INTERNATIONAL STANDARD

ISO 8791-4

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Paper and board — Determination of roughness/smoothness (air leak methods) —

Part 4: Print-surf method

Papier et carton — Détermination de la rugosité/du lissé (méthodes du débit d'air) —

Partie 4: Méthode Print-surf

Reference number
ISO 8791-4:1992(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 8791-4 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*.

ISO 8791 consists of the following parts, under the general title *Paper and board — Determination of roughness/smoothness (air leak methods)*:

— *Part 1: General method*

— *Part 2: Bendtsen method*

— *Part 3: Sheffield method*

— *Part 4: Print-surf method*

Parts 2 and 3 together cancel and replace ISO 2494:1974, which formerly dealt both with the Bendtsen method and with the Sheffield method.

Annexes A, B, C and D form an integral part of this part of ISO 8791. Annex E is for information only.

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Introduction

This part of ISO 8791 is part of a series which specifies methods of measuring the surface roughness of paper by air leak methods. It prescribes the procedure to be used when using an instrument which operates according to clause 4. It should be read in conjunction with ISO 8791-1 which is a general standard for air leak methods.

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Paper and board — Determination of roughness/smoothness (air leak methods) —

Part 4:
Print-surf method

1 Scope

This part of ISO 8791 specifies a method of determining the roughness of paper and board using the Print-surf apparatus. It is applicable to all printing papers and boards with which it is possible to form a substantially airtight seal against the guard lands of the measuring head.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8791. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8791 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.*

ISO 8791-1:1986, *Paper and board — Determination of roughness/smoothness (air leak methods) — Part 1:* General method.

3 Definition

For the purposes of this part of ISO 8791, the following definition applies.

3.1 Print-surf roughness: The mean gap between a sheet of paper or board and a flat circular land pressed against it under specified conditions.

The mean gap is expressed as the cube root mean cube gap calculated as prescribed in annex A.

4 Principle

The test piece is placed between a circular flat metal sensing head and a resilient blanket, and inner and outer circular lands form a seal with the test piece. Under the influence of a pressure difference across the measuring land, air flows between the measuring land and the test piece. The rate of air flow is measured on a variable area flowmeter or the pressure difference across the measuring land is compared to the pressure difference across a known impedance. In both cases the reading is of air gap in micrometres.

5 Apparatus

Print-surf tester, which operates according to one of the two following principles.

a) **Variable area flowmeter type**, in which a standard pressure difference is created across the measuring land and the air flow rate is measured on a variable area flowmeter. The flow diagram for this type of instrument is shown in figure 1.

b) **Impedance type**, in which the air from the controlled pressure source passes first through a fluidic impedance and then through the sensing head, after which it discharges to atmosphere. The pressure differences across the fluidic impedance and across the land are each measured by a transducer. These pressure differences vary

with roughness and the signals are converted to roughness in micrometres. The flow diagram for this type of instrument is shown in figure 2.

Procedures for maintaining these models in good working order are given in annex B.

The principal components of the system are the following.

5.1 Air supply, supplying clean air, free of oil and water droplets, at a steady pressure within the range 300 kPa to 600 kPa.

5.2 Sensing head pressure regulator, allowing setting of the sensing head differential pressure on variable area flowmeter instruments to either 6,2 kPa ± 0,1 kPa or 19,6 kPa ± 0,1 kPa.

5.3 Sensing head, annular (see figures 3 and 4), consisting of three stainless steel lands which have coplanar, polished surfaces. The centre or measuring land shall be 51,0 µm ± 1,5 µm wide and have an effective length of 98,0 mm ± 0,5 mm. The two other guard lands shall each be at least 1 000 µm wide at any point and the radial distance between them at any point shall be 152 µm ± 10 µm. The measuring land shall be centred between them to within ± 10 µm.

The lands shall be mounted in an airtight mounting, constructed so that air can be passed into the gap between the inner guard land and the measuring land and exhausted from the gap between the measuring land and the outer guard land. The back of the mounting shall be flat and form a ground mating surface with the flat surface of a manifold fitted with air inlet and outlet ports.

A spring loaded protective collar shall be fitted outside the guard lands. The force exerted by the loading spring (usually 9,8 N) shall be taken into account when setting the clamping pressure.

