edge test strip
- 3 centre test strip
- 4 centre test strip
- 5 edge test strip

Figure 1 — Positions of edge and centre test strips

Discard the top and bottom strip from each set; combine the two sets representing the centre to form one test piece and the two from the edges to form another test piece. Each test piece shall have a mass of at least 50 g. Immediately place each test piece in a container. Weigh each container with its contents and calculate the mass of each test piece at the time of sampling, m_0 .

Prepare duplicate test pieces for each unit and position sampled.

Where the bulk of a 50 g test piece is very large, as for instance for very lightweight papers, a smaller mass of at least 25 g may be used. If a smaller mass is used, state this mass in the test report.

8.2.2 When the unit is composed of elements

Select reams, parcels, etc. in accordance with ISO 186 and proceed as specified in [8.2.2.1](#) to [8.2.2.3](#), as appropriate.

8.2.2.1 Average moisture content, grammage < 225 g/m²

From the centre of each ream or parcel, take at least four consecutive sheets and then proceed as specified in [8.2.1.1](#).

8.2.2.2 Average moisture content, grammage ≥ 225 g/m²

From the centre of each ream or parcel, take at least four consecutive sheets and then proceed as specified in [8.2.1.2](#).

8.2.2.3 Variation in moisture content of the sheets

To determine the variation in moisture content between the centre and edges of the sheet, select a layer of sheets in accordance with [8.2.2.1](#) or [8.2.2.2](#) and proceed as specified in [8.2.1.3](#).

8.2.3 When the unit is a reel

8.2.3.1 Average moisture content

Discard all damaged layers from the exterior of the reel. Discard also at least three undamaged layers if the grammage is less than 225 g/m² or at least one undamaged layer if the grammage is greater than or equal to 225 g/m². The number of layers discarded may need to be increased according to the efficiency of wrapping and influence of storage conditions.

Take, by cutting in the cross-direction, a layer of thickness at least 5 mm across the full width of the reel and lay it out flat. From the selected layer, take sets of strips having a width between 50 mm and 75 mm in the machine direction and a length not less than 150 mm. Cut one set of strips from near each reel edge and another set from the region of the mid-point between the edges, or cut a set of strips from the complete width of the reel. Take care not to separate either the sheets comprising the layer or the strips comprising a set.

Discard the top and bottom strip from each set of strips; the remainder together constitutes a test piece and shall have a mass of at least 50 g. Quickly fold or cut the strips comprising the test piece and enclose them together in a container. Weigh the container with its contents and calculate the mass of the test piece at the time of sampling, m_0 .

Prepare duplicate pieces for each unit and position sampled.

Where the bulk of a 50 g test piece is very large, as for instance for very lightweight papers, a smaller mass of at least 25 g may be used. If a smaller mass is used, state this mass in the test report.

8.2.3.2 Variation in moisture content across the reel

Proceed as specified in [8.2.3.1](#), taking test pieces from at least three positions across the reel, but cut test pieces with the 50 mm to 75 mm dimension in the cross-direction and the larger dimension in the machine direction. Carry out the test procedure on test pieces from each position and report the results separately.

8.3 When the unit is a package that cannot or should not be completely unwrapped

The package can consist of, for example, reels, pallets or possibly reams, in storage or selected by Customs.

8.3.1 Average moisture content for samples with known machine direction

Cut a window of dimension 50 mm to 75 mm wide and at least 150 mm long with the short dimension parallel to the machine direction. Cut the sample to a sufficient depth to enable the requisite number of strips, after discarding the top three strips and any damaged strips, to constitute a test piece of at least 50 g. Immediately, place the test piece in a container. Weigh the container and its contents and calculate the mass of the test piece at the time of sampling, m_0 .

Vary the position of the window from unit to unit.

Prepare duplicate test pieces for each unit and position sampled.

Alternatively, test pieces 50 mm to 75 mm wide and the full cross-direction width of the sample may be used.

Where the bulk of a 50 g test piece is very large, as for instance for very lightweight papers, a smaller mass of at least 25 g may be used. If a smaller mass is used, state this mass in the test report.

8.3.2 Average moisture content for samples with unknown machine direction

Cut windows approximately 100 mm × 100 mm, such that one dimension is parallel to the long side of the sheet. Then proceed as specified in [8.2.1.1](#) or [8.2.1.2](#), depending on grammage.

8.3.3 Variations in moisture content of sheets or across the reel

For the determination of variations in moisture content across the reel, or between the centre and edges of the sheets, proceed as specified in [8.2.3.2](#), taking test pieces 50 mm to 75 mm wide and at least 150 mm long but with the long dimension parallel to the machine direction. Take at least three test pieces across the reel or sheet. Carry out the test procedure on test pieces from each position and report the results separately.

Carry out duplicate tests on each unit and position sampled.

