SCAN-CM 27:00
Revised 2000

SCANDINAVIAN PULP, PAPER AND BOARD
TESTING COMMITTEE

Mechanical and chemical pulps

Preparation of laboratory sheets for determination of light-scattering and light-absorption coefficients, opacity and Y-value

0 Introduction

This SCAN-test Method replaces SCAN-C 27:76 and SCAN-M 7:76 from which it differs in several respects. The revised SCAN-CM 27 describes only the preparation of laboratory sheets; all measurements of reflectance factors and the calculations will be according to ISO 2471 and ISO 9416. The option to calculate light-absorption and light-scattering coefficients as well as opacity and Y-value of the laboratory sheets from reflectance factor measurements has been included.

The light-absorption coefficient can be used as an estimate of the content of chromophores in the sheet, while the light-scattering coefficient can be used as an estimate of the structure of the sheet.

The light-scattering coefficient, but not the light-absorption coefficient, is strongly dependent upon beating.

The light-absorption and light-scattering coefficients are dependent upon the wavelength. For pulp characterisation, ISO brightness is normally used with an effective wavelength of 457 nm (diffuse blue reflectance factor). The effective wavelength for the determination of opacity and light-scattering coefficient is 557 nm.

At the same time, SCAN-M 7:76 has been withdrawn.

1 Scope

This Method describes the procedures for the preparation of laboratory sheets for measuring reflectance factors, from which light-scattering and light-absorption coefficients, opacity and Y-value can be calculated.

> *Note* – The measuring procedures are described in ISO 2471 and ISO 9416.

The Method is applicable to all kind of pulps having an opacity of the laboratory sheets prepared not exceeding 95 % or with a light-absorption coefficient below 5 m^2/kg.

Annex A describes a procedure, which can be used if the light-absorption coefficient exceeds 5 m^2/kg.

2 References

ISO 638 Pulps – Determination of dry matter content – Oven-drying method (EN 20638)
ISO 14487 Pulps – Standard water for physical testing
ISO 5263-1 Pulps – Laboratory wet disintegration – Part 1: Disintegration of chemical pulps (EN ISO 5263-1)

ISO 5263-2	Pulps – Laboratory wet disintegration – Part 2: Disintegration of mechanical pulps at 20 °C (EN ISO 5263-2)
ISO 5263-3	Pulps – Laboratory wet disintegration – Part 3: Disintegration of mechanical pulps at >85 °C (EN ISO 5263-3)
ISO 5269-1	Pulps – Preparation of laboratory sheets for physical testing – Part 1: Conventional sheet former (EN ISO 5269-1)
SCAN-CM 64	Pulp – Preparation of laboratory sheets for physical testing – Closed water system
ISO 536	Paper and board – Determination of grammage (EN ISO 536)
ISO 2471	Paper and board – Determination of opacity (paper backing) – Diffuse reflectance method
ISO 9416	Paper – Determination of light scattering and absorption coefficients (using Kubelka-Munk theory)
SCAN-G 5	Pulps, papers and boards – Basic equations for optical properties

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

3 Definitions

For the purpose of this Method, the following definitions apply:

3.1 *Chemical pulp* – Pulp in which the fibres have been principally separated by chemical means.

3.2 *Mechanical pulp* – Pulp in which the fibres have been principally separated by mechanical means.

Note 1 – In this Method all chemi-mechanical (CMP) and chemi-thermomechanical (CTMP) pulps are regarded as being mechanical pulps.

3.3 *Dilution pulp* – Pulp of high brightness (low light-absorption coefficient) used to dilute the test pulp in order to facilitate meaningful optical measurements.

Note 2 – The definitions of light scattering, light absorption, opacity, Y-value and reflectance are given in ISO 9416 and ISO 2471.

4 Principle

Chemical pulp and mechanical pulp are disintegrated using standard water.

For chemical pulp, laboratory sheets are prepared from the disintegrated sample using standard water and a sheet former having an open water system.

For mechanical pulp, laboratory sheets are prepared from the disintegrated sample using standard water and a sheet former having a closed water system where sheets are not taken for measurement until the water system (the retention of fines in the sheet) has come to a balance (at least eight sheets).

5 Apparatus

5.1 *Disintegrator*, as described in ISO 5263-1 or ISO 5263-2 for chemical pulp or mechanical pulp respectively, with the following exceptions:

The interior of the disintegrator shall be of non-corrosive material, such as stainless steel or plastic material.

5.2 *Sheet-forming apparatus*, as described in ISO 5269-1. A wire screen of stainless steel or plastic material is recommended.

5.3 *Sheet-forming apparatus,* as described in SCAN-CM 64. A wire screen of stainless steel or plastic material is recommended.

5.4 *Standard water*, as described in ISO 14487.

Note – Do not use tap water because the amount of Cu, Fe and coloured material can vary depending on the season.

6 Sampling

This Method does not cover the sampling procedure. Make sure that the test pieces taken to disintegration are representative of the sample received.

