BS ISO 5636-6:2015

BSI Standards Publication

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

Part 6: Oken method

National foreword

This British Standard is the UK implementation of ISO 5636-6:2015.

The UK participation in its preparation was entrusted to Technical Committee PAI/11, Methods of test for paper, board and pulps.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2015

ISBN 978 0 580 71194 7

ICS 85.060

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 May 2015.

Amendments/corrigenda issued since publication

Date	Text affected

INTERNATIONAL STANDARD

ISO 5636-6

First edition
2015-05-01

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

Reference number
ISO 5636-6:2015(E)

Contents

Page

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 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 [$1\ ml/(m^2Pa \cdot s) = 1\ \mu m/(Pa \cdot s)$].

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 ± 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 ± 10) IRHD (international rubber hardness degrees) in accordance with ISO 48. The inside diameter of the gasket is (28,3 ± 0,3) mm and the outside diameter is (34,5 ± 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 ± 0,15) mm and an outside diameter of (35,5 ± 0,5) mm. The depth of the groove with a square bottom shall be (0,5 ± 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 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.

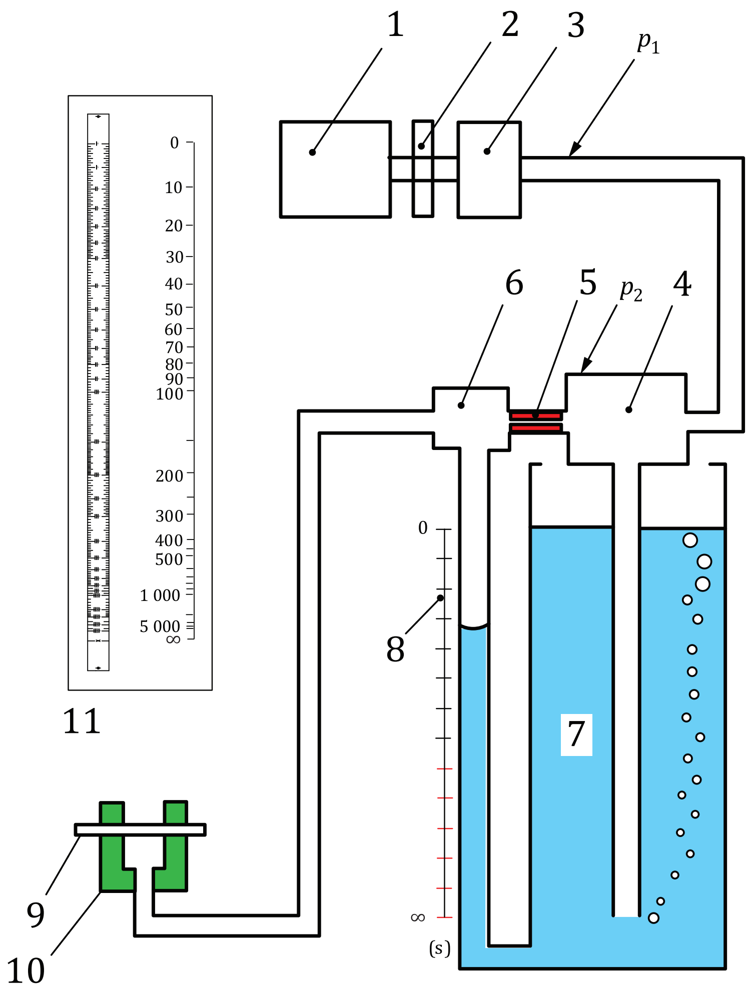
5.2.1.3 The filter water column regulator and capillary, provide a constant pressure. The filter water column regulator consists of a water tank with an internal diameter of approximately 100 mm and a height of approximately 700 mm and a constant pressure chamber with a side tube. The open end of the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

The air at approximately 10 kPa introduced into the constant pressure chamber is controlled to (4,90 ± 0,01) kPa [(500 ± 1) mmH_2O] 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_2O), a scale reading of 100 s/100 ml at the midpoint 250 mm below the surface level in the tank and infinity (∞) at a pressure of 4,90 kPa (500 mmH_2O).

