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Paper and board — Determination of air resistance (Gurley)

Papier et carton — Détermination de la résistance à l'air (Gurley)

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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 3687 was drawn up by Technical Committee ISO/TC 6, *Paper, board and pulps,* and was circulated to the Member Bodies in April 1975.

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

Australia	Ireland	South Africa, Rep. of
Belgium	Israel	Spain
Bulgaria	Italy	Sweden
Canada	Mexico	Switzerland
Czechoslovakia	Netherlands	Thailand
Finland	New Zealand	Turkey
Germany	Norway	United Kingdom
Hungary	Pakistan	U.S.A.
Iran	Romania	U.S.S.R.

No Member Body expressed disapproval of the document.

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Paper and board — Determination of air resistance (Gurley)

0 INTRODUCTION

This International Standard specifies a method for measuring the resistance to air flow through a sheet of paper or board. The results obtained with the apparatus described cannot be accurately related to those of other instruments, because in this instrument the air pressure varies slightly during the test. Information concerning the relation between air permeance and the results obtainable by the method specified are given in annex D.

1 SCOPE

This International Standard specifies the equipment required and the method for determining the air resistance of paper and board by the principle known as "Gurley".

2 FIELD OF APPLICATION

This method is applicable to papers and boards that (under the conditions specified) permit the passage of 100 ml of air in 5 to 1 800 s. The method is unsuitable for rough-surfaced papers such as crêped and corrugated papers, which cannot be securely clamped to avoid leakage.

3 REFERENCES

ISO 186, *Paper and board — Sampling for testing.*[1)]

ISO 187, *Paper and board — Conditioning of test samples.*[2)]

4 PRINCIPLE

Compression of air by the weight of a vertical cylinder floating in a liquid. A test piece is in contact with the compressed air and the cylinder falls steadily as air passes through the test piece. The time for a given volume of air to pass through the test piece is a measure of its air resistance.

5 EQUIPMENT

5.1 Air-resistance apparatus

The apparatus, a diagrammatic sketch of which is shown in the figure, consists of an outer cylinder which is partly filled with sealing fluid, and an inner cylinder, having an open or closed top, sliding freely in the outer cylinder. Air pressure provided by the weight of the inner cylinder is

1) At present at the stage of draft. (Revision of ISO/R 186.)

2) At present at the stage of draft. (Revision of ISO/R 187.)

applied to the test piece held between clamping plates in a circular orifice of diameter 28,66 mm (area approximately 6,4 cm^2). The clamping plates may be at the top of the inner cylinder or, preferably, may be mounted in the base of the apparatus (see annex B). An elastic gasket which is attached to the clamping plate on the side exposed to the air pressure prevents leakage of air between the surface of the paper and the clamping plate.

The gasket consists of a thin, elastic, oil-resistant, non-oxidizing material, having a smooth surface and a thickness of 0,70 to 1,00 mm.

The inside diameter of the gasket is 28,6 ± 0,1 mm, and the outside diameter 34,9 ± 0,1 mm. The aperture of the gasket is accurately 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 clamping plate. The groove is concentric with the aperture in the opposing plate. Its internal diameter is 28,41 ± 0,04 mm and its depth 0,45 ± 0,05 mm. Its ouside diameter is 35,14 ± 0,04 mm for convenience in inserting and attaching the gasket.

The outer cylinder has a height of 254 mm and an internal diameter of 82,6 mm. It has four vertical bars, each of length 245,5 mm, and diameter 2,4 mm, mounted equidistantly on the inner surface of the outer cylinder to serve as guides for the inner cylinder. The inner cylinder is made of aluminium alloy, is graduated in units of 50 ml and has a total range of 350 ml. The volume tolerance is 0,5 %. It has a height of 254 mm, an external diameter of 76,2 mm and an internal diameter of 74,1 mm. Its mass is 567,0 ± 0,5 g.

The volumes referred to are nominal volumes and should, in principle, be increased by the volume of fluid displaced by the walls of the inner cylinder during the test; in practice, since this error is common to all instruments from the normal source, it is ignored.

5.2 Sealing fluid

The outer cylinder is filled with an oil having a density of approximately 0,86 g/ml, a kinematic viscosity of 10 to 13 mm^2/s (60 to 70 s Saybolt) at 38 °C and a flashpoint of at least 135 °C. (See annex C.)

