INTERNATIONAL STANDARD ISO 2494

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Paper and board — Recommended procedure for the determination of roughness — Constant-pressure air-flow method

Papier et carton — Mode opératoire recommandé pour la détermination de la rugosité — Méthode du débit d'air sous pression constante

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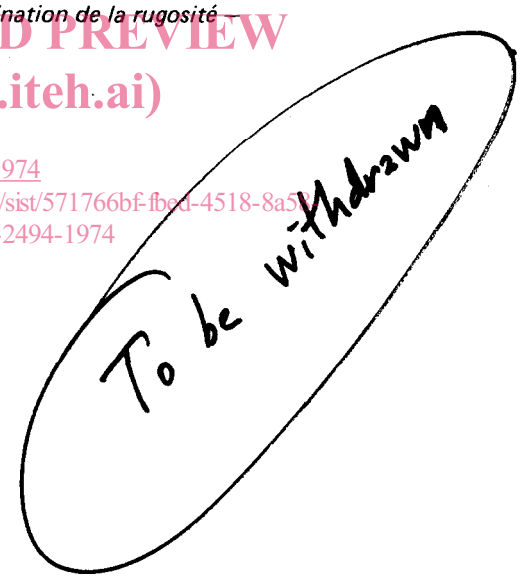

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2494 was drawn up by Technical Committee ISO/TC 6, *Paper, board and pulps,* and circulated to the Member Bodies in September 1971.

It has been approved by the Member Bodies of the following countries :

Australia	Hungary	Romania
Austria	India	South Africa, Rep. of
Belgium	Iran	Spain
Bulgaria	Israel	Sweden
Czechoslovakia	Italy	Switzerland
Egypt, Arab Rep. of	New Zealand	Thailand
Finland	Poland	Turkey
France	Portugal	U.S.A.

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Netherlands
Norway
United Kingdom

Printed in Switzerland

Paper and board — Recommended procedure for the determination of roughness — Constant-pressure air-flow method

0 INTRODUCTION

In the present state of knowledge it is not possible to recommend a single method for measuring the smoothness or roughness of a paper, and there is no exact correlation among the various methods used for determining these properties. Instruments of the constant-pressure air-flow type are designed to obtain a numerical value indicative of the roughness of paper or board; it is necessary to refer to the results of this test in terms of the specific type of instrument used, as Bendtsen roughness, Sheffield roughness, and so forth. Results of determinations obtained with different instruments are not necessarily convertible.

Some useful information is given in the annex.

1 SCOPE AND FIELD OF APPLICATION

This International Standard describes a recommended procedure for measuring the roughness of paper with constant-pressure air-flow instruments of the Bendtsen and Sheffield types.

2 REFERENCES

ISO/R 186, *Method of sampling paper and board for testing.*

ISO/R 187, *Method for the conditioning of paper and board test samples.*

3 DEFINITION

For the purpose of this International Standard roughness is defined as the measure of the extent to which the surface of the paper deviates from a plane and involves the depth, width and number of departures from that plane.

4 PRINCIPLE

The test piece is pressed under a definite pressure by one or two annular metal lands against a smooth, plane, hard surface. Air is supplied at a constant pressure to the centre of the annular land or between the lands, and the air-flow passing between the annular land and the surface of the paper is measured. The instrument reading is greater with rougher papers and boards and, for this reason, the values are known as a measure of roughness.

5 APPARATUS

The apparatus shall consist of the following major components :

5.1 Means of supplying clean conditioned air to the measuring head at a relative humidity and a temperature in agreement with one of the conditions specified in ISO/R 187, and at a constant pressure of

- 1,47 ± 0,02 kPa* (150 ± 2 mmH_2O) in the Bendtsen-type instrument and
- 10,3 ± 0,2 kPa* in the Sheffield-type instrument.

NOTE — This may conveniently be done by passing the normal conditioned air in a laboratory through a small compressor. The compressed air should be cooled to room temperature and the pressure stabilized by means of a large capacity reservoir (about 10 l is a suitable size).

