SCAN-P 26:78
Revised 1978

SCANDINAVIAN PULP, PAPER AND BOARD
TESTING COMMITTEE

Paper and board

Air Permeance

Method for dense papers

0 Introduction

This SCAN-test Method is a revised version of SCAN-P 26:68. The SI units have been adopted and the results are expressed in SI units. The name of the property determined has been changed to air permeance.

The apparatus and measuring procedure are the same as in SCAN-P 26:68.

1 Scope

This SCAN-test Method specifies the equipment required and the procedure of determining the air permeance of dense papers and of boards. It applies to all papers and boards having an air permeance (determined under the conditions specified) of less than 300 nm/(Pa•s) on condition that they can be clamped without air leakage at the edges.

2 Reference

ISO 187 Paper, board and pulps – Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples (EN 20187)

Note – SCAN-test has withdrawn a number of test methods and refers instead to the corresponding ISO and/or EN Standards.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

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

The air flow through the paper under specified test conditions is measured with an air-flow meter.

5 Apparatus

5.1 *Test apparatus* consisting of a clamping device, an air-flow meter and a manometer.

5.1.1 *The clamping device* consists of two circular plates, the lower one adjustable and the upper one fixed, *Figure 1*. At the periphery of each plate is a rubber sealing ring, which fits into a groove 1,80 mm–1,90 mm deep and encloses an area of 50 cm^2, corresponding to a diameter of (79,7 ± 0,1) mm. The rubber ring is rectangular in cross-section, about 5 mm high and at least 3 mm wide. It is smooth and has a Durometer hardness of approx. 80°Shore.

The lower plate has a central bore which is connected to the air-flow meter and to one limb of the manometer. During measurement the test piece is held firmly between the sealing rings, and is supported by concentric bars in the lower plate. The bars have a triangular cross section with a top angle of 90°, and a height of 3 mm and each is interrupted in at least two places to allow air to pass between the chambers that they form. Compressed air is fed to a central bore in the upper plate. This bore is connected to the other limb of the manometer.

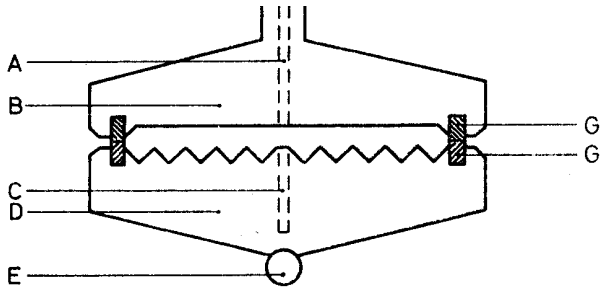

Figure 1. Clamping device
A. Bore connected to air compressor and manometer
B. Upper plate
C. Bore connected to rotameters and manometer
D. Lower plate
E. Universal joint
G. Rubber rings

5.1.2 *The air-flow meter* consists of three rotameters in series.

At both their upper and lower ends the rotameters are furnished with stops for the rotating body. The stops are designed to prevent interruption of the air-flow. The rotameters are of different sizes and together cover the range from 0,02 cm^3/s to 20 cm^3/s. Each rotameter covers a scale range of about one decade, with an overlap between the rotameters of at least 20 % of the full scale. The rotameters are connected in series, the smallest first and the biggest last, with its upper end open. The rotameters are each calibrated to an error of less than 2 % of their respective full scale values.

Note – Some instruments are provided with a capillary air-flow meter to be used when testing very dense papers. The capillary, which is placed horizontally and is used instead of the rotameters, is about 1 mm wide and has two marks ca 200 mm apart. The volume between the two marks should be known with an error of less than 2 %. From a side tube, a droplet of butanol can be pressed into the capillary by means of a rubber bulb, while air enters the capillary.

When the capillary air-flow meter is used the air supply should be adjusted so that the difference between the two mercury levels in the manometer is (100 ± 1) mm. The air flow is measured by determining the time the droplet takes to pass between the two marks.

State, with the test results, whether a capillary air-flow meter has been used.

5.1.3 *The manometer* consists of a U-tube filled with mercury, and is connected to the air chambers on each side of the test piece. The difference between the two mercury levels can be read on a vertical scale, graduated in millimetres.

The pressure drop can be regulated by adjusting a reducing valve in the air line from the compressor.

5.2 *Air compressor* with a capacity of at least 50 cm^3/s, the pressure difference between inlet and outlet being at least 20 kPa.

5.3 *Calibration device*, see Annex.

6 Preparation of test pieces

Condition the specimens as specified in ISO 187 and keep them in the conditioning atmosphere throughout the test. Cut test pieces at least 120 mm square, free from folds, wrinkles and other defects normally not inherent in the paper.

