
**Information and documentation —
Papers and boards used for
conservation — Measurement of
impact of volatiles on cellulose in paper**

*Information et documentation — Papiers et cartons utilisés pour la
conservation — Mesure de l'impact des substances volatiles sur la
cellulose du papier*

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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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 46, *Information and documentation*, Subcommittee SC 10, *Requirements for document storage and conditions for preservation*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

According to ISO 16245^[1], materials used for storage boxes and file covers in archives and libraries “*shall not contain or form any substances which may be harmful to the documents being stored*”. Although ISO 16245 specifies important material properties as alkalinity and resistance to oxidation, as well as absence of, for example, optical brighteners and plasticizers, it does not provide a suitable method for evaluating potential effects of volatiles formed and emitted by the specific material which are the subject of this document.

This document can serve as a suitable tool for a completion of ISO 16245.

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Information and documentation — Papers and boards used for conservation — Measurement of impact of volatiles on cellulose in paper

1 Scope

This document describes a test method for conservation materials which can evaluate their impact on cellulose as the main constituent of paper-based collections caused by emission of their volatile compounds.

NOTE This test can be extended to museum artefacts.

This document is applicable to papers and boards used for conservation and storage of cellulose based items.

It is not applicable to parchment-based items.

It does not evaluate the effects due to direct contact between the papers and boards used for conservation and the collections.

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*

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

ISO 638, *Paper, board and pulps — Determination of dry matter content — Oven-drying method*

ISO 5351, *Pulps — Determination of limiting viscosity number in cupri-ethylenediamine (CED) solution*

ISO 14487, *Pulps — Standard water for physical testing*

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:

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

3.1

conservation

preservation measures and action applied to prevent, arrest or delay deterioration of a document or other material object

[SOURCE: ISO 5127:2017, 3.12.1.01]

3.2

reference paper

specified material used for the evaluation of the impact of boards and papers on cellulose

3.3

lot

aggregate of paper or board of a single kind with specified characteristics produced under conditions that are presumed uniform, and available for sampling at one time

Note 1 to entry: A lot comprises one or more nominally identical units. Where the material to be tested has already been incorporated into a manufactured article (for example a packing case), the lot is the aggregate of such articles of a single kind, of specified characteristics.

[SOURCE: ISO 186:2002, 3.1]

3.4

standard water

water purified to electrical conductivity $\leq 0,25$ mS/m at 25 °C

[SOURCE: ISO 14487:1997, 3.1]

3.5

viscosity-average degree of polymerization

DP_v

average number of anhydroglucose units (monomers of cellulose) in the cellulose macromolecule, determined by measuring the viscosity of solutions in cupri-ethylenediamine (CED)

[SOURCE: ISO/TS 18344:2016, 3.3, modified — "Viscosity" has been added to the term, and the determination process has been added to the definition.]

3.6

limiting viscosity number

$[\eta]$

limiting value of the viscosity number at infinite dilution

$$[\eta] = \lim_{\rho \rightarrow 0} \left(\frac{\eta - \eta_0}{\eta_0 - \rho} \right)$$

Note 1 to entry: Limiting viscosity number is measured in millilitres per gram.

Note 2 to entry: In the literature the term intrinsic viscosity is often used and is equal to the limiting viscosity number. There is no general conversion factor between the limiting viscosity number in ml/g and other viscosities, determined by other methods and expressed in millipascal seconds (mPa·s).

[SOURCE: ISO 5351:2010, 3.5]

3.7

loss of DP_v

arithmetic mean of the *viscosity-average degree of polymerization* (3.5) of an exposed sample of reference paper against the viscosity-average degree of polymerization of an unexposed sample of same paper

4 Principle

Studies have shown that neutral or alkaline papers and boards can emit volatiles (such as acids, aldehydes, sulfur-containing compounds, etc.) that may depolymerize paper cellulose and therefore weaken it^{[2][3][4]}.

