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**Paper and board — Determination of  
air permeance (medium range) —**

**Part 6:  
Oken method**

*Papier et carton — Détermination de la perméabilité à l'air (plage de  
valeurs moyennes) —*

*Partie 6: Méthode Oken*

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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](http://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](http://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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

ISO 5636 consists of the following parts, under the general title *Paper and board* — *Determination of air permeance (medium range)*:

- *Part 3: Bendtsen method*
- *Part 4: Sheffield method*
- *Part 5: Gurley method*
- *Part 6: Oken method*

NOTE 1 *Part 1: General method* will be withdrawn after parts 3, 4, and 5 have been revised and published, as it was considered redundant.

NOTE 2 *Part 2: Schopper method* was withdrawn in 2006 as it was considered obsolete.

# Paper and board — Determination of air permeance (medium range) —

## Part 6: Oken method

### 1 Scope

This part of ISO 5636 specifies the Oken method for determining the air permeance and air resistance of paper and board. There is no limitation on the measuring range of air permeance or air resistance of papers and boards. It is unsuitable for rough-surfaced materials, which cannot be securely clamped to avoid leakage.

### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

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*

### 3 Terms and definitions

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

#### 3.1

##### air permeance

mean air flow rate through unit area under unit pressure difference in unit time, under specified conditions

Note 1 to entry: Air permeance is expressed in micrometres per pascal second [ $1 \text{ ml}/(\text{m}^2\text{Pa} \cdot \text{s}) = 1 \mu\text{m}/(\text{Pa} \cdot \text{s})$ ].

Note 2 to entry: This property is called air permeance and not air permeability because it is reported as a sheet property and is not normalized with respect to thickness to give a material property per unit thickness.

#### 3.2

##### air resistance

time required for a specific volume of air under unit pressure to pass through unit area

Note 1 to entry: Air resistance is expressed in seconds per 100 millilitres (s/100 ml).

### 4 Principle

A test piece is clamped between a circular gasket and an annular flat surface of known dimensions. The absolute pressure on one side of the test piece is equivalent to atmospheric pressure. The air pressure on the inlet side of a narrow capillary of controlled dimensions is maintained at a constant value above

atmospheric pressure. The air passes through the capillary and then the test piece. The air pressure between the capillary and test piece depends on the permeance of the test piece. It is measured and converted to air permeance.

## 5 Apparatus

### 5.1 Air resistance apparatus (Oken tester)

Use either the water column type described in [5.2](#) or the electronic sensor type described in [5.3](#).

### 5.2 Water column type

**5.2.1 The water column type** (see [Figure 1](#)), consists of an air compressor ([5.2.1.2](#)), filter water column regulator ([5.2.1.3](#)), capillary ([5.2.1.3](#)), water column manometer ([5.2.1.4](#)), measuring head ([5.2.1.1](#)), and scale plate ([5.2.1.4](#)).

**5.2.1.1 The measuring head**, consists of clamping plates and a rubber gasket. The clamping plates are at the base of the apparatus and connected to the pressure measuring chamber by a tube. The equipment shall have a means of tightening the clamping plates together which might be a capstan (jackscrew) arrangement or a pneumatic system. The recommended clamping force is  $(180 \pm 30)$  N. This mechanism provides a technique to give uniform loading and thus minimize the operator influence on the test. A controlled clamping force is the preferred method of clamping the test piece.

A rubber gasket is inserted concentrically into a groove in the upper surface of the lower clamping plate to prevent leakage of air between the surface of the paper and the clamping plate. The gasket consists of a thin, elastic, non-oxidizing material, having a smooth surface, rectangular cross section, a thickness of 1,5 mm to 2,0 mm, and a hardness of  $(50 \pm 10)$  IRHD (international rubber hardness degrees) in accordance with ISO 48. The inside diameter of the gasket is  $(28,3 \pm 0,3)$  mm and the outside diameter is  $(34,5 \pm 0,5)$  mm.

The aperture of the gasket is concentrically aligned with the aperture in the clamping plates. To align and protect the gasket in use, it is cemented to a groove machined in the lower clamping plate. The groove is concentric with the aperture in the opposing plate, has an internal diameter of  $(28,60 \pm 0,15)$  mm and an outside diameter of  $(35,5 \pm 0,5)$  mm. The depth of the groove with a square bottom shall be  $(0,5 \pm 0,1)$  mm less than the thickness of the gasket when mounted. The gasket, when mounted inside the concentric groove, defines the measurement area ( $642 \text{ mm}^2$  area). The gasket should be changed at regular intervals.

**5.2.1.2 The air compressor and regulator**, supply compressed and filtered air. The air is controlled to approximately 10 kPa by the air regulator.

