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SCANDINAVIAN PULP, PAPER AND BOARD
TESTING COMMITTEE

Mechanical and chemical pulps

Initial wet-web tensile strength, stretch and tensile energy absorption

25 % dry matter content

0 Introduction

SCAN-CM 31:77, applicable to chemical and mechanical pulps, replaces SCAN-C 31:77 (applicable to chemical pulps) and M 11:77 (applicable to mechanical pulps) since C 31:77 is identical with M 11:77. In December 2005, C 31 and M 11 were withdrawn.

1 Scope

This SCAN-test Method specifies a procedure for determining the initial wet-web tensile strength index, the initial wet-web stretch and the initial wet-web tensile energy absorption index. The results describe the stress-strain properties of the wet web and are intended for judging the processability of a pulp on a paper machine or the influence on the pulp of different production processes and fibre treatments.

This Method is applicable to all kinds of paper pulps.

2 References

ISO 5263-1 Pulps – Laboratory wet disintegration – Part 1: Disintegration of chemical pulps

ISO 5263-2 Pulps – Laboratory wet disintegration – Part 2: Disintegration of mechanical pulps at 20 °C

ISO 5263-3 Pulps – Laboratory wet disintegration – Part 3: Disintegration of mechanical pulps at $\geq$ 85 °C

ISO 5269-1 Pulps -Preparation of laboratory sheets for physical testing – Part 1: Conventional sheet-former method

Note – SCAN-test has withdrawn a number of test methods and refers instead to the corresponding ISO and/or EN Standards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 *Initial wet-web tensile strength* – The maximum tensile force per unit width that a wet test piece, made from a pulp under specified conditions, will stand before breaking in a tensile test.

3.2 *Initial wet-web tensile index* – The initial wet-web tensile strength divided by the grammage (oven-dry basis) of the test piece.

3.3 *Initial wet-web stretch* – The ratio of the increase in length of a wet test piece, made from a pulp under specified conditions, at the moment when the maximum tensile force is reached during a tensile test, to the initial test length.

> *Note 1* – The test length is the free length between the clamps. In practice, the increase in length is measured at the point where the tensile force begins to decrease.

3.4 *Initial wet-web tensile energy absorption* – The total work done per unit area when a wet test piece, made from a pulp under specified conditions, is stretched to rupture (the point of maximum tensile force).

> *Note 2* – In practice, the total energy absorption is measured to the point where the tensile force begins to decrease.

3.5 *Initial wet-web tensile energy absorption index* – The initial wet-web tensile energy absorption divided by the grammage (oven-dry basis) of the test piece.

4 Principle

From a pulp suspension, laboratory sheets are formed in a sheet former. The sheets are couched and gently pressed at a very low pressure between blotters to obtain a dry matter content of 25 %. Test pieces from the sheets are stretched at a constant rate of elongation in a testing machine that automatically records the tensile force as a function of the elongation. From the recorded values the tensile strength, the stretch and the tensile energy absorption of the wet test piece are calculated.

5 Apparatus

5.1 *Sheet former and stirrer* as described in ISO 5269-1. The grid plate and the wires shall be in good contact with each other.

5.2 *Mould or punch,* for preparing test pieces 20 mm ± 0,2 mm wide and sufficiently long so that .they can be securely clamped in the testing machine, the test length being 100 mm.

> *Note* – The mould can be made from strips of stainless steel, 2 mm thick and ca 10 mm wide. The strips form the vertical sides of the mould, the upper edge should be rounded and the lower edge may be tapered down to 1 mm.

5.3 *Blotters* as described in ISO 5269-1.

5.4 *Couch weight* of approximately the same size as the blotters and having a mass of 15 g ± 3 g per square centimetre of laboratory sheet area.

5.5 *Tensile testing machine* designed to stretch a test piece at a constant rate of elongation of 1,5 mm/s ± 0,1 mm/s and to record the tensile force as a function of the elongation on a strip chart recorder or an equivalent device.

The testing machine shall have two clamps for holding a test piece 20 mm wide. Each clamp shall be designed to grip the test piece along a straight line (the clamping line) without slippage or damage and so that it will not become dewatered. During the test the clamping lines must be parallel to within an angle of 1 °, and perpendicular to the direction of the applied tensile force and to the longitudinal dimension of the test piece to the same level of accuracy.