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

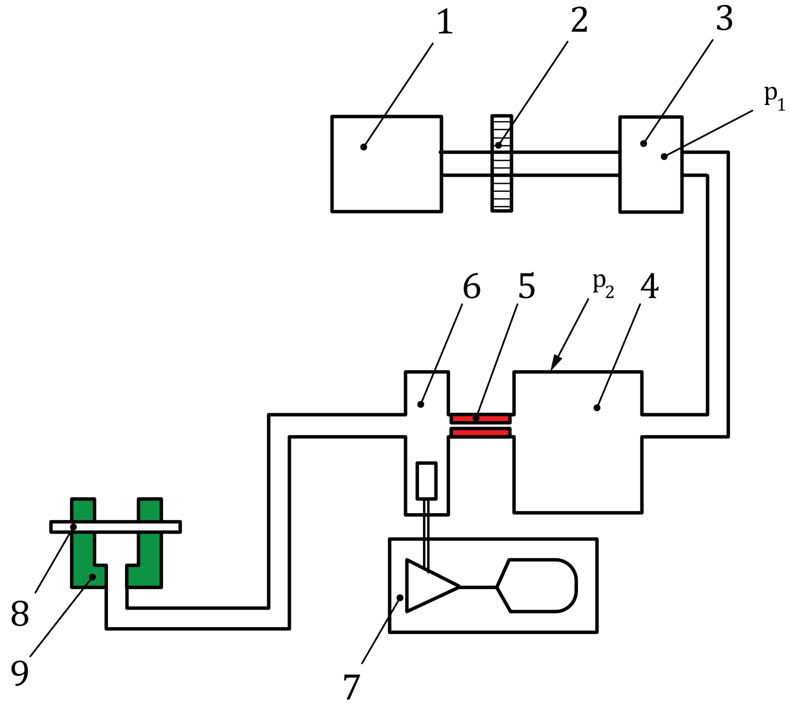
5.3.1 The electronic sensor type (see Figure 2), consists of a measuring head (5.3.1.1), air compressor (5.3.1.2), filter, regulator (5.3.1.2), capillary (5.3.1.3), pressure sensor (5.3.1.4), sensor amplifier (5.3.1.4), and digital display (5.3.1.4).

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 ± 0,01) kPa [(500 ± 1) mmH_2O].

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_2O) and second per 100 millilitres.



Key

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

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 ± 0,01) kPa [(0 ± 1) mmH_2O]. 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_2O). 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.

11 Expression of results

11.1 Calculation of air permeance

Calculate the air permeance, P, in micrometres per pascal second, to two significant figures, from Formula (1):

$$P = \frac{127}{t_k} \tag{1}$$

where

t_k is the mean value of the air resistance in seconds by the Oken tester.

Formula (1) is based on a mean pressure difference between 0 and 4,90 kPa depending on the measured value and a test area of 642 mm^2.

NOTE 1 The coefficient of Formula (1) for the Oken tester is different from that for the Gurley apparatus because the calibration is based on 100 ml of air, at room pressure, passing through the test piece measured at a pressure difference of 1,23 kPa, which was specified in ISO 5636-5:1986.

NOTE 2 Air resistance (Oken) can be converted to air resistance (Gurley) using the conversion formula given in Annex A.

If required, calculate the mean air permeance for each side separately.

11.2 Reporting the results

Report the air permeance to two significant figures.

If the air resistance is required, this shall be reported as “Air resistance (Oken)” in seconds that corresponds to t_k defined in 11.1. Report the air resistance to two significant figures.

11.3 Standard deviation and coefficient of variation

If the standard deviation or coefficient of variation is required, first calculate the individual air permeance for each test piece and from them, the standard deviation and coefficient of variation.

If the results for the two sides of the samples are reported separately, calculate the standard deviations or coefficients of variation for the two sides separately.

