INTERNATIONAL STANDARD

ISO 11004

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Paper and board — Determination of air permeance — Low range

Papier et carton — Détermination de la perméabilité à l'air — Valeur faible

Reference number
ISO 11004:1992(E)

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.

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.

International Standard ISO 11004 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Sub-Committee SC 2, *Test methods and quality specifications for paper and board*.

Annex A forms an integral part of this International Standard. Annex B is for information only.

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Paper and board — Determination of air permeance — Low range

1 Scope

This International Standard specifies a method of determining the air permeance of paper and board in the low air permeance range.

The method is applicable to all papers and boards having an air permeance of less than 3×10^{-1} µm/(Pa·s) when determined under the specified conditions. For air permeances greater than this, methods such as those specified in the ISO 5636 series are recommended (see annex B).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 186:1985, *Paper and board — Sampling to determine average quality.*

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

3 Definition

For the purposes of this International Standard, the following definition applies.

3.1 air permeance: The mean flow of air through unit area under unit pressure difference in unit time, under specified conditions.

It is expressed in micrometres per pascal second:

$[1 \text{ ml}/(\text{m}^2 \cdot \text{Pa} \cdot \text{s}) = 1 \text{ µm}/(\text{Pa} \cdot \text{s})]$.

NOTE 1 Although the micrometre per pascal second is the standard unit for air permeance, because of the low air flows involved it may be more convenient to express the results in nanometres per pascal second:

$[0{,}001 \text{ ml}/(\text{m}^2 \cdot \text{Pa} \cdot \text{s}) = 1 \text{ nm}/(\text{Pa} \cdot \text{s})]$.

4 Principle

A test piece is clamped between circular plates and the air flow through the paper under specified conditions is measured.

5 Apparatus

5.1 Air-flow meter, consisting of three flowmeters covering a total range of 0,02 ml/s to 20 ml/s with an overlap between the flowmeters of at least 20 % of the full scale. Each flowmeter is calibrated to an error of less than 2 % of its full-scale value.

The flowmeters are fitted with stops for the rotors at both their upper and lower ends, the stops being designed to prevent interruption of the air flow.

The flowmeters are connected in series, the smallest first and the largest last, with its upper end open and air only being able to flow in the direction of the smallest to the largest.

NOTE 2 Some instruments are provided with a capillary air-flow meter to be used when testing very dense papers. The capillary, which is placed horizontally and is used in place of the flowmeters, is about 1 mm wide and has two marks about 200 mm apart. The volume between the two marks should be known with an error of less than 2 %. From a side tube, a droplet of butanol can be passed into the capillary tube by means of a rubber bulb and the time the droplet takes to pass between the two marks is used to determine the air flow.

5.2 Manometer, consisting of a U-tube filled with mercury and fitted with a vertical scale graduated in millimetres.

WARNING — Mercury is a hazardous substance and suitable safety precautions are necessary.

5.3 Test piece holder (see figure 1), consisting of two circular plates, the lower one adjustable and the upper one fixed. Each plate has a groove 1,80 mm to 1,90 mm deep around its periphery into which is fitted a smooth rubber sealing ring so as to enclose an area of 50 cm^2, corresponding to an internal diameter of 79,8 mm $\pm$ 0,1 mm. The rubber ring is rectangular in cross section being about 5 mm high and at least 3 mm wide and has a Shore hardness of about 80.

The lower plate has a central bore which is connected to the air-flow meter and one limb of the manometer. The lower plate has a series of concentric bars to support the test piece. The bars have a triangular cross section and a height of 3 mm and each is interrupted in at least two places to allow air to pass between the chambers that they form. The upper plate has a central bore through which compressed air is fed and which is connected to the other limb of the manometer (see figure 2).

NOTE 3 All connection tubes should be of a sufficient diameter and length to prevent leakage and flow restrictions due to kinks.

