SCANDINAVIAN PULP, PAPER AND BOARD
TESTING COMMITTEE

SCAN-P 53:84
Accepted 1983

Low density papers

Air permeance

Gurley method

1 Scope

This SCAN-test Method specifies a procedure for measuring the air permeance of low density papers, such as crepe papers and soft tissues, using a Gurley tester.

The apparatus and the measuring procedure are essentially the same as those described in SCAN-P 19 and ISO 3687(withdrawn 1992).

2 Reference

ISO 187 Paper and board – Paper and board – Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples

Note – SCAN-test has withdrawn a number of test methods and refers instead to the corresponding ISO and/or EN Standards.

3 Definition

For the purpose of this Method, the following definition applies:

3.1 *Air permeance* – The mean air flow, $\bar{u}$, through a paper, divided by the area, A, and by the difference in air pressure, Δp, between the two sides of the paper, when determined under specified conditions. The air permeance S is thus

$$S = \bar{u}/A\Delta p \qquad [1]$$

4 Principle

Air is compressed by the weight of a hollow, vertical cylinder, having an open bottom and a closed top, and floating in a liquid. A pad of test pieces is in contact with the compressed air and the cylinder sinks steadily as air passes through the pad. The time for a given volume of air to pass the pad of test pieces is measured.

5 Apparatus

5.1 *Gurley apparatus.* A sketch of the apparatus is shown in *Figure 1*. It consists of a cylinder, closed at one end, floating with the closed end uppermost in another vertical cylinder that is partly filled with a sealing fluid.

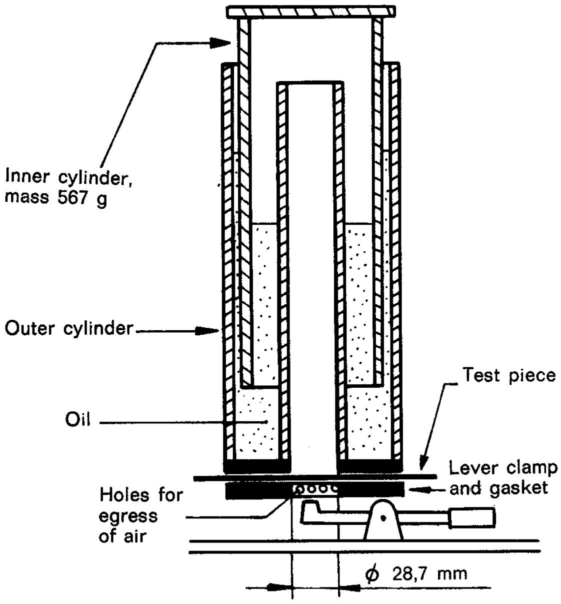

Figure 1. Diagram of the Gurley apparatus (not to scale).

A mean air pressure of 1,21 kPa due to the weight of the inner, floating cylinder is applied to a circular area of the clamped pad of test pieces through a central tube. The pad is fixed between two circular clamping plates, which are perforated at the centre to allow the air to pass. The upper clamping plate, which is fixed to the central tube, has an annular groove, 0,5 mm deep, to hold an elastic, smooth, oil resistant, non-oxidizing gasket, inner diameter 28,7 mm, outer diameter 34,9 mm and thickness 0,8 mm. The gasket is cemented into the groove with shellac. The lower clamping plate has an annular flange with an inner diameter of 28,7 mm.

> *Note* – A suitable material for the gasket is Thiokol, grade ST, plate-moulded and polished, hardness 50–60 Durometer.

The pad of test pieces is fixed in position by placing it between the clamping plates and pressing the lower one against the upper. The pressure is furnished by a lever arm with a weight hanging at its end, or by a screw and capstan device. The lower plate is accurately aligned so that when the plates are pressed together the inner edge of the flange coincides with the inner edge of the gasket.

The outer cylinder is 254 mm high and with an internal diameter of 82,6 mm. On the inner surface there are four ribs, to guide the inner cylinder. Each is 190 mm long and has a cross section 2,4 mm square; they are placed parallel to the axis and at equal intervals. A horizontal groove on its inner surface, 130 mm above the bottom, indicates the approximate level to which the sealing fluid should be filled. The inner cylinder is 254 mm high, the inside diameter is 74,1 mm and the wall thickness 1,0 mm. It is graduated to indicate the air-flow through the pad of the test pieces, the first 100 ml being divided into units of 25 ml, and the next 250 ml into units of 50 ml. The mass of the cylinder is (567 ± 1) g.

5.2 *Sealing fluid.* The outer cylinder is filled with an oil, resistant to ageing and having a density of approximately 860 kg/m^3, a kinematic viscosity of 10–13 mm^2/s at 38 °C (60–70 s Saybolt at 100 °F) and a flashpoint of at least 135 °C.

5.3 *Stop watch* or electric timer, capable of recording time to the nearest 0,2 s.

6 Preparation of test pieces

Condition the specimens as described in ISO 187 and keep them in the conditioning atmosphere throughout the test.

From undamaged paper free from water-marks, folds and wrinkles or other visible faults not commonly inherent in the paper, cut test pieces not less than 50 mm square.

For the air permeance measurement, combine several test pieces, with their top side up, to a pad. Select the number of test pieces so that the time for 300 ml of air to pass through the pad is at least 1,0 s.

7 Procedure

Place the apparatus on a level, vibration-free surface, with the cylinders vertical. Check that the outer cylinder is filled with oil to the level of the groove on its inner surface. Raise the inner cylinder until it is supported at its top rim by a catch on the outer cylinder; check that the clamping plates are clean, smooth and free from oil, and clamp a pad of test pieces between them. Release the inner cylinder and lower it gently until it floats in the oil. Then, allow the cylinder to descend under its own weight. When it is falling steadily measure with a stop watch the total time in seconds for 300 ml of air to pass the pad by observing the movement of the scale on the inner cylinder in relation to the rim of the outer cylinder. When less permeable papers are tested the time may be recorded for less than 300 ml of air.