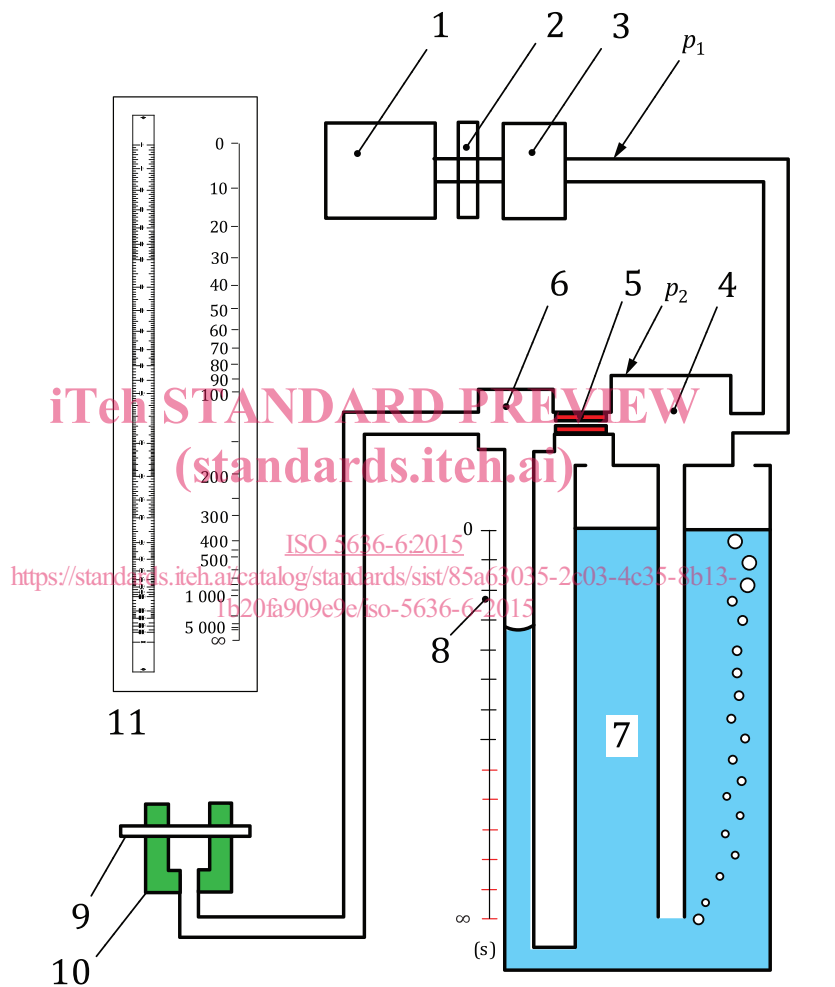
**5.2.1.3 The filter water column regulator and capillary**, provide a constant pressure. The filter water column regulator consists of a water tank with an internal diameter of approximately 100 mm and a height of approximately 700 mm and a constant pressure chamber with a side tube. The open end of the side tube is  $(500 \pm 0,5)$  mm below the water surface.

The air at approximately 10 kPa introduced into the constant pressure chamber is controlled to  $(4,90 \pm 0,01)$  kPa [ $(500 \pm 1)$  mmH<sub>2</sub>O] and transferred to the pressure measuring chamber through the capillary.

The capillary consists of a narrow tube made of stainless material with an inner diameter of approximately 0,4 mm and a length of approximately 54 mm. The capillary length shall be strictly adjusted so that the time required for the passage of 100 ml of air through the capillary under a pressure difference of 1,23 kPa is equal to 100 s (see [A.2](#) for adjustment of the capillary length).

**5.2.1.4 The water column manometer and scale plate**, comprise the pressure measurement system. The water column manometer is connected to the water tank at a depth greater than 500 mm below the surface of the water in the water tank by a pipe with a diameter large enough (with a minimum of 3 mm) to allow water to transfer smoothly between the manometer and water tank. The manometer is connected to the measuring head and capillary. The scale plate for reading air resistance is marked in the units of seconds per 100 millilitres. The scale shall cover the range 0 s to 5 000 s with a scale reading of 0 at a pressure drop of zero (0 mmH<sub>2</sub>O), a scale reading of 100 s/100 ml at the midpoint 250 mm below the surface level in the tank and infinity ( $\infty$ ) at a pressure of 4,90 kPa (500 mmH<sub>2</sub>O).

NOTE High or low air resistance types of Oken tester with different capillary dimensions or measurement areas are available for shorter measurement time or higher precision. However, these types of Oken tester are out of the scope of this part of ISO 5636.



#### Key

1	air compressor	8	scale plate
2	filter	9	test piece
3	regulator	10	measuring head
4	filter water column regulator/constant pressure chamber	11	example of scale plate
5	capillary	$p_1$	approximately 10 kPa
6	water column manometer/pressure measuring chamber	$p_2$	4,90 kPa
7	water tank		