The constant pressure is normally maintained by means of a manostat, or regulator, which is an integral part of the instrument.

5.2 Device to measure the air-flow rate, accurate to ± 5 %.

The lowest flow rate normally measurable is 5 ml/min. However, the required accuracy cannot normally be obtained with a flow rate of less than 10 ml/min. It is convenient to use variable area flowmeters of overlapping ranges. The accuracy requirement then applies to the flowmeter in use.

5.3 Measuring head constructed of hard steel, on the under surface of which one or two optically flat annular metal lands protude far enough so that only the lands contact the test piece. The lands should be made of or finished with a corrosion-resistant material (for example, stainless steel or chromium plating). In the Bendtsen-type instrument, the air supply is led to the annular groove between concentric lands. The air then escapes across the surface of the test

* 1 kilopascal (kPa) = 1 kilonewton per square metre (1 kN/m^2).

piece under the land(s). With the air supply off, the pressure of the land(s) should be 170 ± 5 kPa, obtained as follows :

a) in the Bendtsen-type instrument, with a head having a mass of 267 ± 2 g and an annulus of 0,150 ± 0,002 mm width and 31,75 ± 0,25 mm internal diameter;

b) in the Sheffield-type instrument, with a head having a mass of 1 640 ± 2 g and two concentric lands each of 0,380 ± 0,005 mm in width, the two having a tolerance and total area 97 ± 3 mm^2.

With the air supply on, this pressure is reduced by buoyancy, only slightly on the Sheffield instrument, but to 98 kPa on the Bendtsen instrument.

5.4 Flat plate glass surface, free from flaws, on which to rest the test piece.

NOTE — The flatness of the glass should be sufficient to give no detectable movement of the flowmeter float over the working area.

5.5 Heavy metal annulus or other suitably shaped weight, suitable for keeping the test piece flat around the measuring head.

The components may conveniently be connected with rubber tubing. Care shall be taken to ensure that the rubber tubing does not affect the pressure exerted by the measuring head.

For the connections between instrument and measuring head, thin walled rubber tubing of 5 mm inside diameter and, elsewhere, tubing of 7 mm inside diameter, have been found suitable.

6 CHECKING

6.1 Leakage

Check the instrument frequently for leakage. First place a piece of smooth, soft, impermeable rubber on the plate glass and place the measuring head on it. With the instrument working and the lowest range flowmeter connected, no rise of the flowmeter float should be detectable (other than a slight jump when the air supply is switched on). If this is not so, there is a leak between the flowmeter and the measuring head and the connecting tubing and joints should be checked. Minor leaks on the high pressure side of the flowmeter do not matter.

6.2 Measuring head

If the instrument is leakproof, check the flatness of the annular land(s) on the measuring head. Clean the flat plate glass surface and place the measuring head on it. Switch on the instrument and connect the lowest range flowmeter; it should be possible to find a position on the glass plate where there is no rise of the flowmeter float. If no such position can be found, clean the land(s) with a suitable solvent.

If the instrument is still not leakproof examine the annular land(s) for visible defects. This may be done using a magnification of X20 to X30, for instance, with a stereoscopic microscope. If any major change can be seen, the head should be discarded, or ground and polished by a competent person. Minor defects may be eliminated by placing the head on a plate glass square upon which has been placed some fine polishing powder in a suitable medium, for example, jewellers rouge, crocus powder or metal polish. The defects are polished out by holding the head lightly but firmly flat on the plate and imparting a circular motion to it. The head shall be lifted from time to time and the operation continued until the defect has disappeared.

NOTE — Care should be taken to ensure that the polishing does not change the area of the land(s).

6.3 Rate of air-flow

Use capillary gauges or standardized orifices to check the flowmeters.

6.4 Air pressure

The air pressure should be checked at frequent intervals using, for instance, a water manometer at the input to the flowmeters.