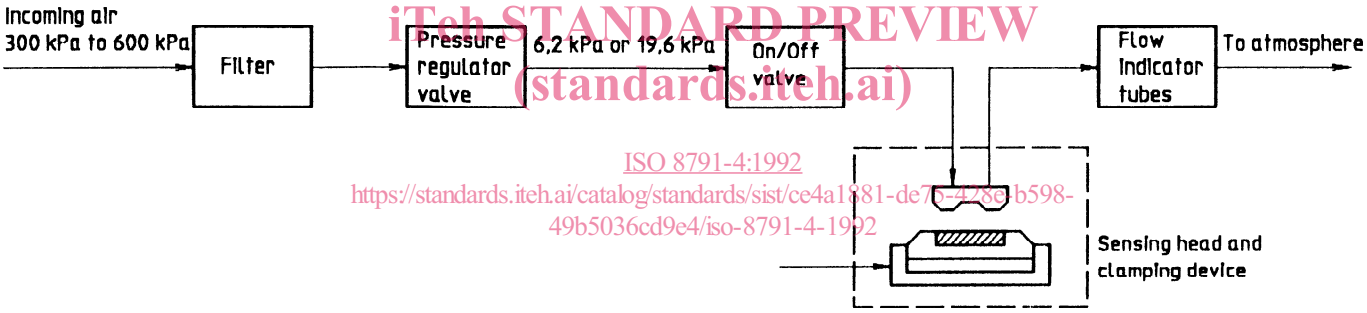

Figure 1 — Flow diagram for variable area flowmeter type

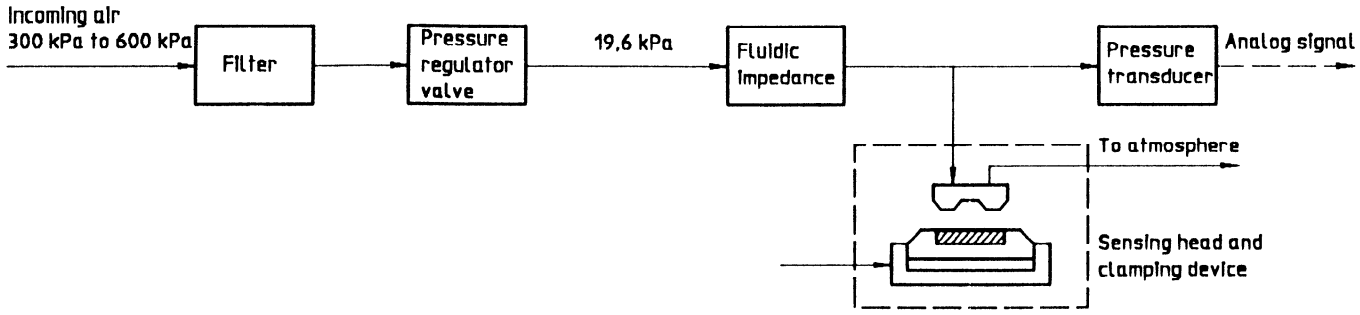

Figure 2 — Flow diagram for impedance type

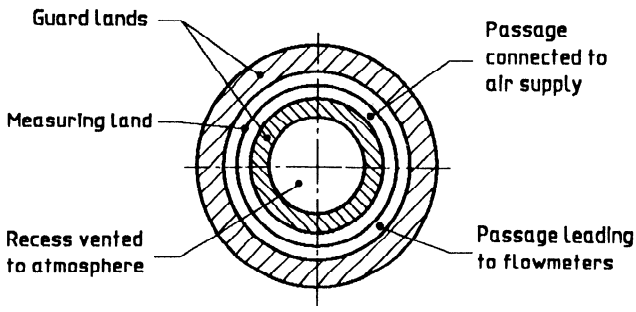

Figure 3 — Plan of the measuring and guard lands of the sensing head

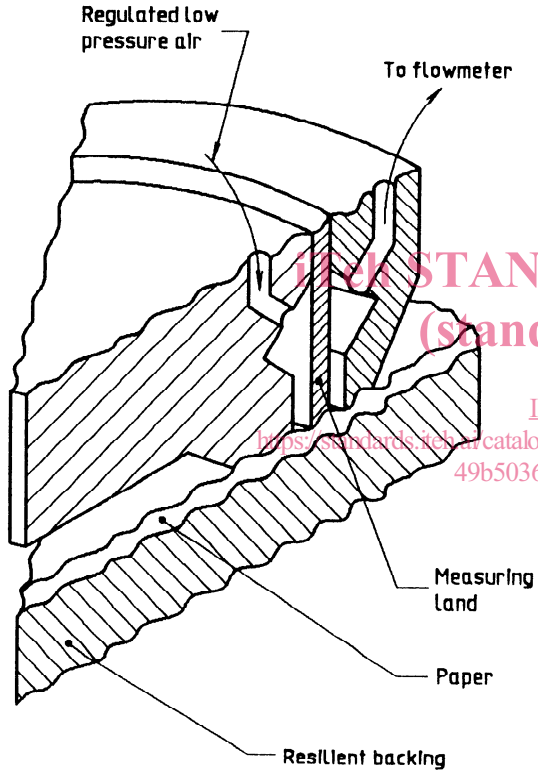

Figure 4 — The sensing head sectioned on two radii

5.4 Backing holders, consisting of rigid metal discs of known mass, each recessed to accommodate a resilient backing at least 10 mm greater in diameter than the outside diameter of the guard land. The mass of both the resilient disc and the holder shall be allowed for in the initial adjustment of the clamping pressure.

5.5 Two resilient backings, of different types, which can be held in the recessed holders by means of double-sided adhesive tape.

5.5.1 Soft backing, resilient, consisting of an offset printing blanket composed of a layer of synthetic rubber, at least 600 µm thick, bonded to a fabric backing giving an overall thickness of 2 000 µm ± 200 µm. The apparent hardness of the complete backing is 83 IRHD ± 6 IRHD (International Rubber Hardness Degrees).

5.5.2 Hard backing, resilient, usually made from a polyester film bonded at its periphery to cork, offset blanket or similar material. There is a small exhaust hole to prevent air being trapped between the film and the backing. The apparent hardness of the assembly is 95 IRHD ± 2 IRHD.

5.6 Clamping mechanism, allowing clamping of the resilient disc at pressures of either 980 kPa ± 30 kPa or 1 960 kPa ± 30 kPa, the pressure being calculated from the total area of both measuring and guard lands. On some instruments these values may be displayed on the gauge as 10 kgf/cm^2 and 20 kgf/cm^2. Note that the spring loading in the protective collar and the weight of the backing and its holder need to be taken into account. The rate of clamping shall be such that the pressure reaches 90 % of its final value in about 0,4 s and 99 % of its final value in about 0,8 s.

