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Paper and board — Automated off-line testing of physical properties for CD (cross direction) profiles

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National foreword

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 6, *Paper, board and pulps*.

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Introduction

The automated off-line testing of cross direction (CD) profiles of paper and board was introduced in the 1980s. The apparatus available then was equipped with various modules for the determination of basic physical properties such as grammage, thickness, Bendtsen roughness, air permeance, etc. In the 90s, more advanced modules were developed for tensile, tear and bending testing. Modules for the measurement of the optical properties with the C/2°, D50/2° and D65/10° illuminants are also available.

The principal benefits of automated off-line testing are the speed with which the results are obtained and the small number of staff required to operate the testing apparatus.

Testing with stand-alone instruments implies much longer time before the results are available. Automated off-line testing improves the repeatability in testing as the operator dependency disappears.

In most of the countries producing paper and board, some type of automated off-line testing of CD profiles is carried out.

For the determination of physical properties, this document refers, where possible, to the relevant International Standards for the description and calibration of the equipment required. The results from automated off-line testing are widely accepted by the customers although the conditioning requirements stated in ISO 187 are not met.

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Paper and board — Automated off-line testing of physical properties for CD (cross direction) profiles

1 Scope

This document specifies the procedures for determining the cross direction profiles of physical properties of paper and board using automated off-line testers. Where available for a given measurement, the relevant International Standard is referred to. It is applicable to most kinds of paper and board, but is not relevant for tissue and corrugated board.

In this document, it is left to the paper and board producer and the customer to agree upon which properties are relevant. The results are reported as mean values or as profiles across the machine. Some properties are reported in index form.

The result obtained using the relevant ISO standard based on stand-alone equipment is used in case of challenge or dispute, if not otherwise agreed.

NOTE 1 The results obtained using specimens conditioned according to ISO 187 and stand-alone test instruments will, for some paper properties, differ from those obtained with unconditioned specimens and automated off-line testers. An investigation was made to only a limited extent, where the automated off-line testing was compared to stand-alone instruments, including the impact of conditioning. A summary of this investigation is reported in Annex B.

NOTE 2 It is also possible to evaluate properties in the machine direction (MD), but this is usually only used for trouble-shooting.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 186:2002, *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*

ISO 534, *Paper and board — Determination of thickness, density and specific volume*

ISO 536, *Paper and board — Determination of grammage*

ISO 1924-2, *Paper and board — Determination of tensile properties — Part 2: Constant rate of elongation method (20 mm/min)*

ISO 1924-3, *Paper and board — Determination of tensile properties — Part 3: Constant rate of elongation method (100 mm/min)*

ISO 1974, *Paper — Determination of tearing resistance — Elmendorf method*

ISO 2469:2014, *Paper, board and pulps — Measurement of diffuse radiance factor (diffuse reflectance factor)*

ISO 2470-1, *Paper, board and pulps — Measurement of diffuse blue reflectance factor — Part 1: Indoor daylight conditions (ISO brightness)*

ISO 2470-2, *Paper, board and pulps — Measurement of diffuse blue reflectance factor — Part 2: Outdoor daylight conditions (D65 brightness)*

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ISO 2471, *Paper and board — Determination of opacity (paper backing) — Diffuse reflectance method*

ISO 2493-1, *Paper and board — Determination of bending resistance —Part 1: Constant rate of deflection*

ISO 2758, *Paper — Determination of bursting strength*

ISO 2759, *Board — Determination of bursting strength*

ISO 5627, *Paper and board — Determination of smoothness (Bekk method)*

ISO 5631-1, *Paper and board — Determination of colour by diffuse reflectance — Part 1: Indoor daylight conditions (C/2°)*

ISO 5631-2, *Paper and board — Determination of colour by diffuse reflectance — Part 2: Outdoor daylight conditions (D65/10°)*

ISO 5631-3, *Paper and board — Determination of colour by diffuse reflectance — Part 3: Indoor illumination conditions (D50/2°)*

ISO 5636-3, *Paper and board — Determination of air permeance (medium range) — Part 3: Bendtsen method*

ISO 5636-6, *Paper and board — Determination of air permeance (medium range) — Part 6: Oken method*

ISO 8254-1, *Paper and board — Measurement of specular gloss — Part 1: 75° gloss with a converging beam, TAPPI method*

ISO 8254-2, *Paper and board — Measurement of specular gloss — Part 2: 75° gloss with a parallel beam, DIN method*

ISO 8254-3, *Paper and board — Measurement of specular gloss — Part 3: 20° gloss with a converging beam, TAPPI method*

ISO 8791-2, *Paper and board — Determination of roughness/smoothness (air leak methods) — Part 2: Bendtsen method*

ISO 8791-4, *Paper and board — Determination of roughness/smoothness (air leak methods) — Part 4: Print-surf method*

ISO 9416, *Paper — Determination of light scattering and absorption coefficients (using Kubelka-Munk theory)*

ISO 9895, *Paper and board — Compressive strength — Short-span test*

ISO 11475, *Paper and board — Determination of CIE whiteness, D65/10° (outdoor daylight)*

ISO 11476, *Paper and board — Determination of CIE whiteness, C/2° (indoor illumination conditions)*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
cross direction sample
CD sample
cut from edge to edge of a mother reel or post winder reel in the cross direction (CD), having a width in the machine direction (MD) appropriate for the tests to be carried out

Note 1 to entry: A typical width along the machine direction is about 300 mm.

