International Standard 8226 / 1

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Paper and board — Measurement of hygroexpansivity — Part 1 : Hygroexpansivity up to a maximum relative humidity of 68 %

Papiers et cartons — Détermination de la dilatation à l'humidité — Partie 1 : Dilatation à l'humidité jusqu'à une humidité relative maximale de 68 %

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Foreword

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Paper and board — Measurement of hygroexpansivity — Part 1 : Hygroexpansivity up to a maximum relative humidity of 68 %

0 Introduction

The measurement of dimensional change in paper and board with changes in ambient humidity is necessary for accurate control of printing and similar processes. The change in length, or hygroexpansivity, is due to stress relaxation of the paper fibres and swelling or contraction of the fibres by absorption or desorption of water. The proportion of the two mechanisms causing hygroexpansivity depends upon the upper limit of relative humidity. For the purpose of this part of ISO 8226, an upper limit of relative humidity of 68 % is imposed to minimize the effects of stress relaxation on the hygroexpansivity.

Methods at other levels of maximum relative humidity will form the subjects of subsequent parts of this International Standard.

1 Scope and field of application

This part of ISO 8226 specifies a method for the determination of the hygroexpansivity of paper and board when subjected to a change in the relative humidity with which it is in equilibrium from 33 ± 2 % to 66 ± 2 %. It is applicable to paper and board generally. It is not, however, recommended for crepe papers and corrugated fibreboard.

2 References

ISO 186, *Paper and board — Sampling to determine average quality.*

ISO 187, *Paper and board — Conditioning of samples.*

3 Definition

For the purpose of this part of ISO 8226, the following definition applies.

hygroexpansivity : The increase in length relative to the initial length that occurs when the relative humidity with which the test piece of paper or board is in equilibrium is raised from a specified lower relative humidity to a specified higher relative humidity.

NOTE — A contraction of the test piece is regarded as negative hygroexpansivity.

4 Principle

Preliminary conditioning of test pieces under zero load and a relative humidity of 22 ± 3 % and then at relative humidities of 33 ± 2 % and 66 ± 2 %. Measurement of the change in length between the latter two relative humidities under a load appropriate to the grammage of the test pieces.

5 Apparatus

5.1 Cabinet, with air circulation, capable of being maintained at one of the temperatures specified in ISO 187, preferably 23 ± 1 °C. It shall be possible to attain uniform relative humidities 22 ± 3 %, 33 + 2 % and 66 ± 2 % within the whole cabinet and within a short time, for example 30 min.

Any method which will provide the specified relative humidities within the tolerances indicated may be used — for example the saturated salt solutions given in the annex.

5.2 Clamps, for suspending the test pieces vertically in the cabinet.

5.3 Load, for application to the test pieces during measurement (see table 1).

Table 1 — Test loads

Test piece grammage, ϱ_A	Total load (including clamps)	Equivalent load
g/m²	N/m	g/15 mm
$\varrho_A \leqslant 125$	15 ± 1	23 ± 1,5
$125 < \varrho_A \leqslant 200$	30 ± 1	46 ± 1,5
$200 < \varrho_A \leqslant 275$	50 ± 1	76 ± 1,5
$275 < \varrho_A$	80 ± 1	122 ± 1,5

5.4 Means for measuring the relative humidity of the air in the cabinet with a precision of ± 1 % (maximum error of reading) and an accuracy of ± 2 % (maximum departure from true relative humidity).

5.5 Device for measuring the increase in length of the test pieces to the nearest 0,01 mm. This device may be mechanical or electronic.

6 Sampling and preparation of test pieces

6.1 Where possible, sample in accordance with ISO 186.

6.2 From undamaged test samples free from water marks, folds and wrinkles, cut five test pieces in the machine direction and five in the cross direction. Each test piece shall be at least 20 mm longer than the nominal free span between the clamps, and the minimum free span shall be 100 mm. The width of the test piece shall be at least 15 mm. For the determination of hygroexpansivity in the machine direction or in the cross direction, cut the test pieces with the longer side parallel to the relevant directions.

7 Procedure

7.1 Initial length

Clamp the test pieces inside the cabinet at 23 °C and approximately 50 % relative humidity, so that there is an unloaded free span of at least 100 mm (known to within 1 mm). Record this length as l_0.

7.2 Preliminary conditioning of test pieces

Condition the unloaded test pieces at a relative humidity of 22 ± 3 %. Gently apply the appropriate load in accordance with table 1 and note the readings on the length-measuring devices (5.5). Adjust the test pieces so that they are not under load. Repeat the conditioning and measurement until the length changes by no more than 0,02 mm.

NOTE — These readings are not used in the calculation.

7.3 Measurement of hygroexpansivity

Change the conditioning atmosphere to one of 33 ± 2 % and record the relative humidity value obtained. Successively condition the unloaded test pieces for at least 30 min and note the readings on the length-measuring devices, under the appropriate load, until the length change is not more than 0,01 mm. Record these to the nearest 0,01 mm, l_1. Condition the test pieces in the same way in an atmosphere having a relative humidity of 66 ± 2 %. Note the relative humidity value obtained. Record the new readings, l_2, of the test pieces to the nearest 0,01 mm.

8 Expression of results

8.1 Calculation

The hygroexpansivity, X, expressed as a percentage, between 33 and 66 % relative humidity, is given by the equation

$$X = \frac{33}{R_2 - R_1} \times \frac{l_2 - l_1}{l_0} \times 100$$

where

l_0 is the initial length, in millimetres, i.e. free span between the unloaded clamps;

l_1 is the reading on the length-measuring device, in millimetres, for the test piece at a relative humidity of 33 ± 2 %;

l_2 is the reading on the length-measuring device, in millimetres, for the test piece at a relative humidity of 66 ± 2 %;

R_1 is the recorded lower relative humidity, i.e. 33 ± 2 %;

R_2 is the recorded higher relative humidity, i.e. 66 ± 2 %.

Express the result to the nearest 0,01 %, separately for the machine and cross directions.

8.2 Precision

For test results each of which consisted of the average of five determinations, the following precision data were obtained from an international cross-check involving six laboratories testing five papers.

8.2.1 Repeatability

The repeatability at the 95 % confidence level, for the difference between two test results obtained in a single laboratory, was between 0,02 % and 0,03 % for samples tested in the machine direction, and between 0,04 % and 0,06 % for samples tested in the cross direction.

8.2.2 Reproducibility

There were insufficient data from different laboratories for reproducibility to be assessed accurately.

NOTES

1 The range in repeatability values quoted is due to large differences between mean values of different paper samples.

2 All values for repeatability are per cent absolute hygroexpansivity.

9 Test report

The test report shall include the following information :

a) a reference to this part of ISO 8226;

b) the date and place of sampling and testing;

c) the test span between the clamps at the start of the test;

d) the mean value for the hygroexpansivity in the machine direction and/or the cross direction;

e) the measured values of temperatures and relative humidities used for the test;

f) any deviation from the requirements of this part of ISO 8226 and any incidents which may have affected the results.