
**Pulps — Estimation of dirt and shives —
Part 1:
Inspection of laboratory sheets by
transmitted light**

Pâtes — Estimation des impuretés et bûchettes —

Partie 1: Examen des feuilles de laboratoire par lumière transmise



Reference number
ISO 5350-1:2006(E)

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Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	2
5 Apparatus	2
6 Sampling and preparation of test pieces	3
6.1 Sampling	3
6.2 Pretreatment of the sample	3
6.3 Preparation of laboratory sheets	4
7 Procedure	4
7.1 Determination of dry matter content	4
7.2 Examination	4
7.3 Classification of contraries	4
8 Expression of results	5
8.1 Calculation	5
8.2 Results	5
8.3 Precision	5
9 Test report	7
Annex A (normative) Comparison chart	8
Annex B (informative) Instrumental procedure	10
Bibliography	12

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 5350-1 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 5, *Test methods and quality specifications for pulps*.

This third edition cancels and replaces the second edition (ISO 5350-1:1998, ISO 5350-1:1998/Cor.1:1999), which has been technically revised.

With regard to ISO 5350-1:1998 and Technical Corrigendum 1:1999, the following changes have been made:

- a) the normative references have been updated;
- b) a more precise description of the sampling and preparation of test pieces was given;
- c) precision data have been moved from informative Annex B to 8.3;
- d) the status of the annex for the instrumental procedure has been changed from normative to informative and a more precise description of the instrumental procedure was given;
- e) editorial updating.

ISO 5350 consists of the following parts, under the general title *Pulps — Estimation of dirt and shives*:

- *Part 1: Inspection of laboratory sheets by transmitted light*
- *Part 2: Inspection of mill sheeted pulp by transmitted light*
- *Part 3: Visual inspection by reflected light using Equivalent Black Area (EBA) method*
- *Part 4: Instrumental inspection by reflected light using Equivalent Black Area (EBA) method*

Introduction

This part of ISO 5350 is based upon visual inspection. Informative Annex B is used when the inspection is performed by instrumental devices. For the time being, though, visual inspection provides the basis for this part of ISO 5350. This will eventually be changed when more experience with instrumental devices is gained, and it has been shown that such equipment can estimate dirt and shives to an acceptable level of precision at least equal to visual inspection.

This part of ISO 5350 is complementary to ISO 5350-2, which concerns visual inspection of mill sheeted pulp by transmitted light, and ISO 5350-3, which concerns visual inspection by reflected light.

ISO 5350-4 is based on automatic inspection by reflected light.

Pulps — Estimation of dirt and shives —

Part 1: Inspection of laboratory sheets by transmitted light

1 Scope

This part of ISO 5350 specifies a method for the estimation by transmitted light of the visible dirt and shives in laboratory sheets prepared from pulp. It is, in principle, applicable to all kinds of pulp, although it is mainly intended for pulp that is not manufactured in sheet form.

This part of ISO 5350 can also be applied to mill sheeted pulp, if the sheets have high grammage or are very opaque for other reasons, in which case ISO 5350-2 is not applicable.

This part of ISO 5350 is not intended for recycled pulp.

NOTE Shives in mechanical pulp are usually determined by means based on screening or optical analyses. Some grades of mechanical pulps can cause problems in sheet-making or inspection, which makes this part of ISO 5350 impractical.

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 638, *Pulps — Determination of dry matter content*

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 5269-2, *Pulps — Preparation of laboratory sheets for physical testing — Part 2: Rapid-Köthen method*

ISO 7213, *Pulps — Sampling for testing*

3 Terms and definitions

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

- 3.1 sheet**
a sheet of pulp taken from a bale, or a part of a roll of pulp
- 3.2 laboratory sheet**
a sheet formed from disintegrated pulp
- 3.3 test piece**
a laboratory sheet taken for inspection
- 3.4 contrary in pulp**
any unwanted particle, of specified minimum size and having a contrasting colour or opacity with respect to the surrounding area of the sheet, according to the comparison chart given in Annex A
- 3.4.1 dirt**
any non-fibrous contrary
- 3.4.2 shive**
sliver of wood, or fibre bundle

4 Principle

Test pieces, formed from disintegrated pulp, are inspected in transmitted light. The area of all contraries larger than a specified value and showing contrasting opacity, with respect to the surrounding area of the sheet, according to the comparison chart given in Annex A, are estimated. The estimated areas of the contraries are added, and the total area of dirt and shives is reported as square millimetres per kilogram of oven-dry pulp (mm^2/kg).