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4 Principle

This document describes the procedure for the determination of CD profiles of physical properties of paper and board using the relevant automated off-line testers on the market which fulfil the requirements of this document. The results are reported as mean values or as profiles across the machine. Some properties are reported in index form.

5 Apparatus

5.1 Sample cutter

5.1.1 A motor driven cutter for cutting the CD samples, capable of accurately cutting samples perpendicular to the edges of the reel from edge to edge, and the width to an accuracy so that test methods which are sensitive to direction changes are not influenced. Control that the width (MD) does not vary so as to influence test methods which are sensitive to direction changes. Means may be provided for controlling the sample and feeding it to the test line, such as automated winding of the CD sample onto a removable cylinder which can be inserted in the automated off-line tester.

5.1.2 It is possible to use **manual sample cutters**. The sample can be trimmed to the accuracy required of motor driven sample cutters using a table top cutter.

5.2 Automated off-line testers

There are a number of automated off-line testers on the market for which testing in many cases is based on existing International Standards. They are typically composed of an unwinder followed by several units placed sequentially, with the destructive test measuring heads located at the end of the line. Some test lines are equipped with a moisture content module providing the possibility of correcting the values if needed.

Some of the test methods are not the same as those in the equivalent reference standards for stand-alone instruments. In these cases, correction factors and correction procedures can be a way to get results that correlate with those obtained using the reference standards.

The equipment shall be calibrated in accordance with the instructions in the relevant International Standards. Where this is not possible, for example, in the case of non-standard testers or alternative methods, advice may be provided on calibration by the manufacturer or any suitable party, allowing due regard to the measurement capability of the tester.

6 Sampling

6.1 General

The sampling of CD profiles is performed according to ISO 186. If sampling according to the procedure described in the main body of ISO 186 is impossible, impracticable or inappropriate, alternative sampling procedures as described in ISO 186:2002, Annex A can be used.

Sampling can be performed using hand or motor driven cutters. Before taking the CD sample, remove all damaged layers from the outside of the reel. CD samples are normally taken from every produced reel, or according to some other specific routine decided at each mill. The number of CD samples taken is determined by the number of tests to be performed and the amount of required material for later follow-up testing. Normally, one CD sample is used for testing directly in the automated off-line testers. When taking CD samples, ensure that the front side (FS) and drive side (DS), and top side and bottom side are identified, e.g. by marking the FS and top side.

Care shall be taken in handling CD samples as contact with bare hands can appreciably affect the chemical, physical, optical, surface and other characteristics of the paper or board. Use of cotton gloves

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is recommended during the sampling procedure. CD samples shall be free from wrinkles, folds and dirt and protected from exposure to conditions which may change the relevant properties. Avoid contact with the surface that is to be tested and place the CD sample on a clean table if necessary.

The average of a single CD profile for a specific sheet property may not be the same as the average obtained by the sampling procedures described in ISO 186.

Differences in average values may be due to the machine position (FS, DS or mid position) in which the samples are taken, the variability in paper properties and the number of positions in which the CD sample is tested, and not only the difference between sampling of reels in ISO 186 and in this document.

NOTE Winding the reel too tightly might cause problems with other measurements (e.g. bending measurements) for high grammage grades such as liquid board and folding box board.

6.2 Cutting samples

Cut the CD sample (3.1) perpendicular to the machine direction from edge to edge of the reel and of the required width using a sample cutter (5.1). The sample shall be clean, wrinkle-free and free of atypical defects.

7 Conditioning

As with non-automated testing, for quick feedback for the production line, it is usually impracticable to condition samples according to ISO 187. Locate the automated off-line tester in a conditioned test room meeting the requirements of ISO 187 and allow sufficient time for the CD sample to partially condition before testing of properties sensitive to moisture content is carried out. The time required will depend on equipment available for rapid conditioning and the grammage of the sample. It is desirable for preconditioning to be carried out as the first step.

NOTE Usually, the testing is started within 3 min to 15 min from sampling in the machine hall.

A suitable method for accelerated conditioning is described in Annex A.

The principle is that a CD sample is placed on a bench where air, meeting the temperature and relative humidity requirements of ISO 187, passes through the sample by means of vacuum fans. The specific time needed depends on the type of material and is more effective for lower grammages, <300 g/m^2. Mechanical properties like bending resistance and tear resistance are sensitive to the moisture content. In production, conditioning according to ISO 187 may not be practicable, instead, an accelerated conditioning can be used.

8 Procedure

8.1 General

A standard orientation and direction should be selected for feeding CD samples into the automated off-line tester. Ensure that the CD sample is fed into the tester with the chosen direction and orientation.

Choose the right configuration for your testing including the following:

— the machine direction width of the CD sample;

— properties to be tested;

— step length between tests;

— number of measurement points in the cross direction for each property;

— profile and/or mean value of properties.

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