7 Procedure

Ascertain that the apparatus is in good working order (Appendix A.1). Start the compressor. Clamp the test piece between the two plates so that the rubber rings bear on it, and adjust the air-flow so that the difference between the two mercury levels is between 50 mm and 150 mm. Read the distance to the nearest 1 mm. Read off the rotameter that gives a reading on the upper part of the scale.

Test at least five test pieces with the top side up and the same number with the bottom side up.

8 Calculation

Calculate the mean air flow from the rotameter readings, or from the mean time required for the droplet to pass between the two marks on the capillary.

Calculate the mean air flow separately for the top and bottom sides. If the difference between the means obtained exceeds 10 %, the results should be calculated and reported separately. Otherwise, calculate the grand mean.

Calculate the air permeance from the expression

$$S = \frac{1500a}{b} \qquad [2]$$

where
a = air flow, in cubic centimetres per second;
b = difference between the two mercury levels of the manometer, in millimetres;
S = air permeance, in nanometres per pascal second.

Note – The formula is derived as follows: In accordance with the definition the air permeance is given by the expression

$$S = \bar{u}/A\Delta p \qquad [3]$$

In this method

$\bar{u} = a$ cm^3/s = a 10^{-6} m^3/s;
A = 50 cm^2 = 50 10^{-4} m^2;
$\Delta p = b/(7{,}5\ 10^{-3})$ Pa.

thus
S = 1,50 10^{-6} a/b *m/* (Pa·s) = 1500 a/b nm/(Pa·s) [4]

9 Report

The test report should include a 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, to two significant figures;
(d) any departure from the procedure described in this Method or any other circumstance which might have affected the results.

Annex – Calibration and checking

A.1 Checking of apparatus

A.1.1 Check the tightness of the apparatus by clamping an air-tight material with a smooth surface – e.g. a foil of metal or plastic – between the plates, and applying to the upper end of the last rotameter a reduced pressure corresponding to a difference in the mercury levels of 150 mm; the rotameter readings should be zero.

A.1.2 Check the smoothness of the rubber rings by clamping a piece of carbon paper together with a piece of white paper between the plates. The print obtained should show no unevenness of the inner edge and should be of uniform width (check of the concentricity).

A.2 Calibration of rotameters

A.2.1 ***Apparatus***

A.2.1.1 *Soap-bubble tester* consisting of a volumeter with the volume between two marks carefully calibrated, *Figure 2*. The volumeter has an air inlet tube on one side and a rubber bulb at its lower end. One volumeter for each rotameter is recommended. Suitable volumes are 1 cm^3, 10 $cm^3$and 100 cm^3.

A.2.1.2 *Stop watch*.

A.2.1.3 *Soap solution*, 3 % to 5 % liquid detergent in distilled water.

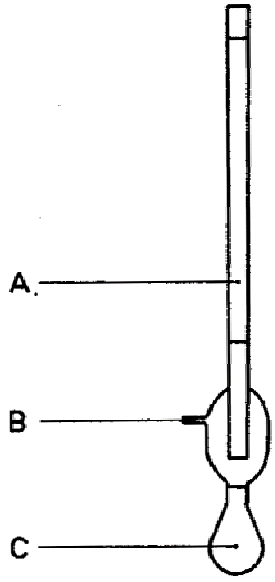

Figure 2 Calibration device
A. Graduated glass tube
B. Side tube
C. Rubber bulb containing soap solution

A.2.2 ***Procedure***

Calibrate the rotameters in a conditioned room at (23 ± 2)°C as follows:

Connect the upper part of the largest rotameter to the air inlet tube of the volumeter. Start the compressor and clamp a paper so selected that a reading is obtained on the rotameter tube under calibration. Fill the rubber bulb with soap solution and squeeze it so that a soap bubble enters the volumeter tube. Note the time required for the bubble to ascend from the lower to the upper mark. Check that the rotameter reading remains constant. Repeat the procedure with 6 to 8 papers of different permeabilities, so that the whole rotameter is calibrated.

A.3 Calculation

Calculate the flow rate as follows :

$$X = \frac{PV}{1013t} \qquad [A.1]$$

where
P = atmospheric pressure, in millibars;
V = volume between the marks of the volumeter tube, in cubic centimeters;
t = time required for the bubble to travel between the marks, in seconds;
X = flow rate, in cubic centimetres per second.

The factor 1013 is the normal atmospheric pressure in millibars at sea level. 1 mb = 100 Pa.

Literature

1. Nilsson, T. H. and Bergwall, J.: Svensk Papperstidn. *46* (1943):19, 441–447.

2. Brauns, O. and Lexell, A.: Pappersbrukens Centrallaboratorium, Meddelande nr 13 B, 1955.

3. Ringqvist, G.: Ibid nr 26 B, 1958.

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.
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