SCANDINAVIAN PULP, PAPER AND BOARD
TESTING COMMITTEE

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Pulps

Initial wet tensile properties at different dry matter content

0 Introduction

This SCAN-test Method replaces SCAN-CM 35:81.

The results describe the stress-strain properties of the wet web and are intended for evaluating the processability of a pulp on a paper machine or the influence on the pulp of different production processes and fibre treatments.

1 Scope

This SCAN-test Method specifies a procedure for determining the initial wet tensile strength index, the initial wet strain and the initial wet tensile energy absorption index on laboratory sheets compressed by wet pressing and dried to a specified dry matter content.

> *Note* – In contrast to SCAN-CM 35:81, this Method does not specify a fixed dry matter content. The dry matter content to which the results are to be related should be chosen by agreement between the parties concerned.

This Method is applicable to all kinds of pulps.

2 Normative 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 ≥ 85 °C
ISO 5269-1	Pulps – Preparation of laboratory sheets for physical testing – Part 1: Conventional sheet-former method
ISO 638	Paper, board and pulps – Determination of dry matter content - Oven-drying method
ISO 1924-3	Paper an board – Determination of tensile properties – Part 3: Constant rate of elongation method (100 mm/min)
ISO 5270	Pulps – Laboratory sheets – Determination of physical 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Note – SCAN-test has withdrawn a number of test methods and refers instead to the corresponding ISO and/or EN Standards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 *Initial wet tensile strength* – The maximum tensile force per unit width that a wet test piece, made from a pulp under specified conditions, will withstand before breaking in a tensile test.

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

3.3 *Elongation* – Increase in length of a test piece.

Note – The increase in length is determined in relation to the test length which is equal to the free length between the clamps.

3.4 *Strain* – Ratio of the elongation of a test piece to the initial test length.

3.5 *Initial wet strain at break* – Strain at the maximum tensile force.

3.6 *Initial wet tensile energy absorption* – The amount of energy absorbed per unit surface area (test length x width) of a test piece when it is strained to the maximum tensile force.

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

4 Principle

From a pulp suspension, laboratory sheets of the desired grammage are formed in a sheet former. The sheets are pressed at 410 kPa between blotters to obtain a certain density. Test pieces are either cut from the sheets or formed in the sheet former using a mould. The test pieces are strained at a constant rate of elongation in a testing machine that records the tensile force as a function of the elongation. From the recorded values the tensile strength, strain, and tensile energy absorption of the wet test piece are calculated.
To obtain the different dry matter contents, the test pieces are allowed to dry for different periods of time in the clamps of the tensile testing machine before the tensile test is started. The dry matter content of each test piece is measured immediately after the tensile test in the region around the break.

The values at the specified dry matter content are obtained by interpolation.

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 (optional)*, for preparing test pieces 20 mm ± 0,2 mm or 50 mm ± 0,2 mm wide and sufficiently long so that they can be securely clamped in the testing machine with a test length of (100 ± 1) mm.

Note – The mould can be made from strips of stainless steel, 2 mm thick and ca 10 mm wide, forming 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 *Punch (if a mould is not used)*, for preparing test pieces 20 mm ± 0,2 mm or 50 mm ± 0,2 mm wide and sufficiently long so that they can be securely clamped in the testing machine, with a test length of (100 ± 1) mm.

5.4 *Blotters* as described in ISO 5269-1. Blotters with a lower grammage may also be needed.

5.5 *Couch weight* as described in ISO 5269-1

5.6 *Sheet press* as described in ISO 5269-1.

5.7 *Tensile testing machine* as described ISO 1924-3, vertical and designed to strain a test piece at a constant rate of elongation of (100 ± 10) mm/min 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 either 20 mm or 50 mm wide. Each clamp shall be designed to grip the test piece along a straight line (the clamping line) without

slippage or damage. During the test, the clamping lines shall be parallel 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 ± 1) mm.

The testing machine shall have a means of recording the elongation to an accuracy of 0,2 mm and the force to an accuracy of 10 mN. It is recommended to use a load cell with a capacity of 100 N.

> *Note 1* – For initial wet strength testing, the breaking process is slow. For the correct measurement of strain and tensile energy absorption, it is therefore especially important that the electrical and mechanical lag of the recording device are as low as possible.