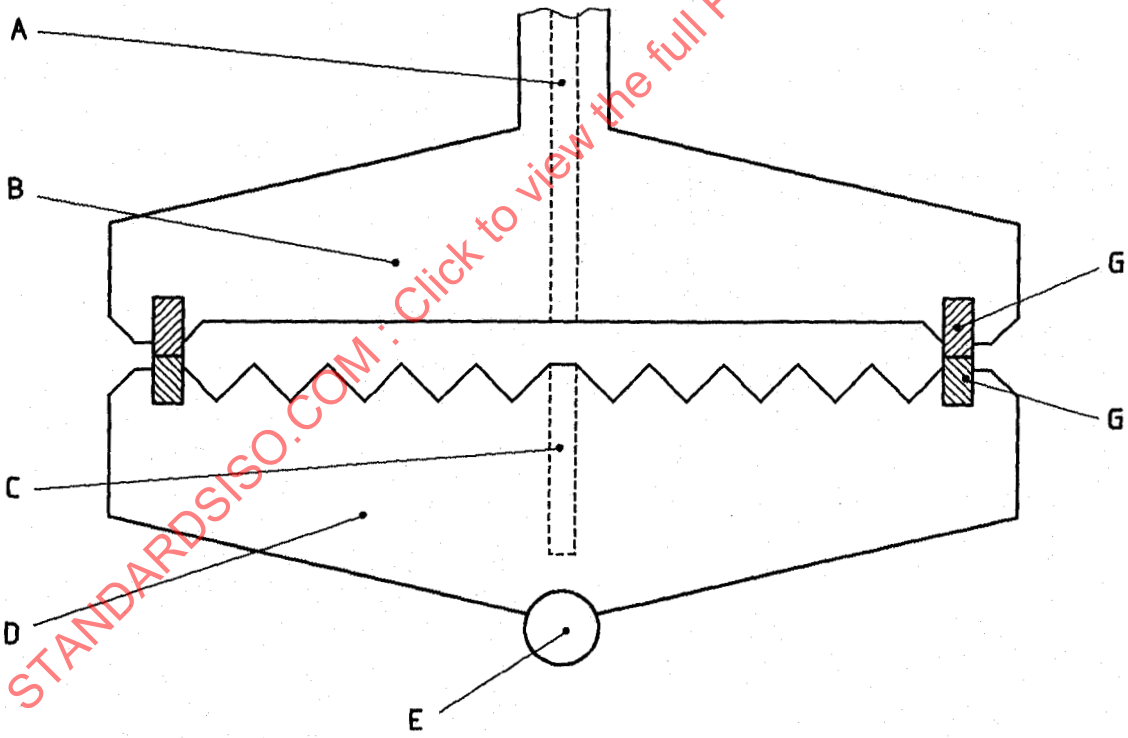
5.4 Air compressor, with a capacity of at least 50 cm^3/s and the minimum pressure difference between inlet and outlet being at least 20 kPa.

The compressor shall be installed so that the flowmeter readings are not affected by vibrations.

5.5 Calibration device (see annex A).

6 Sampling

Samples shall be taken in accordance with ISO 186.



A Bore connected to air compressor and manometer
B Upper plate
C Bore connected to rotameters and manometer
D Lower plate
E Universal joint
G Rubber rings