NOTE If required, the areas of dirt and shives in different classes can also be reported.

5 Apparatus

5.1 Viewing table, with an illumination device suitable for inspecting the test pieces in transmitted artificial daylight. The luminance, as measured at the surface of the viewing table, shall be 2 500 cd/m^2 to 3 000 cd/m^2 . Daylight or direct light from any external source should be avoided.

NOTE The luminance can be measured by a luminance meter.

5.2 Comparison chart: a transparent film with a series of black and grey spots of different shapes, areas and contrasts. This shall be used for visual inspection or for calibration of an instrumental device. The chart is provided in normative Annex A.

Do not use a photocopy of the chart in any inspection, because reproduction may change the size and contrast of the spots.

5.3 Apparatus to prepare laboratory sheets

5.3.1 General

Care shall be taken to avoid contamination of the pulp during the test. It is necessary to ensure that the surface and elements of the disintegrator and sheet-making equipment are clean and free from corrosion and deposits. Make sure that the water to be used is free from foreign particles; if necessary, filter the water.

5.3.2 Disintegrator, as specified in ISO 5263-1, ISO 5263-2 or ISO 5263-3.

5.3.3 Sheet-former equipment, as specified in ISO 5269-1 or ISO 5269-2.

5.3.4 Blotters, of a size corresponding to the sheet-former equipment.

6 Sampling and preparation of test pieces

6.1 Sampling

If the test is being made to evaluate a pulp lot, the sample shall be selected in accordance with ISO 7213. If the test is made on another type of sample, report the source of the sample and, if possible, the sampling procedure used. From the sample received, make sure that the test portions taken are representative of the whole sample.

The total oven-dry mass of test pieces shall be at least 180 g.

100 g of test pieces are required for the inspection, but 180 g provides the possibility to make a preliminary test as described in 6.2.

6.2 Pretreatment of the sample

The sample should be soaked in water and disintegrated in accordance with the procedure stated in ISO 5263-1, ISO 5263-2 or ISO 5263-3.

Choose the number of revolutions so that extensive disintegration is avoided, but all lumps of fibers have disappeared. It is advisable to make some preliminary tests to establish the number of revolutions needed. Table 1 gives an indication of the number of revolutions found appropriate for some grades of dry pulp.

Table 1 — Recommended values for the number of revolutions, the grammage (as oven-dry) and minimum number of laboratory sheets

Pulp quality	Number of revolutions	Maximum grammage g/m ²	Minimum number of sheets		
			Square conventional sheet-former	Round conventional sheet-former	Rapid-Köthen sheet-former
Flash-dried bleached chemical pulp	10 000	700	6	7	5
Mechanical pulp, dry	6 000 ^a	150	25	32	22
Unbleached, kraft pulp, dry	8 000	80	47	59	40

^a For some grades, as many as 12 000 revolutions are needed for complete disintegration.

It is very time consuming to examine pulp with a very high dirt count, so if it is found by a preliminary test that the number of contraries exceeds 300 per kilogram of oven-dry pulp, the amount to be inspected can be reduced to 50 g of oven-dry pulp. This shall be reported with the results.

6.3 Preparation of laboratory sheets

Prepare a number of laboratory sheets in the sheet-former apparatus. The number of laboratory sheets and their grammage shall correspond to at least 100 g of oven-dry pulp. Table 1 gives the recommended grammages and the minimum number of test pieces to be inspected for some pulp qualities. Mark the topsides of the test pieces. Press the laboratory sheets at about 400 kPa. A final dry matter content of about 30 % is recommended. However, dry test pieces may be used if they are transparent enough to ensure that all contraries are visible, but the use of dry test pieces shall be reported together with the results.