NOTE 1 A third pressure of 490 kPa (5 kgf/cm^2) is available on most instruments but is not acceptable for use with this part of ISO 8791 because of a tendency for air to leak under the guard lands.

Variable area flowmeter models have a pressure gauge fitted to the instrument to indicate the clamping pressure, and the pressure can be adjusted by adjusting screws on the side of the instrument. Impedance models have integrated pneumatic and electronic circuitry which automatically controls the clamping pressure. In each case the actual pressure achieved must be verified as specified in B.3.

5.7 Measuring system.

Variable area flowmeter instruments shall be fitted with flowmeters which are graduated to read the "cube root mean cube gap" between the paper and the measuring land surface in micrometres (see annex A). The flowmeters shall be calibrated by the procedures outlined in either annex C or D.

Impedance instruments measure air leakage by means of fluidic impedance, a pressure transducer and a function generator. They give a digital reading in micrometres to the nearest 0,1 µm, based on automatic measurement of pressure difference, over the range 0,6 µm to 6,0 µm. The reading displayed shall be the reading calculated after 3 s to 5 s. This device shall be calibrated by the procedure described in annex D.

6 Sampling

Sampling shall be carried out in accordance with ISO 186.

7 Conditioning

The sample shall be conditioned 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 at least 10 test pieces for each side to be tested. The minimum size of each test piece shall be 100 mm × 100 mm and their surfaces identified in some convenient way (for example side one or side two).

The test area shall be free of all folds, wrinkles, holes, or other defects and should not include watermarks. Do not handle that part of the test piece which will become part of the test area.