NOTE — Further specification of the checking methods for air pressure and flow rates is not considered justified because of the limited overall accuracy of the method and the limited overall precision resulting from the high variability of the roughness of paper.

Where maximum accuracy of the instrument is regarded as essential, reference may be made to detailed published checking methods issued in certain countries, for example SCAN P 21 : 67 in Scandinavia.

7 SAMPLING

Select specimens and take at least ten test pieces according to ISO/R 186, each measuring not less than 100 mm × 100 mm. It is essential to use a fresh test area for each determination. There shall be no folds, creases, visible cracks or other defects on the area to be tested and the test piece shall not include any part of the sample that is less than 15 mm from the edge of the sheet or reel. If watermarks are present, this should be stated in the test report.

8 CONDITIONING

Condition the test pieces at one of the atmospheres in ISO/R 187. Carry out tests in the same conditioning atmosphere.

9 PROCEDURE

Level the instrument and place it on a surface free from vibration[1]. Remove or raise the measuring head, place the test piece on the glass plate with the side to be tested uppermost. If the test piece will not lie flat, it is important to use the metal annulus (5.5). Turn on the compressed air supply and select the maximum flowmeter range.

NOTE – In the Bendtsen-type instrument, the air supply should be turned on before the manostat is placed on the spindle, and the manostat weight should be removed before the air supply is turned off. This prevents wear of the manostat and spindle caused by friction.

Gently place the measuring head on the test piece keeping the land(s) parallel to the test piece surface and being careful not to exert any pressure on it apart from the weight (see 5.3) of the gauging head, as this will deform the paper excessively and lead to a falsely low value.

NOTE – The way in which the head is placed on the test piece is most important and has been shown to affect the results by as much as 20 %. Great care should be taken to see that this is done properly.

Ensure that the connecting tube is correctly positioned.

If the flow rate is within the compass of a lower range meter, switch over to it. Note the reading indicated at the top of the float 5 s after the head is placed on the test piece (even if the flowmeter reading is still changing).

For subsequent readings, leave the instrument switched on and merely raise and place the head on other test pieces, until ten readings have been obtained. When possible, use the same flowmeter throughout a series of measurements.

10 EXPRESSION OF RESULTS

10.1 Express the results as Bendtsen roughness in millilitres per minute or as Sheffield roughness in "Sheffield units", separately for each side of the paper or board.

10.2 No general figure for the precision of the results can be quoted. The range of variability of results is a particular feature of this property.

10.3 Roughness values of some papers are subject to large irreversible changes due to moisture brought about by standard conditioning and the results of this test will not necessarily indicate the roughness of the paper as manufactured.

11 TEST REPORT

The test report shall include the following particulars :

a) reference to this International Standard;

b) type of instrument used;

c) mean result, calculated to three significant figures;

d) number of tests;

e) precision of the mean;

f) coefficient of variation, as a percentage;

g) conditioning atmosphere used;

h) any deviation from this International Standard, and details of any features that are optional;

i) any circumstances which have may affected the results.

1) Information on the effect of vibration on the results is given in Aaltonen, P, Nordman, L, "Comparative Investigations with the Bendtsen Smoothness and Porosity Tester" : Paper and Timber (Finland) 1964, 46 (5), 345-352.

ANNEX

USEFUL INFORMATION

A.1 In addition to the standard manostat (controlling the pressure of the air supply at 1,47 kPa* two extra weights are supplied with the Bendtsen instrument. These are designed to control the pressure at 0,735 Kpa** and 2,21 kPa*** respectively. If a non-standard manostat weight is used, this fact shall be stated in the test report.

A.2 Results at one pressure may be very approximately converted to results at another pressure in proportion to the actual pressure used.

A.3 Apparatus meeting the requirements of this method is made by Anderson and Sorenson, Copenhagen, Denmark, and by Sheffield Corp. Dayton, Ohio, USA.

* 150 mmH_2O

** 75 mmH_2O

*** 225 mmH_2O