**Figure 1 — Diagram of water column type Oken tester**

5.3 Electronic sensor type

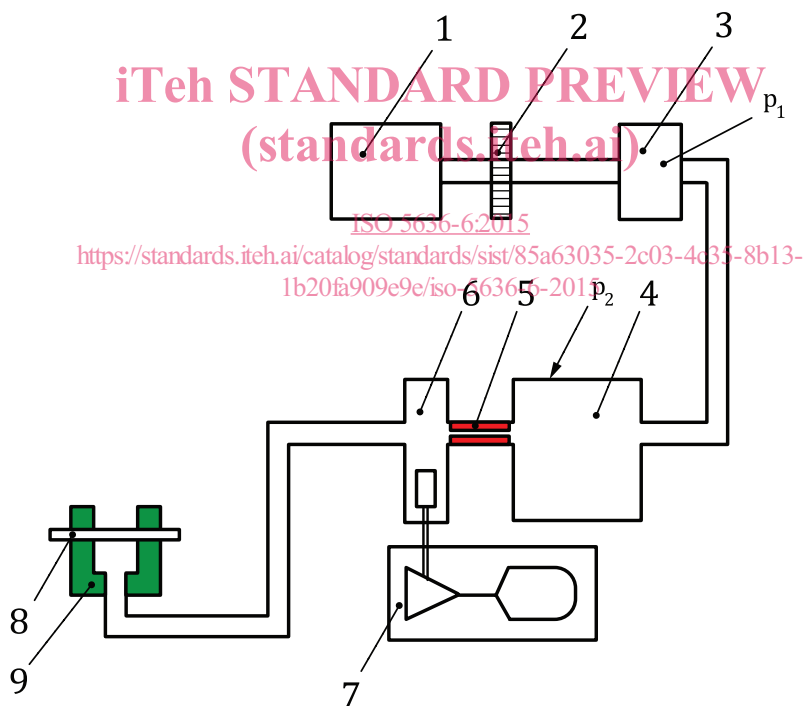
5.3.1 The electronic sensor type (see Figure 2), consists of a measuring head (5.3.1.1), air compressor (5.3.1.2), filter, regulator (5.3.1.2), capillary (5.3.1.3), pressure sensor (5.3.1.4), sensor amplifier (5.3.1.4), and digital display (5.3.1.4).

5.3.1.1 The measuring head, consists of clamping plates and a rubber gasket. The structure is the same as the measuring head (5.2.1.1) for the water column type.

5.3.1.2 The air compressor and regulator, are the same as the air supply system (5.2.1.2). The regulator controls air directly to  $(4,90 \pm 0,01)$  kPa [ $(500 \pm 1)$  mmH<sub>2</sub>O].

5.3.1.3 The constant pressure chamber and capillary, are the same as those for the water column type (5.2.1.3). Air at the pressure controlled by the regulator is transferred to the measuring head through the capillary.

5.3.1.4 The pressure measuring chamber, electronic pressure sensor, amplifier, and digital display, comprise the electronic sensing system. The digital display shows the pressure of the pressure measuring chamber and the air resistance calculated from the pressure (see A.3), as units of kiloPascal (mmH<sub>2</sub>O) and second per 100 millilitres.



Key

- |   |   |       |                           |
|---|---|-------|---------------------------|
| 1 | air compressor  | 7     | amplifier/digital display |
| 2 | filter  | 8     | test piece                |
| 3 | regulator   | 9     | measuring head            |
| 4 | constant pressure chamber                             | $p_1$ | approximately 10 kPa      |
| 5 | capillary   | $p_2$ | 4,90 kPa                  |
| 6 | pressure measuring chamber/electronic pressure sensor |       |                           |

Figure 2 — Diagram of electronic sensor type Oken tester



## 6 Sampling

If the mean quality of a lot is to be determined, sampling shall be 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 Preparation of test pieces

Prepare the test pieces in the same atmospheric conditions as those used to condition the sample.

Cut not less than 10 test pieces and identify their two sides, for example, side 1 and side 2. The test area shall be free from folds, wrinkles, holes, watermarks, or defects not inherent in the sample. Do not handle the part of the test piece which will become part of the test area. An adequate test piece size is 100 mm × 100 mm.

If the mean air permeance measured on the two sides is significantly different and if this difference is required to be shown in the test report, 10 tests are required for each side.

## 9 Calibration

Calibrate the apparatus according to instructions of the manufacturer.

Check the pressure of the water column manometer or digitally displayed pressure with no test piece between the clamping plates. It should be reading zero ( $0 \pm 0,01$ ) kPa [ $(0 \pm 1)$  mmH<sub>2</sub>O]. If the water level does not read zero, adjust the water level by pouring water into the water tank. Check the apparatus for air leakage by clamping a thin sheet of smooth, rigid, impermeable material. The pressure shall be reading a value higher than 4,88 kPa (498 mmH<sub>2</sub>O). If the value is less than the specified pressure, suggesting air leakage, check possible defects in the clamping plates, rubber gasket, and tubes to be repaired or replaced with new ones.

## 10 Procedure

Carry out the test in the same atmospheric conditions as those used to condition the samples.

Tests shall be performed according to the instructions of the manufacturer.

After the calibration process in [Clause 9](#), test a minimum of 10 test pieces, five with side 1 up and five with side 1 down.

Clamp a test piece between the clamping plates. Read the air resistance value of the water column manometer or digital display after the indication becomes stable.

Repeat the procedure until five valid measurements are obtained for each side.

Obtain the mean value of the 10 tests and also for the two sides separately.

If the mean air permeance measured on the two sides is significantly different (more than 10 %) and if this difference is required to be shown in the test report, 10 tests are required for each side.