9 Procedure

9.1 Carry out the test in the same atmospheric conditions as those used to condition the sample (see clause 7).

9.2 Ensure that the instrument is on a rigid horizontal surface free from vibration and that it is level. Before use on any individual day, check the system for leakage as specified in B.1.

9.3 Select and fit the backing disc appropriate for the material being tested. In general the hard backing should be used for papers that are to be printed by letterpress presses fitted with paper packings. Papers to be printed by other processes, and boards however printed, should be tested with the soft backing.

9.4 Select and adjust the clamping pressure using the following as a guide:

hard backing letterpress	1 960 kPa ± 30 kPa
soft backing letterpress	1 960 kPa ± 30 kPa
soft backing offset	980 kPa ± 30 kPa

9.5 For the variable area flowmeter types select the lowest range flowmeter which will give readings greater than 20 % of the scale range.

Always start with the highest range flowmeter and turn the flow range selector switch successively to flowmeters of lower range in order to avoid subjecting the low range flowmeters to high air flow.

9.6 Test the first test piece by the following procedure.

9.6.1 Variable area flowmeter type

Set the sensing head differential pressure to 6,2 kPa ± 0,1 kPa by adjusting the pressure from the low side.

NOTES

2 If the pressure gauge indicates differential pressure in metres of water gauge, 0,63 m is equivalent to 6,18 kPa.

3 The pressure gauge on some instruments has been found to be sensitive to jolts and if adjusted downwards from a higher pressure the resulting pressure for a given scale reading will be higher than if the adjustment was upwards from a lower pressure.

Clamp a test piece under the sensing head with the side to be tested uppermost. This operation can cause the reading on the sensing head pressure gauge to change, but such change may be ignored. Record the reading on the flowmeter to the nearest 0,05 µm, 3 s to 5 s after application of pressure. Readings shall be taken level with the top of the flowmeter float. Select the lowest range flowmeter which gives results greater than 20 % of the scale range.

If the reading obtained is less than 20 % of the range of the lowest range flowmeter increase the sensing head pressure to 19,6 kPa ± 0,5 kPa (2,0 m water gauge). All readings taken at this pressure must be multiplied by 0,667 to give roughness in micrometres, unless the flowmeters are calibrated for this pressure.

9.6.2 Impedance type

Place a test piece under the head with the side to be tested uppermost. The test piece is clamped automatically. Record the reading.

NOTE 4 On some instruments an indicator lamp marked "air" will light up and after about 4 s the roughness will be shown on the digital display. At the same time the test piece will be released. The reading is held until the next test piece is inserted. Small samples can fail to actuate the automatic clamping process. When this occurs the sample may be clamped by operating the button marked "manual start".

9.7 Repeat step 9.6 for the other test pieces and calculate the arithmetic mean and standard deviation or coefficient of variation for the side tested.

9.8 If a result is required for the roughness of the other side, take a new set of test pieces and repeat steps 9.6 and 9.7 for this other side.

10 Precision

Interlaboratory proficiency testing programs in Canada, the UK and USA have resulted in the following typical values, expressed in micrometres.

	at 1 µm	at 6 µm
Repeatability	0,04 to 0,10	0,06 to 0,20
Reproducibility	0,20 to 0,40	0,40 to 0,60

11 Test report

The test report shall give the following particulars:

a) reference to this part of ISO 8791;

b) date and place of testing;

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

d) the type of instrument used;

e) the backing used;

f) the nominal temperature and relative humidity of the conditioning and test atmosphere;

g) the number of test pieces tested;

h) the sensing head differential pressure, in kilopascals;

i) the clamping pressure, in kilopascals;

j) the mean of the test results for each side tested;

k) the standard deviation or coefficient of variation for each side tested;

l) any deviation from this procedure.

Annex A
(normative)

Calculation of roughness in micrometres

For the purposes of this part of ISO 8791, the cube root mean cube gap G_3, in metres, in the direction of the air flow between the measuring land and the test piece is calculated from the equation

$$G_3 = \left(\frac{12 \times \eta \times b \times q_V}{l \times \Delta p} \right)^{1/3} \quad \ldots (A.1)$$

where

η is the viscosity, in pascal seconds, of air at room temperature;

b is the width, in metres, of the measuring land;

q_V is the volume of air flowing in unit time, in cubic metres per second;

l is the median length, in metres, of the measuring land;

Δp is the pressure difference, in pascals, across the measuring land.