This test method consists of measuring the impact of volatile compounds emitted by the tested material on a reference paper made of pure cellulose. These volatile compounds are developed by exposure at elevated temperature in closed vessels^{[5][6]}.

The impact of the volatiles emitted by the test material on the reference paper is evaluated by comparing its degree of polymerization after a given exposure time in specific conditions to that of an unexposed control sample.

NOTE 1 The determining degree of polymerization has been proven to be a reliable analytical method for describing the condition of cellulose^[7].

5 Apparatus

5.1 Vials.

The vials shall be of borosilicate glass. Each vial shall be equipped with a screw cap and a gasket which ensures an airtight sealing during the accelerated ageing.

The materials (such as glass, caps and gaskets) shall be stable. They shall not emit volatile compounds when heated at 105 °C and shall be resistant to acidic corrosion.

The internal height of the vials shall be high enough to contain the samples and their opening shall be wide enough to insert the microtube and additional vessel described in 5.2 and 5.7.

NOTE Caps of polybutylene terephthalate (PBT) and polytetrafluoroethylene (PTFE) linings were found to be most suitable^[8].

All materials in contact with samples and reference papers shall be inert.

5.2 Vessels.

If an additional vessel is used in the vial, this shall be made of borosilicate glass.

5.3 Viscometer.

The viscometer used to determine the degree of polymerization of cellulose shall comply with the equipment described in ISO 5351.

5.4 Ageing chamber.

Fan forced air circulation ageing chamber, thermostatically controlled at $(100,0 \pm 1,0)$ °C.

5.5 Reference paper.

Cellulose filter paper manufactured from cotton linter. It shall contain a minimum of 98 % alpha cellulose, have grammage of $(90,0 \pm 0,9)$ g/m² and a thickness of (180 ± 18) µm¹⁾.

5.6 Wire, made of galvanized steel, 1 mm diameter.

5.7 Microtube, made of borosilicate glass, 0,5 ml.

5.8 Carded cotton.

1) Whatman® filter paper grade 1 is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

6 Preparation of apparatus

6.1 Glass vials and vessels

Both vials and vessels new from the factory and already used shall be carefully cleaned according to the following protocol:

- wash vials and vessels meticulously with tap water and non-ionic detergent;
- rinse vials and vessels meticulously with tap water for the removal of detergent residues;
- rinse vials and vessels three times with standard water (with a conductivity $\leq 0,25$ mS/m at 25 °C, in accordance with ISO 14487) and let them drain;
- dry vials and vessels in an oven at 105 °C;
- condition all the vial and vessel components at least 24 h in the same atmosphere as the one used to condition the samples directly prior to experimental use (see [Clause 8](#)).

If vials or vessels are overly scratched or cannot be cleaned, they shall not be used.

6.2 Vial storage

After conditioning, close vials and keep them closed until needed for testing. At this stage, an airtight sealing is not required.

7 Sampling

If the average quality of a lot shall be determined, the sampling shall be carried out according to ISO 186.

Ensure that the samples taken are representative of the material to be tested.

The paper or board samples shall be handled with disposable synthetic polymer laboratory gloves. They shall be cut with clean and dry scissors or cutting devices, the cutting edge of which shall be cleaned with ethanol or acetone.

If metal instruments are used, they shall be free of traces of oxidation.

8 Conditioning

The samples and reference paper shall be conditioned at (23 ± 1) °C and at (50 ± 2) % RH according to ISO 187.

To avoid cross contamination the samples and reference paper shall not be conditioned in contact with each other.

The unexposed sheets of reference paper shall be stored in the standard atmosphere until needed for testing.

9 Determination of the dry matter content

The dry matter content of the samples and the reference paper is determined according to ISO 638.

10 Preparation of the samples

10.1 Test vial

Cut a piece of conditioned sample with dry matter corresponding to $0,027\ 8\ \text{g} \pm 0,000\ 7\ \text{g}$ per ml of internal vial volume. If the calculation does not result in a whole number, round up to the next higher whole number.