NOTE The laboratory sheets can dry out if inspection is not made immediately after sheet-making. This can be avoided by covering the laboratory sheets with a clean sheet of plastic until used. If the laboratory sheets become too dry, they may be rewetted by the use of a hand spray or an atomizer.

To confirm that all contraries are visible, make a small mark at the surface of the test piece, and check the visibility of this spot when viewing the test piece from the other side.

7 Procedure

7.1 Determination of dry matter content

Determine the dry matter content of the inspected test pieces in accordance with ISO 638.

7.2 Examination

Examine the test pieces (6.3) visually using the viewing table (5.1). Examine half of the test pieces produced from the topside, and the other half from the wire side. Use the comparison chart in Annex A as an aid to estimate the area of each speck. Only contraries having an area of $\geq 0,04 \text{ mm}^2$ shall be noted. Size class 5 can be omitted, if agreed upon.

Classify the contraries according to their area (see Table 2). Distinguish between dirt and shives, if required.

7.3 Classification of contraries

It is usual to report only the total area of contraries, although when required the contrary area in each class can be reported. In this case, the classification given in Table 2 shall be used. Size class 5 can be omitted if agreed upon, but this shall be stated in the test report.

Table 2 — Recommended classification of contraries according to area

Size class	Area mm ²	Logarithmic mean area $[(A_{\max} - A_{\min}) / \ln(A_{\max}/A_{\min})]$ mm ²
1	above 5	—
2	1,00 to 4,99	2,482
3	0,40 to 0,99	0,651
4	0,15 to 0,39	0,251
5	0,04 to 0,14	0,080

Dirt and shives may be reported separately by agreement.

8 Expression of results

8.1 Calculation

For all contraries (or separately as dirt and shives, if required) calculate the total area, or the area in each size class according to Formula (1):

$$X = \sum \frac{c_i n_i}{m} \quad (1)$$

where

X is the total area of contraries (or the area of the contraries in each class), expressed in square millimetres per kilogram (mm^2/kg);

c_i is the logarithmic mean area of the size class, indicated in Table 2, expressed in square millimetres (mm^2);

n_i is the number of contraries in the size class;

m is the oven-dry mass of the test pieces, expressed in kilograms (kg).

The logarithmic mean areas are given in Table 2.

For contraries exceeding 5 mm^2 , the factor $c_i n_i$ is replaced by the contraries' "true area", which shall be evaluated separately for each contrary and stated in the test report.

NOTE The logarithmic mean area of a class is justified, as there is a tendency towards enrichment of contraries towards the lower limit of the class.

EXAMPLE

If 8 contraries are counted within the size class $0,15 \text{ mm}^2$ to $0,39 \text{ mm}^2$, their area $c_i n_i$ is calculated as follows:

$$8 \times 0,251 \text{ mm}^2 = 2,0 \text{ mm}^2$$

8.2 Results

Report the total area of contraries, in square millimetres per kilogram of pulp, to the nearest integer. Results below $5 \text{ mm}^2/\text{kg}$ shall be reported to one decimal place.

NOTE On request, the results can be expressed separately for each size class, or separately for dirt and shives. However, if the count is reported by categories, the categories containing few contraries will be subjected to a much higher sampling uncertainty.

8.3 Precision

No exact figures concerning the precision can be given. The precision data varies from case to case because of the subjective nature of the test method. The results depend very much on the observer and on the sample. However, the following results provide some information about the precision of the method.

8.3.1 Repeatability

Two samples, one bleached chemical pulp and one CTMP, were inspected in one laboratory by one person according to this part of ISO 5350. Five parallel inspections were made in each case. The results are shown in Table 3.

Table 3 — Repeatability

Sample	Mean value mm ² /kg	Coefficient of variation %
Bleached hardwood	64	36
CTMP from softwood	60	29

In a study on ground wood pulp from hardwood, 5 parallel tests, each consisting of 25 laboratory sheets of 150 g/m², were made by one person. The results are given in Table 4.