12 Test report

The test report shall include the following information:

a) a reference to this part of ISO 5636, i.e. ISO 5636-6;

b) the date and place of testing;

c) all the information necessary for complete identification of the sample;

d) the conditioning atmosphere used;

e) the number of test pieces tested, as specified in Clause 10 and 11.1;

f) the type of Oken tester used;

g) the mean air permeance or permeances, as specified in 11.2;

h) if required, the air resistance or air resistances, as specified in 11.1;

i) if required, the standard deviation or coefficient of variation or the values for each side, as specified in 11.3;

j) any deviation from the specified procedure which might have affected the result.

Annex A
(informative)

Measurement principle of air resistance (Oken) and its relation to air resistance (Gurley)

The principle for the calculation of air resistance (Oken) from the measured pressure to graduate the scale plate or display air resistance digitally and the formula for conversion from air resistance (Oken) to air resistance (Gurley) will be described below.

A.1 Definitions of air resistance (Gurley) and air resistance (Oken)

Before ISO 5636 was established, the Gurley tester was supposed to be designed to measure air resistance (Gurley) t_G, that is, time in seconds required for the volume V_G = 100 ml of air, measured at room pressure, under the pressure difference p_G = 1,29 kPa to pass through a test area of 642 mm^2 of a test piece.

In ISO 5636-5:1986, air resistance (Gurley) t_{G1986} was redefined as time required for the volume V_G = 100 ml of air under the pressure difference p_{G1986} = 1,23 kPa to pass through the test area.

The Oken tester is designed or calibrated according to the definition of ISO 5636-5:1986 assuming that air behaves as a laminar flow. In ISO 5636-5:2003, air resistance (Gurley) t_{G2003} was redefined again now as time required for the volume V_G = 106 ml of air under the pressure difference p_{G2003} = 1,22 kPa to pass through it. However, for the same test piece, the measured air resistance (Gurley) (s) has been the same value through the ISO revisions because the tester design was unchanged. In short, although it seemed that t_G or t_{G1986} was measured, whereas in practice, it was t_{G2003} that was measured.

The conversion formula from the measured pressure p to air resistance (Oken), $t_{K,}$ is determined following the definition of t_{G1986}. Therefore, air resistance (Oken), $t_{K,}$ is equal to air resistance (Gurley) t_{G1986}, namely, $t_K = t_{G1986}$, by definition and not equal to t_G or t_{G2003}.

A.2 Adjustment of the capillary length of the Oken tester

The air flow rate Q (ml/s) through the capillary from the constant pressure chamber at the pressure p_c to the pressure measurement chamber at a pressure p is equal to the air flow rate through the specimen, also expressed as Q (ml/s), when the relevant air volume is measured at room pressure (See Figures 1 and 2). A rate of laminar air flow would be proportional to the pressure difference and Formulae (A.1) and (A.2) apply.

$$Q = k_c \left(p_c - p \right) \tag{A.1}$$

$$Q = k_s p \tag{A.2}$$

where

k_c and k_s are the coefficient of air flowability [ml/(s kPa)] of the capillary and the test piece, respectively. k_s is assumed to be specific to the test piece, and not dependent on the pressure *p.*

For air resistance (Gurley) t_{G1986} and air flow rate Q_{G1986} (ml/s) in the Gurley condition specified in 1986 (1,23 kPa and 100 ml),

$$Q_{G1986} = k_s p_{G1986} \tag{A.3}$$

$$t_{G1986} = \frac{V_{G1986}}{Q_{G1986}} = \frac{100}{k_s p_{G1986}} \tag{A.4}$$

When Formula (A.1) and subsequently Formula (A.2) are substituted into Formula (A.4), Formula (A.5) is obtained.