NOTE If a 100 ml vial is used, the mass of piece of conditioned sample with dry matter to be cut is $2,78\ \text{g} \pm 0,07\ \text{g}$.

Insert the specimen in the vial.

This vial is called the test vial.

10.2 Control vial

Repeat the procedure described in [10.1](#), but instead replace the sample by the reference paper.

10.3 Sealing leak indicator

For each vial prepare a microtube containing 2 cm of galvanized steel wire and closed with a piece of carded cotton. This sealing leak indicator is placed at the bottom of each vial (see [Figure 1](#)).

NOTE If the vial is well sealed, the moisture emitted by the testing materials and the reference paper in the vial when heating the vial at $100\ ^\circ\text{C}$ promotes the oxidation of the indicator (zinc layer). This oxidation is visible in the form of a white deposit of ZnO which does not appear if there is a leak.

10.4 Reference paper

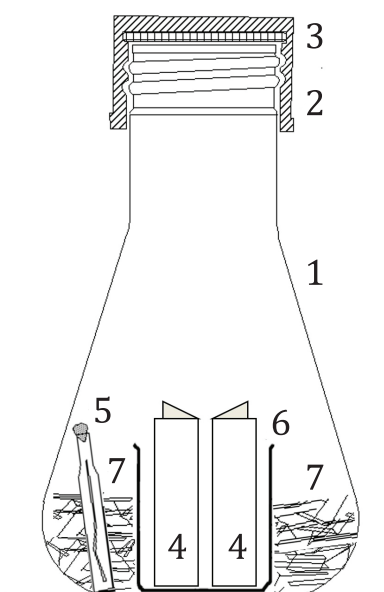
For each vial, test vial and control vial, cut two $1,5\ \text{cm} \times 2\ \text{cm}$ pieces of reference paper. These test pieces shall be handled and cut according to the specifications of [Clause 7](#). During accelerated ageing, the test pieces shall not be in contact either with each other or with the sample.

NOTE In order to achieve this, the reference paper test pieces can be placed next to each other (side by side) in a borosilicate glass vessel placed at the bottom of the vial. The sample is placed outside the vessel (see [Figure 1](#)).

Two additional reference paper test pieces are stored at $(23 \pm 1)\ ^\circ\text{C}$ and $(50 \pm 2)\ \%$ RH. They do not undergo accelerated ageing and are used for the determination of DP_{v,t_0} (viscosity-average degree of polymerization of unaged reference paper test pieces) for the validation of the control (see [12.2.1](#)) and the calculation of ωDP_v , the DP loss of the reference paper test pieces aged with the samples (see [12.3](#)).

All the test pieces (aged and unaged) shall be taken from the same sheet of reference paper.

If the testing set-up used is different from the one of [Figure 1](#), it should be documented and illustrated by a figure or photo.



Key

- | | | | |
|---|-----------------------------|---|--|
| 1 | vial | 5 | sealing leak indicator |
| 2 | cap | 6 | vessel |
| 3 | gasket | 7 | sample (test vial) or reference paper (control vial) |
| 4 | reference paper test pieces | | |

Figure 1 — Example of testing set-up

10.5 Vial sealing

To ensure a high sealing efficiency tighten the cap and its gasket properly. The validity of the test depends strictly on the vial's airtightness. Before each test, it is necessary to make sure that the gaskets show no visible defect and to replace them regularly.

11 Procedure

11.1 Number of vials

For each testing, three test vials per sample and two control vials shall be prepared.

11.2 Accelerated ageing

The test vials and the two control vials shall be placed in an ageing chamber heated to a temperature of $(100 \pm 1) ^\circ\text{C}$ for 5 days.

The cap tightness shall be checked after a few hours of heating. It shall be tightened again if necessary.

11.3 Reference paper test pieces removal and reconditioning

After ageing, the closed vials are kept at ambient temperature for at least 1 h. The reference paper test pieces are taken out of the vial and allowed to equilibrate for at least 12 h in the same standard atmosphere as the one used for the conditioning.