Figure 1 — Test piece holder

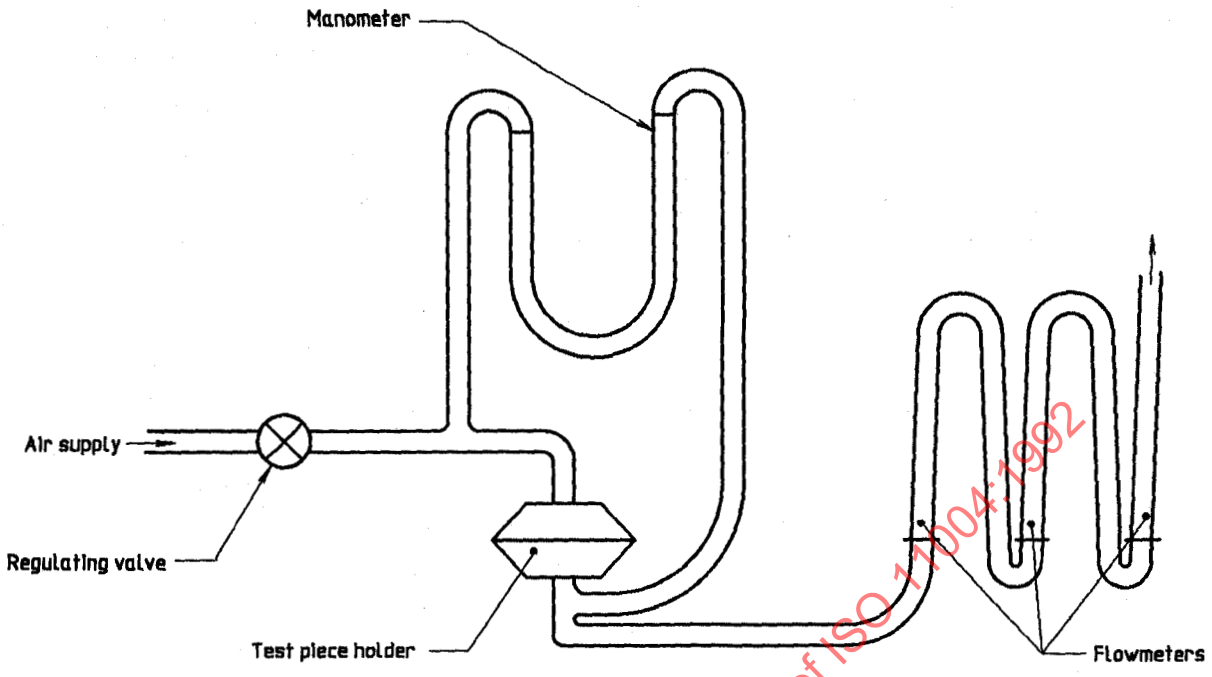


Figure 2 — Schematic of apparatus

7 Conditioning

The samples shall be conditioned in accordance with ISO 187 and test piece preparation and testing shall be carried out in the same conditioning atmosphere used to condition the sample.

8 Preparation of test pieces

Cut 10 test pieces, at least 120 mm × 120 mm ensuring that the test pieces are free from folds, wrinkles and other defects. Identify the two faces of the test pieces in some convenient way.

9 Procedure

Check that the apparatus is in good working order (see A.1). Start the compressor (5.4). Clamp the test piece between the two plates (5.3) so that the rubber rings bear on it and there is no leakage and adjust the air flow so that the difference between the two mercury levels shown by the manometer (5.2) is between 50 mm and 150 mm. Read the distance to the nearest 1 mm. Record the reading from the flowmeter (5.1) which gives a reading in the upper part of the scale. Test five test pieces with one face up and five test pieces with the other face up, using the same flowmeter for each group of tests.

NOTE 4 When the capillary air-flow meter is used, the air supply should be adjusted so that the difference between the two mercury levels in the manometer is 100 mm ± 1 mm. The air flow is measured by determining the time the droplet takes to pass between the two marks. If the capillary flowmeter is used, this should be noted in the test report.

10 Expression of results

Calculate the mean air flow from the flowmeter readings or from the mean time required for the droplet to pass between the two marks on the capillary. Calculate the mean air flow separately for the two sides. If the difference between the means exceeds 10 %, the results should be calculated and reported separately. Otherwise calculate the grand mean.

Calculate the air permeance P, expressed in micrometres per pascal second, using the equation

$$P = \frac{1{,}5\ q_V}{\Delta h}$$

where

q_V is the air flow, in millilitres per second;

Δh is the difference between the two mercury levels of the manometer, in millimetres.