Table 4 — Mean values and coefficient of variations for the contraries of various size classes

Classes of contraries	Mean value mm ² /kg	Coefficient of variation %
Above 5 mm ² , shives	0	—
Above 5 mm ² , dirt	0	—
1 to 4,99 mm ² , shives	12	91
1 to 4,99 mm ² , dirt	31	96
0,4 to 0,99 mm ² , shives	7	108
0,4 to 0,99 mm ² , dirt	10	100
0,15 to 0,39 mm ² , shives	17	37
0,15 to 0,39 mm ² , dirt	41	33
0,04 to 0,14 mm ² , shives	14	51
0,04 to 0,14 mm ² , dirt	80	23
Total mm ² , shives	50	15
Total mm ² , dirt	162	31
Total mm ² , dirt and shives	212	23

8.3.2 Reproducibility

Two samples, one bleached chemical pulp and one CTMP, were inspected in four different laboratories according to this part of ISO 5350. The results are shown in Table 5.

Table 5 — Reproducibility

Sample	Mean value mm ² /kg	Coefficient of variation %
Bleached hardwood	16	79
CTMP from softwood	303	44

9 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 5350;
- b) the date and place of testing;
- c) all information for complete identification of the sample;
- d) the results, expressed in square millimetres of contraries per kilogram of oven-dry pulp; on request, the result can be divided into classes according to size and/or nature, i.e. dirt or shive;
- e) any optional points observed in the course of the test;
- f) any operations not specified in this part of ISO 5350 or in the International Standards to which reference is made or regarded as optional, which might have affected the results.

Annex A (normative)

Comparison chart

Use the chart enclosed.

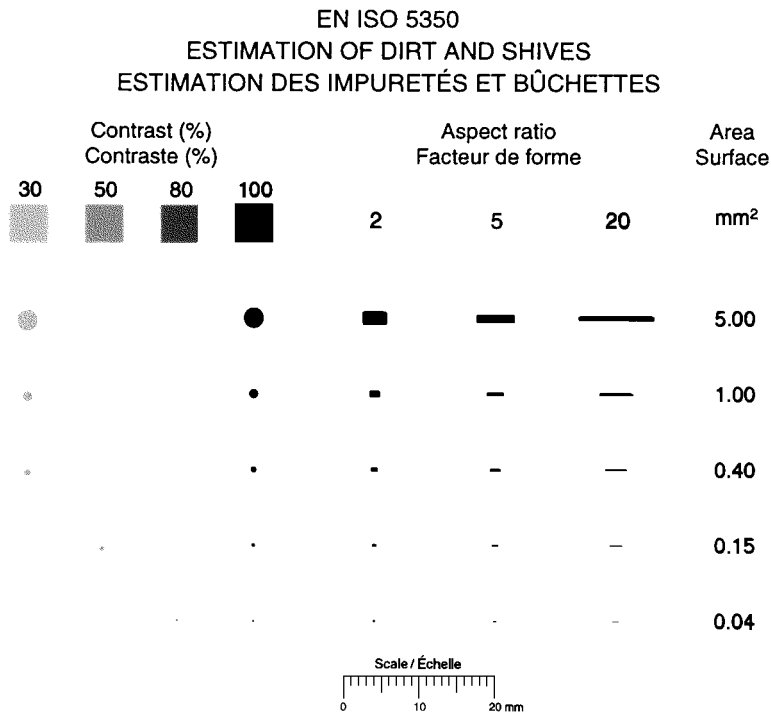


Figure A.1 — Estimation of particle size – Comparison chart

Do not use a photocopy of the chart in any inspection, because reproduction may change the sizes and contrasts of the spots.

The left part of the chart is intended as an aid for visual inspection. The spots having the minimum contrast to be considered in each size class are indicated, i.e. 30 % and 50 % minimum contrast for contraries equal to or larger than 0,40 mm² and 0,15 mm², respectively.

The spots on the right-hand side indicate contraries of different aspect ratios. The contrast ratio is 100 %. This part of the chart is to be used as an aid for size classification.

NOTE On this comparison chart, a dot is used as the decimal sign.



Copies of this part of ISO 5350 printed by ISO include a comparison chart reproduced on transparent film (see 5.2). Users having only an electronic copy, or a printed copy reproduced from an electronic copy, may obtain an original transparent film comparison chart from the ISO Central Secretariat (price code: A).