$$t_{G1986} = \frac{100p}{Qp_{G1986}} = \frac{100p}{k_c\left(P_c - P\right)p_{G1986}} = \frac{100}{k_c p_{G1986}} \frac{p}{p_c - p} = K_{G1986} \frac{p}{p_c - p} \tag{A.5}$$

where

$$K_{G1986} = \frac{100}{k_c p_{G1986}} \tag{A.6}$$

For the Oken tester, the scale is graduated so that t_K = 100, namely, t_{G1986} = 100 at P = 0,5p_c. In this condition, Formula (A.5) leads to K_{G1986} = 100 and Formula (A.6) leads to

$$k_c = \frac{1}{p_{G1986}} \tag{A.7}$$

This means that the capillary length shall be adjusted so that k_c satisfies Formula (A.7). In this case, p = 0 and Formula (A.1) become $Q = k_o p_c$. By definition, the time, t (s), required for the passage of 100 ml of air is such that $t = \frac{100}{Q} = \frac{100}{k_c p_c}$ and when this relationship is substituted into Formula (A.7), Formula (A.8) is obtained.

$$t = 100 \frac{p_{G1986}}{p_c} \tag{A.8}$$

Therefore, the capillary length should be adjusted so that t = 25,1 s, which is calculated by substituting p_{G1986} = 1,23 kPa and p_c = 4,90 kPa into Formula (A.8).

A.3 Graduation of air resistance (Oken) from the measured pressure

If the relationship between pressure difference p and air resistance (Oken), t_K, is known, graduation on the scale plate or digital display of t_K will become possible. This relationship is $t_K = t_{G1986} = K_{G1986} \frac{p}{p_c - p}$ as shown by Formula (A.5). If a pressure difference p is expressed in water surface depth in the water column manometer, p_c = 500 mmH$_2$O (equivalent to 4,90 kPa). K = 100 is adopted for the Oken tester. Therefore, the conversion formula $t_K = \frac{100p}{500 - p}$ applies. For example, a water surface depth of 300 mmH$_2$O corresponds to t_K = 100 × 300/(500 - 300) = 150 (s).

A.4 Conversion from air resistance (Oken) to air resistance (Gurley) and air permeance

If the definition of t_{G2003} is represented like Formulae (A.3) to (A.6), Formulae (A.9) to (A.11) are obtained as follows:

$$Q_{G2003} = k_s\, p_{G2003} \tag{A.9}$$

$$t_{G2003} = \frac{V_{G2003}}{Q_{G2003}} = \frac{106}{k_s\, p_{G2003}} \tag{A.10}$$

$$t_{G2003} = \frac{106p}{Qp_{G2003}} = \frac{106p}{k_c\left(P_c - P\right)p_{G2003}} = \frac{106}{k_c p_{G2003}}\frac{p}{p_c - p} = K_{G2003}\frac{p}{p_c - p} \tag{A.11}$$

where

$$K_{G2003} = \frac{106}{k_c p_{G2003}} \tag{A.12}$$

The formula of conversion from air resistance (Oken), t_K, to air resistance (Gurley) t_{G2003} is obtained by the following process. For a test piece of air flowability k_s, air resistances measured with the two testers are from Formulae (A.4) and (A.10), $t_{G1986} = \frac{100}{k_s\, p_{G1986}}$ and $t_{G2003} = \frac{106}{k_s\, p_{G2003}}$, respectively. These two formulae are combined and give

$$t_{G2003} = \frac{106 t_{G1986} p_{G1986}}{100 p_{G2003}} \tag{A.13}$$

If p_{G1986} = 1,23 kPa and p_{G2003} = 1,22 kPa are substituted into Formula (A.12), Formula (A.14) is obtained.

$$t_{G2003} = \frac{106\times 1{,}23}{100\times 1{,}22}t_{G1986} = 1{,}07 t_{G1986} = 1{,}07 t_K \tag{A.14}$$

Formula (A.14) is the conversion formula.

To calculate air permeance P [ml/(m^2·Pa·s)] from air resistance (Oken) ,t_K, Formula (A.15) is applied.

$$P = \frac{100}{Ap_{G1986}t_K} = \frac{100}{0{,}000\ 642\times 1{,}23\times 1\ 000\times t_K} = \frac{127}{t_K} \tag{A.15}$$

Note that this formula is different from the formula for air resistance (Gurley) t_{G2003} which is

$$P = \frac{106}{Ap_{G2003}t_{G2003}} = \frac{106}{0{,}000\ 642\times 1{,}22\times 1\ 000\times t_{G2003}} = \frac{135{,}3}{t_{G2003}} \tag{A.16}$$

Annex B
(informative)

Precision data

The precision data presented in Tables B.1 and B.2 have been obtained from JTAPPI-TSC, the testing standard committee of Japan TAPPI. The estimates of repeatability and reproducibility are based on data from the JTAPPI-TSC interlaboratory program in 2012. The materials on which these data are based were various grades of paper and board with a broad range of air resistance as listed in the tables. Only participants that were judged as acceptable by the interlaboratory analysis were included. The precision estimates are based on 10 determinations per test result and one test result per lab, per material.