NOTE 5 If it is required to report the result in nanometres per pascal second, multiply the value obtained by 1 000.

11 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) date and place of testing;

c) all information necessary for identification of the sample;

d) the mean test result, or the mean results of the separate faces, to two significant figures;

e) the range or standard deviation or coefficient of variation;

f) any deviation from the standard procedure or other circumstance which might have affected the results.

Annex A
(normative)

Checking and calibration of apparatus

A.1 Checking of apparatus

A.1.1 Check the air tightness of the apparatus by clamping a smooth surfaced non-porous material such as a metal foil or a plastics sheet between the plates and applying a reduced pressure corresponding to a difference in mercury levels of 150 mm to the upper end of the last flowmeter; the flowmeter reading should be zero.

A.1.2 Check the smoothness of the rubber rings by clamping a piece of carbon paper together with a piece of smooth white paper between the plates. The print obtained should show no unevenness of the inner edge and should be of uniform width (check of concentricity).

A.2 Calibration of flowmeters

A.2.1 Apparatus

A.2.1.1 Soap-bubble meter (see figure A.1), consisting of a volumeter with the volume between two marks known accurately. The volumeter has an air inlet tube on one side and a rubber bulb at its lower end. One volumeter for each flowmeter is recommended, suitable volumes being 1 ml, 10 ml and 100 ml.

A.2.1.2 Soap solution, 3 % to 5 % liquid detergent in distilled water.

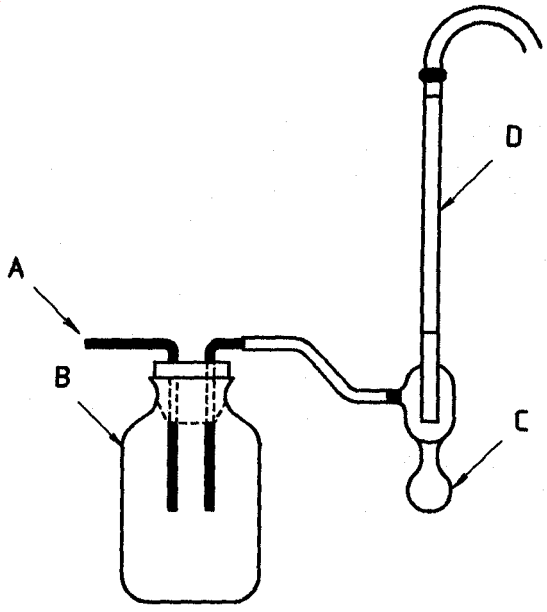
A.2.1.3 Stop watch.

A.2.2 Procedure

Calibrate the flowmeters in the same atmospheric conditions as used to carry out the test.

Connect the upper part of the largest flowmeter to the air inlet tube of the volumeter. Start the compressor and clamp a paper selected so as to give a reading on the flowmeter tube under calibration. Fill the rubber bulb with soap solution and squeeze it so that a bubble enters the volumeter tube. Note the time required for the bubble to ascend from the lower to the upper mark. Check that the flowmeter reading remains constant. Repeat the procedure with six to eight papers of different permeabilities, so that the whole flowmeter range is calibrated.

For each reading, calculate the flow rate q_V using the equation given in A.3 and compare with the flowmeter reading. If the flowmeter readings differ from the flow rate by more than 2 % of the full-scale value, examine the flowmeter tubes and rotors for dirt and/or damage and replace if necessary. As a temporary measure, a correction chart of flow rate versus flowmeter reading may be constructed.



A Inlet
B Glass flask
C Rubber bulb
D Volumeter

Figure A.1 — Soap-bubble meter

A.3 Expression of results

Calculate the flow rate q_V, expressed in millilitres per second, using the equation

$$q_V = \frac{V}{t}$$

where

V is the volume, in millilitres, between the marks of the volumeter tube;

t is the time, in seconds, required for the bubble to travel between the marks.