The distance between the clamping lines (the test length) shall be 100 mm ± 1 mm.

The testing machine shall have means of recording the elongation to an accuracy of 0,2 mm and the force to an accuracy of 10 mN.

> *Note* – For initial wet-web strength testing the breaking process is slow. For correct measurement of stretch and tensile energy absorption it is therefore especially important that the electrical and mechanical lag of the registering device is as low as possible.

5.6 *Planimeter* or another means for measuring the area between the force-elongation curve and the elongation axis, or an integrator for directly computing the work to rupture.

6 Calibration

Level the testing machine accurately.

Calibrate its force-measuring component with weights of accurately known mass. Calculate the force as the product of the mass of the weight and the local acceleration of free fall. Calibrate the extension-measuring mechanism over the required force range with either inside vernier calipers or gauge blocks.

Check the test length and adjust the rate of separation of the clamps (the rate of elongation of the test piece) to 1,5 mm/s ± 0,1 mm/s.

7 Preparation of test pieces

7.1 *Disintegration*

If required, disintegrate mechanical pulp as described in ISO 5263-2 or, if the pulp exhibit latency, as described in ISO 5263-3. If required, disintegrate chemical pulp as described in ISO 5263-1.

It is essential that dry pulp be thoroughly wetted before disintegration.

7.2 *Forming of laboratory sheets*
Form laboratory sheets by the procedure described in ISO 5269-1, but adjust the amount of pulp so that the grammage, calculated on an oven- dry basis, is 100 g/m^2 ± 5 g/m^2.

If a mould (5.2) is used, place this on the wire before preparing the laboratory sheet.

7.3 *Couching*
If a mould is used, remove it carefully. Place two blotters (called *couch blotter* and *filler*) on the laboratory sheet. Place the couch weight on top of the blotters and remove it after a period long enough for the sheet to adhere to the couch blotter.

Avoiding any unnecessary bending lift the blotters and the adhering laboratory sheet from the wire.

If the laboratory sheet tends to stick to the wire, a moistened couch blotter and, if necessary use a moistened filler. It is important that the laboratory sheet adheres to the blotter to avoid extension of the test pieces.

> *Note 1* – Each blotter in direct contact with the laboratory sheet shall be new. The felt side of the blotter shall always face the laboratory sheet.

> *Note 2* – Any change in the length of a test piece before the testing operation such as an ex- tension during handling or contraction by evaporation of moisture will lead to incorrect test results.

7.4 *Pressing*
The object of the pressing step in this procedure is to ensure that a sheet with dry matter content close to 25 % is obtained. The dry matter content is controlled primarily by varying the pressing time and the number of blotters in the pressing, secondly by repeating the pressing or – for pulps of high drainage resistance – by pressing without the filler, in the ways described below.

7.4.1 The normal procedure is as follows (see also the Annex):

Separate the filler from the couch blotter and place it on the other side of the laboratory sheet. The couch blotter and the laboratory sheet must not be separated at any time before or during the pressing.

Place the laboratory sheet, with the couch blotter, the filler and, if necessary, one or several dry backing blotters on each side, on a level table. Press by placing the couch weight on top of the stack formed.

The number of backing blotters and the pressing time should .be selected – by trial and error – to give test pieces with dry matter contents both above and below 25 %, within the range 22 % to 28 %.

7.4.2 If the test pieces obtained are too wet the pressing may be repeated one or more times, the backing blotters being replaced before each pressing.

7.4.3 To obtain the required dry matter content with pulps of high drainage resistance, the filler blotter may be discarded after the couching and replaced by one or more dry blotters before the pressing.

7.4.4 If the test pieces obtained are too dry even before the pressing, a moistened couch blotter and, if necessary, a moistened filler may be used in the couching.

A stack, containing several laboratory sheets, may be pressed in one operation.

> *Note 3* – Each blotter in direct contact with the laboratory sheet shall be new.

The felt side of the blotter shall always face the laboratory sheet.

7.5 *Punching of test pieces*
If no mould has been used, punch out test pieces (5.2). If a mould has been used the test pieces are ready to be removed from the couch blotter.

7.6 *Handling of test pieces*
Remove the test pieces carefully from the couch blotter and, if they are not tested immediately, place them between two rubber sheets.

The number of laboratory sheets and test pieces is chosen with regard to the accuracy desired.