5.3 Ancillary equipment and materials

A stopwatch, or electric timer capable of recording time to the nearest 0,2 s, is required.

6 SAMPLING, CONDITIONING AND PREPARATION OF TEST PIECES

6.1 Sampling and conditioning shall be carried out in accordance with ISO 186 and ISO 187, respectively.

6.2 One test piece cut from each of ten selected sheets is normally sufficient (but see 8.1). Where the clamping plates of the apparatus are at the top of the inner cylinder, a convenient test piece size is 50 mm × 120 mm; for the apparatus having the clamp in the base, 50 mm square is adequate.

7 PROCEDURE

7.1 Checking

Test the apparatus for air leakage as specified in annex A.

7.2 Determination

Place the instrument on a level surface so that the cylinders are vertical. Fill the outer cylinder with oil to a depth of about 120 mm as indicated by a ring marked on the inner surface of the cylinder. For the instrument having the clamp in the top of the inner cylinder, raise the inner cylinder with one hand, clamp the test piece with the other, then lower the inner cylinder and allow it to float in the oil. Alternatively, the inner cylinder may be removed, the test piece clamped, and the inner cylinder lowered gently in the outer cylinder.

NOTE — The proper procedure is to tighten the knurled nuts alternately so that the clamping pressure will be equal on both sides. If only one nut at a time is tightened, the clamp will not bear evenly on the test piece and air leakage will probably occur.

For the instrument having the clamp in the base, raise the inner cylinder until its rim is supported by the catch, clamp the test piece between the clamping plates, and then lower the inner cylinder gently until it floats.

As the inner cylinder moves steadily downward, measure the number of seconds, to the nearest 0,2 s, required for the first two consecutive 50 ml intervals to pass the rim of the outer cylinder, starting at zero point.

For relatively impermeable papers and boards, the reading may be taken at the end of the first 50 ml interval and the result doubled. With very open or porous papers, a larger volume of air may be timed and the result reduced proportionately to 100 ml. If a steady movement of the inner cylinder is not attained before the zero mark is reached, timing may be started at the 50 ml mark.

NOTE — Vibration of the apparatus should be avoided, as this increases the rate of air displacement.

7.3 Number of tests

Five test pieces shall be tested with the top side up and five with the wire side up.

8 CALCULATION AND TEST REPORT

8.1 If the mean air resistance in the two directions through the sheet is significantly different and if this difference is required to be shown in the report, ten tests are required in each direction. The result shall then be reported separately.

8.2 The mean of the ten test results shall be reported as the "Air resistance (Gurley)" in seconds. Report values below 10 s to the first decimal place, otherwise to two significant figures.

9 PRECISION

When two sets of test pieces from the same sample are tested in the same laboratory by the same well-trained operator, the two average test results can be expected, 95 % of the time, to agree within 10 %.