The roughness, in micrometres, is then equal to $G_3 \times 10^6$.

If the differential pressure exceeds 1 % of the absolute pressure then Δp should be calculated as in equation (A.2) to correct for the compressibility of air:

$$\Delta p = \frac{p_u^2 - p_d^2}{2p_m} \quad \ldots (A.2)$$

where

p_u and p_d are respectively the absolute upstream and downstream pressures;

p_m is the pressure at which the flow q_V is measured.

The equation (A.2) is derived on the assumption that the gap between the measuring land and the test piece is uniform across the width of the land, but that it varies along its length.

Equation (A.1) is subject to the assumptions that the flow is laminar, that the temperature is constant throughout, and that the kinetic energy changes per unit volume of air are negligible compared with Δp. The flow conditions are normally well within the laminar range, but the kinetic energy can be important when rough papers are measured, unless the differential pressure is restricted. The full equation (A.3) for flow over the measuring land, given below, may be used to estimate the extent of the error.

$$\Delta p = \frac{12 \times \eta \times b \times q_V}{l \times G_3^3} + \frac{C \times \varrho \times q_{V,\,y}}{2l^2 \times G_3^2} \quad \ldots (A.3)$$

where

ϱ is the density of air measured at pressure p_m;

C is a coefficient found by experiment for a number of papers, and is approximately equal to 2,5.

Annex B
(normative)

Maintenance of Print-surf roughness testers

B.1 Leakage

The apparatus shall be maintained free of leakage, visible surface irregularities of the backings and pressure gauge error, as detailed in B.1.1, B.1.2 and B.3. Check for leakage at the lowest clamping pressure available and a sensing head differential pressure of 19,6 kPa.

B.1.1 Leakage between the back of the sensing head and its supporting manifold is indicated by a measurable air flow when the soft backing is clamped directly against the head. Such leakage can be corrected by a thin smear of petroleum jelly on the mating surfaces.

B.1.2 Damage to the sensing head is detected as follows:

a) Carefully wipe the face of the sensing head with a lint- and oil-free, soft clean material.

b) Clamp a smooth scratch-free piece of 125 µm thick film such as cellulose acetate between the sensing head and the hard backing. Measure the air flow.

NOTES

5 This test is very sensitive to dust due to static charges and even to fingerprints. If a measurable flow is found the first time, carefully wipe the surface of the film and repeat the test.

6 It is recommended that suitable film be obtained from the instrument manufacturer/supplier.

c) If it is impossible to obtain a zero reading on the lowest range flowmeter, confirm damage by inspecting the measuring surface at a magnification of about ×50 with a stereoscopic microscope. On impedance instruments a reading greater than 0,8 µm indicates the possibility of damage.

d) If pits or scratches are apparent, return the head to the maker for repair.

B.2 Measuring head

At frequent intervals inspect the head preferably with a stereoscopic microscope to ensure that the gaps between the measuring land and guard lands are free from debris. If necessary clean as advised by the instrument manufacturer.

B.3 Pressure gauges

Whenever the instrument is used ensure that both gauges register zero when the air supply is disconnected.

At least once a year check the accuracy of pressure gauges and transducers by connecting in parallel a manometer or transducer, the latter having been calibrated against dead weights. Operate the instrument normally and record the actual static pressures achieved.

Convert the clamping pressure readings to force per unit area of guard plus measuring land surface. Correct for the weight of the resilient backing plus holder and for the force exerted by the spring loaded protective collar. Compare the corrected clamping pressure and the measured head pressure to the gauge readings and pressure settings specified in 5.2 and 5.6.

Replace defective gauges or repair faulty control systems.

B.4 Resilient backings

Inspect the clamping surfaces daily and as soon as any visible damage occurs replace the backings using the procedure in the instrument manual. It is advisable to replace backings on a regular basis, for example weekly, and also if a zero reading cannot be obtained.

B.5 Evenness of clamping

Place a sheet of high quality white paper on the hard backing, cover with a piece of carbon paper and apply the clamping pressure. An uneven print indicates uneven clamping which must be corrected by referring to the manufacturer.