9 Procedure

9.1 Initial drying and weighing

Dry the test piece in an oven ([5.3](#)), either in its container ([5.2](#)) with the lid removed or after being removed from the container and spread out. During the drying process, the temperature shall be maintained at (105 ± 2) °C. If the test piece is removed from its container, also dry the container, preferably in the same oven.

The initial drying period shall be not less than 30 min for material of grammage less than 225 g/m² and not less than 60 min for grammage greater than or equal to 225 g/m².

Ensure that, while the test pieces are being dried, other test pieces are not introduced into the oven.

When the test piece is considered to be completely dry, enclose it quickly in the container and allow the container to cool in a desiccator ([5.4](#)). This may require an appreciable time with certain types of container. Equalize the air pressures inside and outside the container by momentarily opening and closing the container. Weigh the container and contents again and calculate the mass of the dried test piece.

9.2 Drying and weighing to constant mass

Place the test piece and container in the oven again and dry for a further period, equal to at least one-half of the initial drying period. Ensure that, while the test pieces are being dried to constant mass, other test pieces are not introduced into the oven.

Enclose the test piece quickly in its container and allow the container to cool in the desiccator. Equalize the air pressures inside and outside the container by momentarily opening and closing the container. Weigh the test piece in its container again. Repeat this process of further drying and weighing as necessary until constant mass is reached (see [3.2](#)), the drying period between consecutive weighings being, in all instances, not less than one-half of the initial drying time.

Consider that the test piece has reached constant mass, m_1 , when two consecutive weighings at the required time interval do not differ by more than 0,1 % of the mass of the test piece at the time of sampling, m_0 .

10 Calculation and expression of results

10.1 Calculation

Calculate the moisture content, $w_{\text{H}_2\text{O}}$, expressed as a percentage mass fraction, according to [Formula \(1\)](#).

$$w_{\text{H}_2\text{O}} = \frac{m_0 - m_1}{m_0} \times 100 \quad (1)$$

where

m_0 is the mass of the test piece at the time of sampling, in g (up to four decimals);

m_1 is the mass of the test piece after drying to constant mass, in g (up to four decimals).

For each unit and/or reel position, calculate the mean moisture content.

Calculate the mean moisture content of the lot.

10.2 Expression of results

Express the results, as a percentage, rounded to the nearest 0,1 %.

11 Test report

11.1 General

- a) The test report shall include a reference to this document (i.e. ISO 287) and the information in [11.2](#) or [11.3](#).
- b) Report the procedure that was used for the selection, preparation and weighing of test pieces (e.g. [8.2.1.1](#), etc.).
- c) Report the mass of the test piece if it is less than 50 g.
- d) Report any and all deviations from this document that were used or performed.

11.2 When an average moisture content is required

- a) Mean moisture content of the lot.
- b) Maximum and minimum moisture content of the lot.
- c) Standard deviation.
- d) Number of tests carried out.
- e) All of the above for the total selected.

11.3 When a variation in moisture content is required

- a) Mean moisture content of the lot.
- b) Maximum and minimum moisture content.
- c) Standard deviation.

- d) Number of tests carried out.
- e) All of the above for each of the selections made according to the scheme in [8.2](#) or [8.3](#), as appropriate.

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Annex A (informative)

Precision data

A.1 Repeatability

One laboratory carried out 10 consecutive tests (each test is the mean of duplicate measurements) on tissue paper and paperboard, and another laboratory carried out 10 consecutive tests on copy paper. The sampling for the tests was performed so that the precision of the measurement procedure was determined, rather than the variation within the lot and the precision of the sampling procedure. The results are shown in [Table A.1](#).

Table A.1 — Precision of the procedure for determination of moisture content

Sample	Number of tests	Moisture content %	Repeatability standard deviation s_r	Repeatability coefficient of variation %	Repeatability limit r
Tissue paper, < 50 g/m ²	10	6,13	0,13	2,1	0,37
Copy paper, < 225 g/m ²	10	5,56	0,05	0,97	0,15
Paperboard, ≥ 225 g/m ²	10	5,21	0,22	4,2	0,60
NOTE 1 The repeatability limit is calculated as $r = 1,96\sqrt{2}s_r$ and indicates the limit within which the difference between two independent tests is expected to lie with 95 % confidence.					
NOTE 2 The coefficient of variation (the relative standard deviation) is calculated as $CV = s_r \times 100/\text{mean}$.					

Under practical conditions of application of the method, the precision of the determination of the moisture content of a lot will be affected by

- the variations in moisture content within the lot,
- the handling and atmospheric exposure, and
- the number of test values averaged.

A.2 Reproducibility

No reproducibility figures are presented in this document. Since the test shall be performed at the time of sampling and since the sampling procedure forms an integral part of this method, laboratories participating in a comparative test would have to be in the same place at the same time to carry out the sampling and the testing.

Bibliography

- [1] ISO 638:2008, *Paper, board and pulps — Determination of dry matter content — Oven-drying method*

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