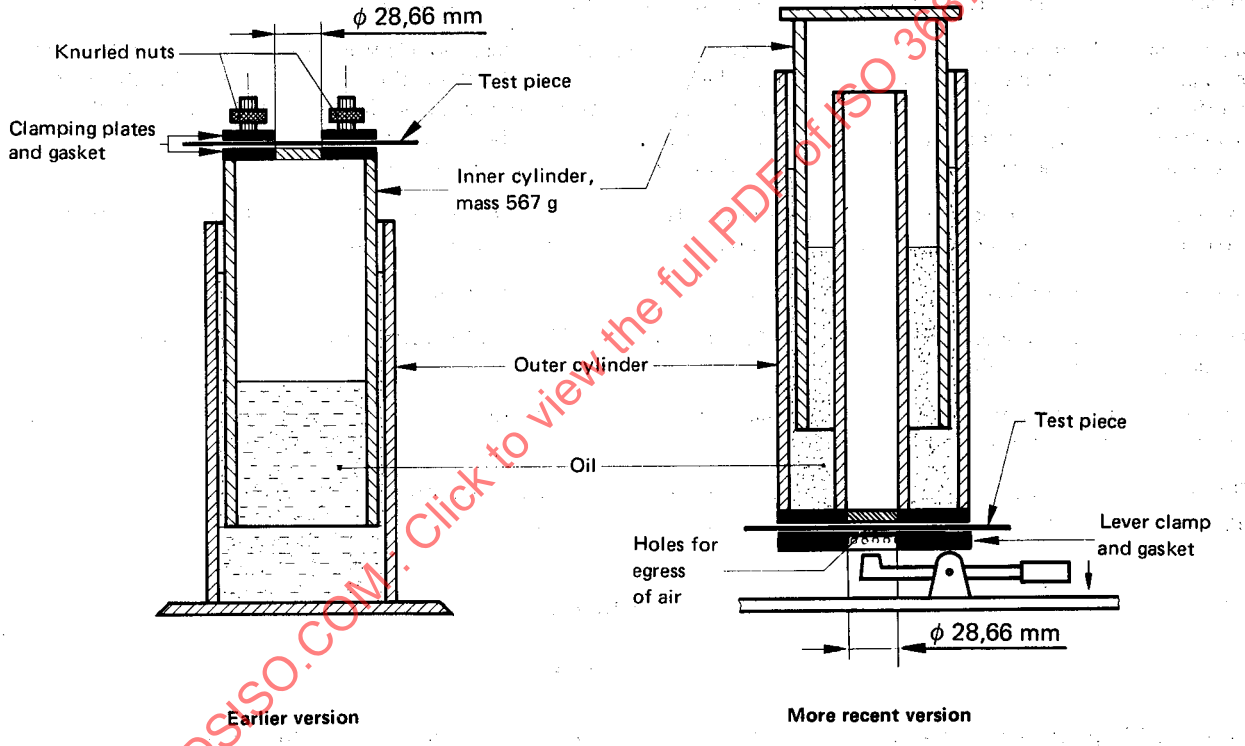

FIGURE – **Diagrammatic sketch of air-resistance (Gurley) apparatus** (not to scale)

ANNEX A

CHECKING AIR LEAKAGE

A thin sheet of smooth, rigid, impermeable metal or plastics shall be clamped between the orifice plates. Using the procedure specified in 7.2, the leakage shall not exceed 50 ml in 5 h.

ANNEX B

VARIATIONS IN APPARATUS

Reference has been made in 5.1 to the existence of two versions of the apparatus. In one version the clamping plates are mounted on top of the floating inner cylinder. In the other version the plates are mounted in the fixed base portion of the apparatus, and all the dimensions quoted relate to the current model of this version.

Many examples of earlier models of this version also exist. The earliest models were not fitted with gaskets, although it is thought that all those made since the end of 1945 are so fitted. In these the dimensions are slightly different, but no significant difference in the results is to be expected. It appears that the inside diameter of the gasket and the groove have been varied slightly, so that at times it has been necessary to stretch the gasket slightly to fix it into the groove. The effective test area, however, always seems to have been within 1 % of the original 1 in^2 (6,452 cm^2).

Some of the inner cylinders are also graduated in units of 25 ml for the first 100 ml and may have a graduation at the 400 ml interval. On some cylinders the engraved graduations are replaced by a "stuck on" graduation label.

Many outer cylinders have four vertical square bars instead of the round bars.

Alternative inner cylinders with a mass of 142 g are available. The results obtained with these cylinders are approximately 4 times those obtained with the 567 g cylinders.

Alternative clamps to expose 1,61 cm^2 (diameter 14,30 mm) or 0,645 cm^2 (diameter 9,05 mm) are available and these give results about 4 or 10 times normal.

The use of the alternative cylinders or clamps referred to above shall be reported because the results can be converted only approximately to those which would be obtained with the standard apparatus.

ANNEX C

SEALING FLUID

Oil is used in preference to water because it does not affect the moisture condition of the air or test piece, or corrode the inner cylinder. The lubricating action of an oil probably assists the smooth motion of the cylinder.

The oil shall not contain any easily volatile material and for that reason a minimum flashpoint is specified.

ANNEX D

RELATION TO AIR PERMEANCE

Since the pressure applied varies during a test for air resistance, and because of turbulence, etc., in the measurement of air permeance, air resistance (Gurley) can be calculated only approximately from the air permeance of a sample.

The approximate numerical conversion is :

$$\text{Air resistance (Gurley)} = \frac{140}{P} \text{ seconds}$$

where P is the air permeance in micrometres per pascal second ($\mu m/Pa \cdot s$).