The tests were conducted according to ISO/TR 24498[2] and TAPPI T 1200.[3]

The repeatability standard deviation reported in Table B.1 is the "pooled" repeatability standard deviation, that is, the standard deviation is calculated as the root-mean-square of the standard deviations of the participating laboratories. This differs from the conventional definition of repeatability in ISO 5725-1.[1]

The repeatability and reproducibility limits reported are estimates of the maximum difference which should be expected in 19 of 20 instances when comparing two test results for material similar to those described under similar test conditions. These estimates might not be valid for different materials or different test conditions.

Repeatability and reproducibility limits are calculated by multiplying the repeatability and reproducibility standard deviations by 2,77.

NOTE 1 The repeatability standard deviation and the within-laboratory standard deviation are identical. However, the reproducibility standard deviation is not the same as between-laboratories standard deviation. The reproducibility standard deviation includes both the between-laboratories standard deviation and the standard deviation within a laboratory, viz.:

$$s^2_{\text{repeatability}} = s^2_{\text{within lab}} \quad \text{but} \quad s^2_{\text{repeatability}} = s^2_{\text{within lab}} + s^2_{\text{between lab}}$$

NOTE 2 $2{,}77 = 1{,}96 \times \sqrt{2}$, provided that the test results have a normal distribution and that the standard deviation, *s*, is based on a large number of tests.

Table B.1 — Estimation of repeatability of the test method from JTAPPI-TSC

Sample	Number of laboratories	Mean value s	Repeatability standard deviation s_r s	Coefficient of variation $C_{V,r}$ %	Repeatability limit r s
Coated paper	9	15 000	580	10,9	1 600
Coated board	9	5 100	120	6,6	340
Matte-coated paper	9	2 600	62	6,5	170
Light-weight coated paper	9	820	33	11,2	92
Uncoated board	9	230	18	20,9	48,5
Uncoated fine paper	7[a]	22	1,7	21,8	4,8

[a] Outliers not included.

Table B.2 — Estimation of the reproducibility of the test method from JTAPPI-TSC

Sample	Number of laboratories	Mean value s	Reproducibility standard deviation s_R s	Coefficient of variation $C_{V,R}$ %	Reproducibility limit R s
Coated paper	9	15 000	910	17,3	2 500
Coated board	9	5 100	280	15,2	770
Matte-coated paper	9	2 600	110	12,1	320
Light-weight coated paper	9	820	47	15,9	130
Uncoated board	9	230	35	42,2	98
Uncoated fine paper	7[a]	22	2,9	36,9	8,2

[a] Outliers not included.

Bibliography

[1] ISO 5636-5, *Paper and board — Determination of air permeance (medium range) — Part 5: Gurley method*

[2] ISO 5725-1:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

[3] ISO/TR 24498:2006, *Paper, board and pulps — Estimation of uncertainty for test methods*

[4] TAPPI Test method T 1200 sp-07, *Interlaboratory evaluation of test methods to determine TAPPI repeatability and reproducibility*

[5] Kano T. A Comparison between Oken Air Resistance-Smoothness Tester and Related Testers in Relation to Measured Values. Japan TAPPI Journal. 2008, **62** (12) p. 84

[6] Yamamoto K., Iwasaki A., Miyagi Z., Iwasaki M., Hara S. Development of a New Permeability Tester of Paper. Journal of Precision Engineering, Japan. 1985, **51** (4) p. 861

ICS 85.060

Price based on 13 pages

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.

...making excellence a habit.™