INTERNATIONAL STANDARD

ISO 3039

Second edition
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Corrugated fibreboard — Determination of grammage of the component papers after separation

Carton ondulé — Détermination du grammage des papiers composants après leur séparation

Reference number
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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 3039 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

This second edition cancels and replaces the first edition (ISO 3039:1975), which has been technically revised to include precision data.

Introduction

This International Standard describes a procedure where the separated component layers are allowed to dry freely, i.e. unrestrained. In 2008, an international round-robin was performed to compare precision data between the two drying procedures: free drying (which can involve shrinkage) and restraint drying (where the layers are prevented from shrinking). As no statistical provable difference in the repeatability and the reproducibility between the two drying procedures was observed, the faster and simpler procedure, i.e. the free drying method, was chosen for this International Standard. Precision data for free drying are given in Annex A.

There is an indication from test results that some of the adhesive enters and stays in the papers it comes in contact with, and is not or cannot be removed by the method we use. Thus, the results for layers will generally be greater than the initial values.

Corrugated fibreboard — Determination of grammage of the component papers after separation

1 Scope

This International Standard specifies a method for determining the grammage of the component layers from which corrugated fibreboard has been made.

This International Standard is applicable to all types of corrugated fibreboard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
grammage
mass per unit area
mass of a unit area of paper or board determined by a specific method of test

NOTE Grammage is expressed in grams per square metre.

[ISO 536:1995[1], definition 3.1]

3.2
corrugated fibreboard
board consisting of one or more sheets of fluted paper glued to a flat sheet of board or between several sheets

[ISO 4046-4:2002[2], definition 4.49]

3.3
layer
component that is a part of corrugated fibreboard, which normally comprises a fluted layer (fluting) and a flat layer (liner) on each side

3.4
facing
linerboard (liner) used as the flat component of corrugated fibreboard

[ISO 4046-4:2002, definition 4.66]

3.5
fluting medium
corrugating medium
fluting paper or board intended for use in the manufacture of corrugated fibreboard

[ISO 4046-4:2002, definition 4.73]

3.6
linerboard
board used as the facing material in the production of combined corrugated fibreboard, solid fibreboard or "carton compact"

[ISO 4046-4:2002, definition 4.105]

4 Principle

Separation of the components of corrugated board specimens, to determine their grammage, by soaking in water so that the component layers can be separated. Drying and conditioning of the component layers. Determination of grammage of the individual layers.

5 Reagents

5.1 **Tap water**, normally having a temperature of 20 °C to 30 °C but not exceeding 60 °C.

6 Apparatus

Use ordinary laboratory apparatus and the following.

6.1 **Tank**, of sufficient size for immersion of the test specimen, to contain water at room temperature (20 °C to 30 °C) or hot water not exceeding 60 °C.

6.2 **Cutting device**, for cutting circular (diameter 112,8 mm ± 0,5 mm) or square (length 100 mm ± 0,5 mm) specimens from the corrugated fibreboard.

6.3 **Drying oven**, capable of maintaining the air temperature at 105 °C ± 2 °C, and suitably ventilated.

6.4 **Balance**, with an actual scale interval of 0,001 g which makes it possible to determine the grammage of the separate layers to three significant figures (including micro-flute with grammage < 100 g/m^2 for the separate layers). When in use, the balance shall be shielded from air currents.

7 Sampling

If the tests are being made to evaluate a lot, carry out the sampling in accordance with ISO 186. If the tests are made on another type of sample, make sure that the specimens taken are representative of the sample received.

The surfaces of the specimens taken from the corrugated fibreboard shall be free from any damage that may affect the test results.

The specimens should, if possible, be taken from non-printed and non-coated corrugated fibreboard.

8 Preparation of specimens

Using the cutting device (6.2), cut the specimens to an area of 10 000 mm^2 (100 cm^2), corresponding to a diameter of 112,8 mm ± 0,5 mm or a square with sides of 100,0 mm ± 0,5 mm.

Cut enough specimens to enable the determination of grammage on five test pieces from each component layer.

9 Procedure

9.1 Separation of component layers

Using the tank (6.1), immerse the specimens in tap water (5.1) long enough to cause the component layers of the corrugated fibreboard to separate spontaneously or with an extremely light pull. Make sure that the corrugated fibreboard remains submerged in the water, placing weights on the top of it if needed. When separating the component layers, care shall be taken to ensure that minimal fibres are removed from one surface and adhere to the adjoining one.

In the case of water-resistant adhesive, the water (5.1) can be heated to a temperature not exceeding 60 °C to accelerate the process and to separate corrugated fibreboard.

The suitable immersion time may vary from grade to grade. In most cases, a few minutes are sufficient, but for grades having highly water-resistant adhesive, the necessary immersion time may be several hours. If the immersion time is unknown, it is recommended that the suitable immersion time be evaluated before testing.

Blotters may be used to remove excess water, but not when drying.

9.2 Removal of the adhesive

By lightly scraping the surface, remove, while still wet, the adhesive showing on the surface of the component layer, which has not been absorbed by the sheet.

Complete removal of the absorbed adhesive cannot be expected. Removal of the fibres shall be avoided.

9.3 Drying of separated layers

Dry the separated layers, i.e. liners and fluting, in an oven at a temperature of 105 °C ± 2 °C (6.3) to constant mass.

Avoid using blotters during drying since components in the adhesive, e.g. starch, might adhere to the fibres.

9.4 Conditioning of separated layers

After drying, condition the separated layers in accordance with ISO 187.

9.5 Preparation of test pieces

After cleaning and conditioning, flatten the fluting medium and re-cut the test pieces to an area of 10 000 mm^2 (100 cm^2) using the cutting device (6.2). It is not necessary to re-cut the liners.