> *Note 2* – To prevent the test piece from breaking in the clamps or slipping, the test piece may, for example, be placed in the clamps with dry blotters at both sides of the test piece in the grip of the clamps. Other solutions such as a rubber clamp on one side and a metal-wire-surfaced clamp on the other side can also be used to achieve a sufficient grip.

6 Preparation of test pieces

6.1 Disintegration

Disintegrate the pulp in accordance with ISO 5263-1, -2 or -3, whichever is relevant.

6.2 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 (60 ± 2) g/m^2.

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

Prepare two extra sheets for the determination of grammage, *w*, in accordance with ISO 5270, without using the mould.

6.3 Couching

If a mould is used, remove it carefully. Place two blotters on the laboratory sheet. The blotter in contact with the laboratory sheet is the couch blotter and the second blotter is the filler blotter. Place the couch weight on top of the blotters and remove it after a period has passed 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, a moistened filler blotter may be used. It is important that the laboratory sheet adheres to the blotter to avoid any extension of the test piece.

Each blotter in direct contact with the laboratory sheet shall be new. The felt side of the blotter shall always face the laboratory sheet.

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

6.4 Pressing

The purpose of the pressing step in this procedure is to ensure that a sheet with a desired dry matter content is obtained.

> *Note* – The specified pressure is that which is applied to the laboratory sheets and may differ from the reading on the pressure gauge.

The normal procedure is as follows:

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 sheet and, if necessary, one or several dry backing blotters on each side, on a level table. Place the pad of sheet and blotters in a press and raise the pressure at a constant rate during (25 ± 5) s to 410 kPa and maintain that pressure for 1 – 4 minutes to reach the desired starting point of the dry matter content (the lowest dry matter content value from which the interpolation curve is plotted, see Annex A).

> *Note 2* – To prevent pressed-out water from being reabsorbed into the sheet when the pressure is released, the pad may in the press be placed on a non-absorbent plane parallel plate of the same size as the blotters, thick enough to allow the water to drain out.

6.5 Punching of test pieces

If no mould (5.2) has been used, use the punch (5.3) to produce the test pieces without removing the blotters. Record the width of the test pieces *b.*

6.6 Handling of test pieces

Keep the couch blotter and the filler blotter on each side of the test piece and place them in plastic bags to prevent the pieces from drying.

Choose the number of laboratory sheets and test pieces taking into consideration the accuracy desired.

If the test cannot be performed the same day, place the test pieces in plastic bags in a refrigerator. When the bags are withdrawn from the refrigerator, allow them to reach temperature equilbrium in the testing room before being opened, in order to reduce the risk of changes in moisture content.

7 Procedure

Using the special test pieces, determine the grammage, *w*, in accordance with ISO 5270.

Ensure that the testing machine (5.7) is calibrated and check the zero position of the recording device.

Place the test piece in the clamps. The test piece shall be without either tension or slack. Protect it against draughts that may cause too fast a loss of moisture by evaporation. Start the testing machine (5.7) and record the maximum tensile force, *a*, the strain at break, *e*, and the tensile energy absorption, *c*, to the precision required. Immediately after each test, remove the test piece from the clamps and cut out and without delay weigh the middle part (i.e. the area around the break, not the area close to the clamps) to and record the weight to the nearest 0,001 g.

To perform tensile tests on test pieces with a higher dry matter content, allow the test piece to remain in the clamps for a short time (approx. 1 – 10 min), before starting the tensile test. The longer the test pieces are left drying in the tensile testing machine, the higher will their dry matter content be.

Make sure that the test piece is weighed so that the loss of moisture by evaporation after the tensile measurement is kept to a minimum. If possible, use weighing bottles of known mass to weigh the test piece. If no weighing bottle is available, 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 middle part of the test piece to constant mass 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, according to ISO 638, to the nearest 0,1 %.

For each pulp sample, test a sufficient number of test pieces to obtain values at both higher and lower dry matter contents than the required dry matter content, with the nearest points preferably within ± 3% of the required value.

8 Calculation

8.1 Initial wet tensile index

For each test piece, calculate the wet tensile strength index according to the expression:

$$X = \frac{a}{b\ w} \qquad (1)$$

where

X is the initial wet 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 (20 mm or 50 mm);
w is the grammage, in grams per square metre (oven-dry basis).