Discard the results for test pieces that have become contaminated with oil during the test, clean the clamping plates and repeat the test with another pad.

Test at least five pads of test pieces with the top side up and the same number of pads with the wire side up.

8 Calculation

Calculate the mean time for the passage of 300 ml of air Calculate the air permeance from the expression.

$$S = \frac{383{,}3}{n\,t} \qquad [2]$$

where

S = the air permeance, in micrometres per pascal second;
t = the mean time, in seconds, for the passage of 300 ml of air through the pad;
n = number of test pieces in the pad.

Note – The air pressure inside the floating cylinder is determined by the mass of the cylinder and the dimensions of the apparatus. The pressure decreases slowly during the test. The decrease during a test is of the order of 1 % of the mean pressure difference, which is 1,21 kPa. The above expression is derived by inserting this pressure difference, the air flow $3 \cdot 10^{-4}/t$ m^3/s and the test area, $646{,}9 \cdot 10^{-6}$ m^2 in the formula given in the definition.

9 Report

The report shall include reference to this SCAN-test Method and the following particulars:

(a) date and place of testing;
(b) identification of the sample;
(c) the test result, with two significant figures;
(d) any departure from the procedure described in this Method or any other circumstances which may have affected the results.

Annex – Calibration

A.1 Check the apparatus for air leakage by placing between the clamping plates a thin piece of smooth, hard-surfaced, air-tight material, such as metal foil, and test as described under “Procedure”. If there is an air leak exceeding 50 ml in 5 h, repeat the test with a sheet of soft rubber instead of the hard-surfaced material. No air will then escape at the clamping plates, and leaks elsewhere can be detected. Seal any leaks found in the inner cylinder or in the base of the outer cylinder with neoprene or other suitable adhesive.

A.2 Check that the mass of the inner cylinder is (567 ± 1) g. If necessary adjust the mass to this value.

A.3 Check the volume of the inner cylinder with the apparatus shown in *Figure 2*. By means of a special adaptor plate *(Figure 3*) connect the Gurley apparatus to a 100 ml burette, graduated in tenths of a millilitre, through two glass stopcocks A and B. Connect another stopcock D to a vacuum line and to stopcock A. For all connections, use rubber pressure tubing.

Fill the burette with water by opening A1, D2 and C, in that order, until the water level is above the 35 ml mark. Restore atmospheric pressure in the burette by opening D1. Open Bland raise the inner cylinder above the oil level so that its zero mark is about 1,5 mm above a reference point on the outer cylinder. Open A2 and B2 and bring the zero mark exactly to the reference point by running water from the burette. Check for air leaks by allowing the apparatus to stand for 15 min. If the cylinder has moved, check all connections for leakage. Adjust the zero mark exactly to the reference point and read the burette to the nearest 0,1 ml. Run water from the burette until the first 50 ml mark on the inner cylinder coincides with the reference point and read the burette again to the nearest 0,1 ml. The difference between the readings gives the volume of air delivered by the Gurley apparatus for the first 50 ml interval.

Perform three measurements for each 50 ml interval from 0 ml to 400 ml and calculate the mean of each set of three. If the three measurements are not within 1,0 ml of the mean, repeat the measurements. If the error is more than 3 %, compile a correction table for the graduation of the inner cylinder.

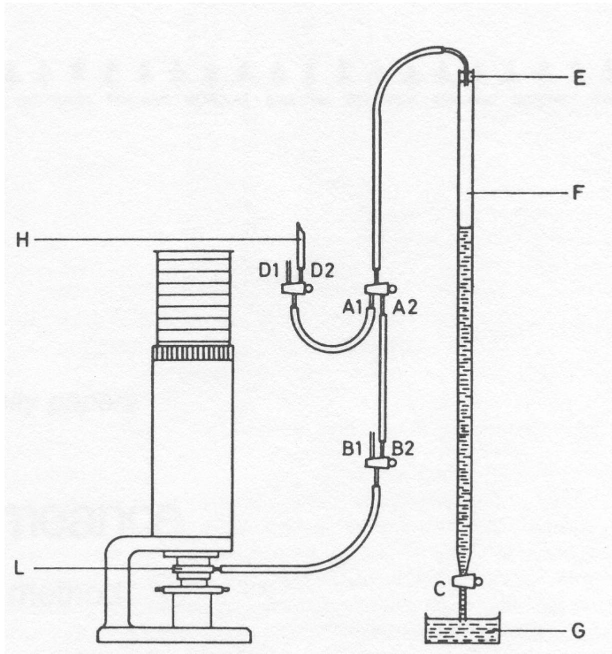

Figure 2. Calibration apparatus

A–D Stopcocks
E Rubber stopper
F 100 ml burette
G Water
H Connection to vacuum
L Adaptor plate

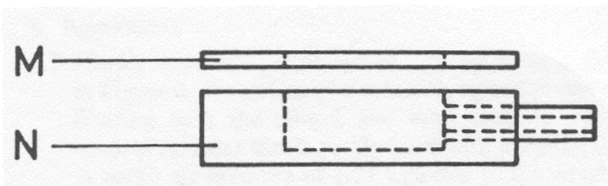

Figure 3. Adaptor plate

M Rubber
N Brass

SCAN-test Methods are issued and recommended by KCL, PFI and STFI-Packforsk for the pulp, paper and board industries in Finland, Norway and Sweden.
Distribution: Secretariat, Scandinavian Pulp, Paper and Board Testing Committee, Box 5604,
SE-114 86 Stockholm, Sweden.