One way is to use the take-up factor (TUF), to calculate the fluting medium mass, according to FEFCO 102[5]. The TUF should be determined for different grades of fluting. The use of the TUF is not a part of this International Standard.

9.6 Determination of grammage

Determine the grammage of the component layers by individually weighing each test piece to the nearest 0,001 g using the balance (6.4). Carry out the weighing in the same atmosphere as that used to condition the separated layers (9.4).

NOTE The individual component mass can be subtracted from the mass of the combined board before separation to obtain an indication of the overall mass of the dried adhesive applied. Conditioning and testing is in accordance with ISO 187.

10 Calculation and expression of results

For each test piece, calculate the grammage, g, in grams per square metre, to three significant figures according to:

$$g = \frac{m}{A} \times 10^6$$

where

m is the mass of the test piece after cutting, in grams (weighing to 0,001 g);

A is the area of the test piece after cutting (10 000 mm^2), in square millimetres.

For each component layer, calculate the mean of the five determinations and report the arithmetic mean grammage to three significant figures and the standard deviation to two significant figures.

11 Test report

The test report shall include the following information:

a) a reference to this International Standard;

b) the date and place of testing;

c) a description and identification of the corrugated fibreboard tested;

d) a description and identification of the component layers;

e) the duration and temperature of soaking;

f) the conditioning atmosphere used;

g) the arithmetic mean grammage of each component layer;

h) the standard deviation of the grammage for each component layer;

i) any deviation from this International Standard that may have affected the results.

Annex A
(informative)

Precision

A.1 General

In January 2009, an international round-robin was performed in which 18 laboratories from 10 different countries participated.

For a single wall of corrugated fibreboard, three laboratories did not report any results and two laboratories deviated from this International Standard which means that 13 laboratories have been included in the calculations.

For a triple wall of corrugated fibreboard, four laboratories did not report any results and three laboratories deviated from this International Standard which means that 11 laboratories have been included in the calculations, with the exception of “Fluting 1” with only 10.

Eight samples of single-wall corrugated board and one sample of triple-wall corrugated board were tested. For each sample, the grammage was determined on five test pieces from each component layer.

The process of separating corrugated boards into component layers may induce changes in the masses measured, associated with adhesives used, the properties of the layers, or other factors. These shifts, being related to the materials in the corrugated fibreboard, will probably occur in most laboratories and so are not explicitly included in the round-robin results. Thus, by its nature, this test is capable of only very limited accuracy for predicting the actual initial masses of the components used. However, it can give useful information concerning a general estimate of those masses.

The calculations were made according to ISO/TR 24498:2006[4] and TAPPI T 1200 sp-07[6].

The repeatability standard deviation reported in Tables A.1 and A.2 is the “pooled” repeatability standard deviation; that is, the standard deviation is calculated as the root-mean-square of the standard deviations of the participating laboratories. This differs from the conventional definition of repeatability in ISO 5725-1[3].

The repeatability and reproducibility limits reported are estimates of the maximum difference that can be expected in 19 of 20 instances when comparing two test results for material similar to that described under comparable test conditions. These estimates may not be valid for different materials or different test conditions.

Repeatability and reproducibility limits are calculated by multiplying the repeatability and reproducibility standard deviations by 2,77.

NOTE $2{,}77 = 1{,}96\sqrt{2}$, provided that the test results have a normal distribution and that the standard deviation, s, is based on a large number of tests.

A.2 Repeatability

Table A.1 — Estimation of repeatability of the test method for single-wall corrugated board

Sample		Number of laboratories	Mean value g/m²	Standard deviation s_r g/m²	Coefficient of variation CV_r %	Repeatability limit r g/m²
A	Marked liner	13	209	2,6	1,2	7,2
	Fluting	13	131	3,0	2,3	8,3
	Liner	13	275	3,3	1,2	9,0
B	Marked liner	13	151	1,4	0,9	3,9
	Fluting	13	133	2,0	1,5	5,5
	Liner	13	154	1,6	1,1	4,5
C	Marked liner	13	125	1,7	1,3	4,6
	Fluting	13	121	2,6	2,1	7,2
	Liner	13	125	1,8	1,4	5,0
D	Marked liner	13	71,9	0,9	1,3	2,5
	Fluting	13	112	1,9	1,7	5,3
	Liner	13	72,2	0,6	0,8	1,6
E	Marked liner	13	87,9	1,3	1,5	3,5
	Fluting	13	97,4	1,3	1,4	3,7
	Liner	13	87,2	0,9	1,1	2,5
G	Marked liner	13	231	1,4	0,6	3,9
	Fluting	13	97,4	0,9	0,9	2,5
	Liner	13	138	0,8	0,6	2,3
H	Marked liner	13	148	1,8	1,2	5,0
	Fluting	13	130	2,5	1,9	7,0
	Liner	13	149	2,2	1,5	6,1
I	Marked liner	13	199	2,6	1,3	7,3
	Fluting	13	130	3,1	2,4	8,7
	Liner	13	198	3,0	1,5	8,4

Table A.2 — Estimation of repeatability of the test method for triple-wall corrugated board

Sample		Number of laboratories	Mean value g/m²	Standard deviation s_r g/m²	Coefficient of variation CV_r %	Repeatability limit r g/m²
F	Liner 1	11	430	5,1	1,2	14,2
	Fluting 1	10	145	3,2	2,2	8,9
	Liner 2	11	186	2,6	1,4	7,1
	Fluting 2	11	163	3,9	2,4	10,9
	Liner 3	11	187	2,9	1,5	7,9
	Fluting 3	11	147	3,3	2,2	9,2
	Liner 4	11	433	5,0	1,2	13,9