Plot a graph of the wet tensile strength index versus dry matter content using all the individual results obtained for the same pulp sample. Determine by interpolation the initial wet tensile index at the required dry matter content. Report the result, in newton metres per gram, to the second decimal place.

8.2 Initial wet strain

Plot a graph of the wet strain at break (3.5) versus dry matter content using all the individual results obtained for the same pulp sample. Determine by interpolation the initial wet strain at break at the required dry matter content. Express and report this as a percentage, to the nearest 0,5 %.

8.3 Initial wet tensile energy absorption index

From the area under the force-elongation curve, calculate the tensile energy absorption index for each test piece according to the expression:

$$Y = \frac{1000\ c}{d\ w} \qquad (2)$$

where

Y is the initial wet 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 between the clamps in square millimetres (standard 2000 mm^2)

w is the grammage, in grams per square metre (oven-dry basis).

Plot a graph of the wet tensile energy absorption index versus dry matter content using all the individual results obtained for the same pulp sample. Determine by interpolation the initial wet tensile energy absorption index at the required dry matter content. Report the result in millijoules per gram to two significant figures.

9 Report

The test report should include the following particulars

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

10 Precision

10.1 Repeatability

Repeatability is not applicable for this Method.

10.2 Reproducibility

Three laboratories tested one chemical pulp and one mechanical pulp. The results are shown in Table 1.

Table 1 Reproducibility

	TMP, 60 CSF		Bleached sulphate softwood	
Dry matter content, %	35	45	35	45
Initial wet tensile strength index(Nm/g)	2,26	2,87	2,60	4,80
CoV (%)	17	14	7,6	6,3

Annex A
Achieving different dry matter contents
(informative)

The information in Table A1 and Figure A1 has been included as an example to illustrate how to achieve different dry matter contents.

Different dry matter contents can be achieved by changing the number of blotters, the press time, and the drying time.

Table A1. Example of data from the interlaboratory testing

Laboratory	Sample	Pressure [MPa]	No of blotters*	Press time [min]	Drying time [min]	Dry matter content [%]	Initial wet tensile strength index [Nm/g]
Lab 4	1	0,4	2	4	2	29	1,99
	2	0,4	2	4	4	32	2,02
	3	0,4	2	4	6	34	2,06
	4	0,4	2	4	8	35	2,02
	5	0,4	2	4	11	36	2,03
	6	0,4	2	4	11	37	2,16
	7	0,4	2	4	17	40	2,35
	8	0,4	2	4	20	43	2,57
	9	0,4	2	4	23	46	2,8
	10	0,4	2	4	25	50	3,02
	11	0,4	2	4	30	51	3,28

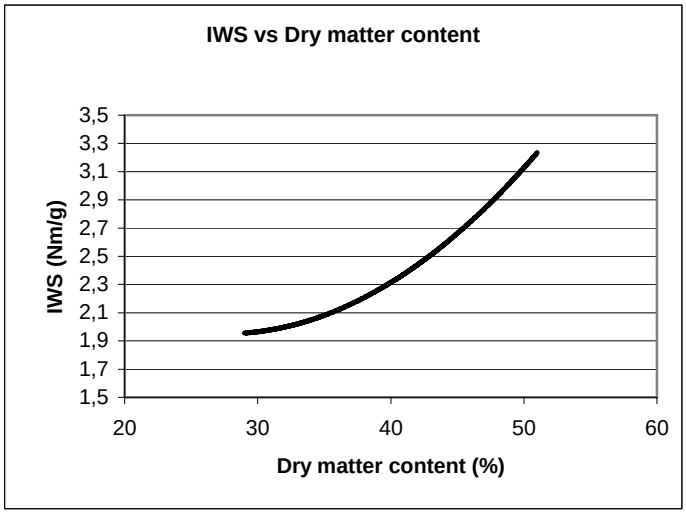

Figure A1 Example of plotted data and the fitted curve used to determine the initial wet tensile strength at he required dry matter content.

SCAN-test Methods are issued and recommended by FFIF, PFI and INNVENTIA for the pulp, paper and board industries in Finland, Norway and Sweden.
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