7 Procedure

7.1 Disintegration

7.1.1 *Chemical pulp*. Use standard water (5.4) and disintegrate the pulp as described in ISO 5263-1, using a disintegrator (5.1).

7.1.2 *Mechanical pulp*. Use standard water (5.4) and disintegrate the pulp as described in ISO 5263-2 (at 20 °C) or ISO 5263-3 (at >85 °C, hot disintegration), using a disintegrator (5.1).

Note 1 – Hot disintegration is recommended for refiner pulps, which have not been latency treated.

7.2 Preparation of laboratory sheets from chemical pulp

Use standard water (5.4) in the sheet former (5.2) and prepare a sufficient number of sheets having a grammage of 60 g/m^2, calculated on an oven-dry basis, using the procedure described in ISO 5269-1.

Condition the sheets (23 °C, 50 % RH) and determine the grammage of the sheets according to ISO 536. Within 12 h after conditioning, measure the reflectance factors on the matt side as described in ISO 2471 and ISO 9416.

Note 2 – The reflectance factors are measured on a single sheet over a black cavity, R_o, and on a pad of sheets, R_∞. From these results, the light-absorption and the light-scattering coefficients, the opacity and the Y-value can be calculated according to ISO 9416 and ISO 2471.

7.3 Preparation of laboratory sheets from mechanical pulp

Use standard water (5.4) in the sheet former (5.3) and prepare laboratory sheets, having a grammage of 60 g/m², calculated on an oven-dry basis using the procedure described in SCAN-CM 64.

Note 3 – For some mechanical pulps having opacity above 95 % a lower grammage shall be used, e.g. 45 g/m².

Reject the sheets prepared during the build-up of the closed water system. Prepare a sufficient number of sheets for the measurement procedure.

Condition the sheets (23 °C, 50 % RH) and determine the grammage of the sheets according to ISO 536. Within 12 h after conditioning, measure the reflectance factors on the matte side as described in ISO 9416 and ISO 2471.

Note 4 – The reflectance factors are measured on a single sheet over a black cavity, R_o, and on a pad of sheets, R_∞. From these results, the light-absorption and the light-scattering coefficients, the opacity and the Y-value can be calculated according to ISO 9416 and ISO 2471.

7.4 Opacity correction

To convert the opacity of laboratory sheets having slightly different grammages to a common grammage i.e. to eliminate the influence of grammage variation on opacity, the Kubelka-Munk theory provides an equation given in SCAN-G 5.

8 Report

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

(a) date, place and time of laboratory sheet preparation;
(b) precise identification of the sample;
(c) the grammage;
(d) if a dilution pulp has been used according to Annex A, the precise identification of that pulp as well as the results from sheets prepared using 100 % of that pulp.
(e) any departure from the procedure described in this Method and any other circumstances that may have affected the results.

9 Literature

9.1 Rundlöf M., Bristow J. A. A note concerning the interaction between light scattering and light absorption in the application of the Kubelka-Munk equations Journal of Pulp and Paper Science, JPPS 23(1997) J220

Annex A (informative)
Procedure for preparing laboratory sheets from pulp having a light-absorption coefficient exceeding 5 m²/kg

A.1 Scope

This procedure is applicable to e.g. unbleached kraft pulp and makes use of the assumption that the light-absorption coefficient of a mixture of pulps is an additive property. Fully bleached chemical pulp, having a low light absorption coefficient, can be used as a dilution pulp in a mixture.

A2 Procedure

Use the procedure described in Clause 7, disintegrate the two pulps (the pulp with the light absorption coefficient >5 m^2/kg and the dilution pulp) separately. Before preparing sheets, mix 9 parts of the dilution pulp with 1 part of the pulp to be tested. Prepare laboratory sheets from the mixture having a grammage of 60 g/m^2 according to subclause 7.2. Also prepare laboratory sheets consisting of 100 % dilution pulp.

A.3 Measurement

Measure the reflectance factors of the sheets prepared from the pulp mixture and of the sheets prepared from 100 % dilution pulp, according to ISO 9416 and calculate the light-absorption coefficients. Check that the value obtained for the laboratory sheets prepared from the pulp mixture is between 1 m^2/kg and 5 m^2/kg.

A.4 Calculation

Calculate the light-absorption coefficient of the pulp to be tested using the equation:

$$k = \frac{k_{mix} - (1 - x)\, k_d}{x} \qquad \text{[A.1]}$$

where

k is the light-absorption coefficient of the pulp to be tested, in square metres per kilogram;

k_{mix} is the light-absorption coefficient of the mixture (dilution pulp and pulp to be tested), in square metres per kilogram;

k_d is the light-absorption coefficient of the dilution pulp, in square metres per kilogram;

x is the weight fraction of the pulp to be tested.

A.5 Literature

Teder, A., Tormund, D. Determination of light absorption coefficient of pulp. Kinetics of Chlorine Dioxide Bleaching CPPA Trans Tech Sec 3(1997):2 TR 41

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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