Annex B (informative)

Instrumental procedure

B.1 Introduction

In the future, instruments will commonly be used for the inspection of contraries in pulp. Such techniques are preferably used for pulps with a high number of contraries. However, it should be noted that results obtained by visual inspection may not be equivalent to those found by instrumental test methods.

B.2 Equipment

B.2.1 An instrumental dirt-counting device, including a light source suitable for inspection by transmission, constructed so that the contraries having areas and contrasts corresponding to Table 2 and Table B.1 can be counted and reported. The light source spectrum must be in the visible part of the spectrum, with 95 % of the radiation occurring between 380 nm and 740 nm. The illuminant spectrum and detector spectral sensitivity must match (References [1] and [2] in the Bibliography). The repeatability of the device shall fulfil the requirement that the coefficient of variation does not exceed 15 % when a test piece is inspected five times. The device shall be able to identify contraries of an aspect ratio exceeding 3:1, if shives are to be reported separately.

It is recommended that the instrument exhibit a maximum pixel size of 0,01 mm² and a minimum grey-scale resolution of 1/2 % transmittance, and that the detection threshold is uniformly set at 10 % contrast. Measure the light transmission of the surrounding area, T_{su} , of 1 mm² or equal to twice the area of the particle outside the dirt particle, whichever is greater.

B.2.2 Comparison chart, for instrumental dirt count. A chart with a series of spots of different areas and contrasts. The contrasts are given in Table B.1. This chart shall be used for calibration of an instrumental device. This chart is found in Annex A.

B.3 Procedure

Follow the principles outlined in the main text and Annex A of this part of ISO 5350. Apply the instructions provided by the manufacturer of the apparatus.

Check the instrument regularly by the use of the comparison chart. Place the chart on a white, even tile or sheet of paper. All the contraries in the actual classes indicated on the comparison chart shall be noted by the instrument. If this is not the case, adjust the instrument, if possible, or contact the manufacturer.

All contraries having an aspect ratio exceeding 3:1 are reported as “shives” by the apparatus. Make sure, by visual inspection, that these “shives” are fibrous and the classification is justified.

NOTE The instruments are usually equipped with a means for automatic calculation of the result, based on the true area of the contraries. In this case, it may not be necessary to use the logarithmic mean areas of the size classes.

B.4 Classification of contraries

B.4.1 Size and nature

Follow the recommendations given in 7.3.

In instrumental inspection, a fibrous contrary is considered as a shive when it has an aspect ratio exceeding 3:1.

The aspect ratio is the ratio of length to width, e.g. of maximum dimension to minimum dimension.

B.4.2 Contrast

The parameter used to measure the difference in light intensity between a foreign particle and its background is called contrast. This is derived from the ratio of the intensity of the light transmitted through the particle compared to the intensity of the light transmitted through the surrounding pulp according to Formula (B.1):

$$C = 100 \times \left(1 - \frac{T_{pa}}{T_{su}} \right) \quad (\text{B.1})$$

where

C is the contrast;

T_{pa} is the transmission of the particle;

T_{su} is the transmission of the surrounding area.

The darker the particle compared to its surrounds, the higher is the contrast.

The contrast needed to make a contrary visible depends on the size of the contrary (small spots are visible only if they have a high contrast to the surrounding pulp, whereas large spots are visible at low contrast). Therefore, one single contrast cannot be specified as a limit. Table B.1 gives the minimum contrast values to be applied.

For the purpose of this part of ISO 5350, the contrast values, which are derived from the optical intensity and density values, are so formulated that a value of zero is obtained when the intensities of the light transmitted through the contrary and the surrounding pulp are equal.

Table B.1 — Minimum contrast values for different size classes

Size class	Minimum contrast %
1	30
2	30
3	30
4	50
5	80

Bibliography

- [1] PAPTAC Useful Method D30.U, *Basic Guidelines for Image Analysis Measurements*
- [2] Tappi Technical Information Paper TIP 0804-09, *Basic Guidelines for Image Analysis Measurements*

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ICS 85.040

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