8 Procedure

Ensure that the testing machine is calibrated and check the zero position of the recording device.

Place the test piece in the clamps without any tension or slack. Protect it against draughts that may cause loss of moisture by evaporation. Start the testing machine and record the maximum tensile force, the stretch and the tensile energy absorption to the precision required (5.5). Immediately after each test, remove the test piece from the clamps and weigh it without delay. All weighings should be made to an accuracy of 1 mg.

> *Note* – It is essential that the test piece be weighed so that the loss of moisture by evaporation is kept to a minimum. In some cases it may be preferable to use weighing bottles of known mass and to weigh the test piece in a bottle.
>
> If no weighing bottle is used, the balance should be of the direct-reading type and the reading shall be taken as quickly as possible, ignoring any slow change in the value shown.

Dry the test piece to constant weight in an oven at 105 °C ± 2 °C and weigh it again. A hot plate may be used if this gives equivalent results. Calculate the dry matter content to the nearest 0,1 % and the grammage (oven-dry basis) at least to the nearest 0,5 g/m^2.

The area of the test piece is that given by the mould or punch used (5.2).

Note – The test piece is considered to have reached constant weight when the results of two consecutive weighings do not differ by more than 1 mg.

9 Calculation and report

For each pulp sample (7.6), test a sufficient number of test pieces to give values on each side of 25 % dry matter content within the range 22 % to 28 %.

9.1 *Initial wet-web tensile index*
For each test piece, calculate the tensile strength index from the expression:

$$X = \frac{a}{b\ w} \qquad [1]$$

where
X is the initial wet-web tensile index, in newton metres per gram;
a is the maximum tensile force, in millinewtons;
b is the width of the test piece, in millimetres (standard 20 mm);
w is the grammage, in grams per square metre (oven-dry basis).

Using all the individual results obtained for the same pulp sample; determine by interpolation the initial wet-web tensile index at a dry matter content of 25 %. Report the results, in newton metres per gram, to the second decimal place.

9.2 *Initial wet-web stretch*
Using all the individual results obtained for stretch at rupture (point of maximum tensile force as defined in Section 3) for the same pulp sample; determine by interpolation the initial wet-web stretch at a dry matter content of 25 %. Express and report this as a percentage, to the nearest 0,5 %.

9.3 *Initial wet-web tensile energy absorption index*
From the area under the force-elongation curve (see Clause 5.6) calculate the tensile energy absorption index for each test piece from the following expression:

$$Y = \frac{1000\ c}{d\ w} \qquad [2]$$

where
y is the initial wet-web tensile energy absorption index, in millijoules per gram;
c is the integrated work to rupture, in millinewton millimetres;
d is the area of the test piece in square millimetres (standard 2000 mm^2)
w is the grammage, in grams per square metre (oven-dry basis).

Using all the individual results obtained for the same pulp sample, determine by interpolation the initial wet-web tensile energy absorption index at a dry matter content of 25 %. Report the result in millijoules per gram to two significant figures.

10 Report

The test report should include reference to this SCAN-test Method and the following particulars

(a) date and place of testing;
(b) description or identification of the material tested;
(c) the test results as specified above;
(d) the standard dry matter content, 25 %;
(e) any departure from the procedure described in this Method or any other circumstances that might have affected the test results.

Annex - Examples of stacking and pressing

1. *Pulps of low drainage resistance*

couch weight
1 backing blotter
the filler
the laboratory sheet, adhering to the couch blotter
1 backing blotter
Pressing time: 2 min

2. Pulps of medium drainage resistance

First pressing	***Second pressing***
couch weight	couch weight
2 backing blotters	1 dry backing blotter
the filler	the filler
the laboratory sheet, adhering to the couch blotter	the laboratory sheet, adhering to the couch blotter
2 backing blotters	1 dry backing blotter
Pressing time: 5 min	Pressing time: 1 min

3. *Pulps of high drainage resistance*

First pressing	***Second pressing***
couch weight	couch weight
2 backing blotters	1 dry backing blotter
a new, dry backing blotter	a new, dry backing blotter
the laboratory sheet, adhering to the couch blotter	the laboratory sheet, adhering to the couch blotter
3 backing blotters	2 dry backing blotters
Pressing time: 8 min	Pressing time: 3 min

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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