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Paper and board — Determination of resistance to picking — Accelerated speed method using the IGT-type tester (electric model)

Papier et carton — Détermination de la résistance à l'arrachage — Méthode d'impression à vitesse accélérée avec l'appareil de type IGT (modèle électrique)

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Contents

Page

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 3783 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

This second edition cancels and replaces the first edition (ISO 3783:1980), which has been technically revised. The main changes are in the use of a pick-start viewer for the assessment of the start of the pick or delamination, the use of the viscosity of the pick-test oils for normalisation of the resuls to 23 °C, and the clear definition of the velocity profile for the testers.

Introduction

Pick is the name commonly given to damage to the paper surface occurring during the printing operation. When the printing form is lifted from the paper, the ink exerts on the paper a force, which increases with increasing viscosity and tack of the ink and with increasing printing speed. When this force exceeds a critical value, which depends on the paper, the surface of the paper is damaged.

The minimum printing speed at which pick occurs is a measure of the pick resistance of the paper.

Using specified testing equipment, the paper or board is printed with a pick-test oil of known viscosity, at constant printing force and at an increasing velocity. Pick velocity and pick resistance are derived from the distance between the starting point of the print and the point on the print where the first damage is observed.

In the case of paperboard when the adhesion between the outer layer and the next layer is too low, delamination between the layers can occur during printing.

Paper and board — Determination of resistance to picking — Accelerated speed method using the IGT-type tester (electric model)

1 Scope

This International Standard specifies an accelerated speed method for determining the surface strength in terms of the pick velocity and pick resistance of coated and uncoated paper and board, and in terms of the delamination resistance of the liner on paperboard, by simulating the behaviour in the printing process. Because of the limited area tested and the general character of the test, it will not usually detect local imperfections such as surface debris.

This test is especially important for papers and boards which are to be printed in lithographic offset or letterpress, because the inks used in these techniques traditionally have a high viscosity and high tack values. Due to the increasing tendency for the tack and viscosity of modern flexographic inks to be high, this method is also useful in that field.

In the interpretation of the test results, attention must be given to the fact that the results can be seriously influenced by differences in testing conditions, differences in instruments and differences in the calibration state of the test equipment.

The pick velocity, etc., determined here should not be interpreted as being the running speed of a printing press in practice.

NOTE 1 Although IGT-type testers of the pendulum type are outside the scope of this International Standard, the described method can also be used for these instruments. The results will be slightly different, due to the difference in velocity profile.

NOTE 2 The use of the Westvaco type device and the use of tack-graded inks are not covered by this International Standard.

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 186, *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*

3 Terms and definitions

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

3.1
pick
rupture of the surface layer of a paper or a board during manufacture or printing, which occurs when an external tensile force applied normal to the surface is greater than the cohesion of the paper or board

NOTE In the case of coated papers, the rupture may take the form of particles of coating or fibres wholly or partly detached from the sheet, blistering or gross stripping. In the case of uncoated papers, the rupture normally takes the form of the removal of fibre aggregates and is difficult to determine due to the paper surface structure, since the visual assessment is easily influenced by human factors.

3.2
pick velocity
v_p
velocity at which pick of the surface of the printed paper begins under the conditions defined in this International Standard

3.3
pick resistance
$P(23)$
velocity at which the surface of the paper begins to exhibit pick at a pick-test oil temperature of 23 °C

3.4
liner lifting
separation of one or more layers of the board caused by the application of a force normal to the surface

3.5
delamination velocity
v_d
velocity at which delamination of the surface of the printed paper begins in the equipment defined in this International Standard

3.6
end-velocity
v_e
set velocity to be reached after 200 mm of the print

3.7
delamination resistance
$D(23)$
velocity at which delamination begins at a pick-test oil temperature of 23 °C

4 Apparatus

4.1 Inking device

4.1.1 Inking device, consisting of two or more inking drums having contact with a top-roller. The ink-distributing surface area A of the rollers shall be known to the nearest 0,1 cm^2. Each inking arrangement shall incorporate one or more holders, on which the printing discs to be inked in can be mounted.

The distributing surface area A is calculated as:

$$A = \sum_{1}^{n} (\pi \times d_n \times l_n) \quad (1)$$

where

d_n is the diameter of roller or drum number (n);

l_n is the effective length of roller or drum number (n);

n is the number of rollers excluding the printing disc.

NOTE 1 The lifetime of the rubber- or elastomer-covered parts is limited, if properly handled, to a maximum of approximately 3 years.

NOTE 2 The transfer characteristics of rubber rollers can be changed by, for example, using them for different applications, inks, bad cleaning, unsuitable cleaning solvents and ageing. If tests are made using different top-rollers, it is important that the top-rollers are identical, and a test to determine the ink transfer may have to be performed.

NOTE 3 The terms “inked in” and “ink” are used here to conform to general usage, even when a pick-test oil is used instead of an ink.

4.1.2 One or more aluminium printing discs, (10,0 ± 0,2) mm wide, with smooth edges, a diameter of (65,0 ± 0,2) mm and a temperature-insulating handgrip.

4.1.3 Ink pipette, for applying an accurate quantity of pick-test oil to the inking device, having a minimum volume of 2 ml and a resolution of at least 0,01 ml, but preferably 0,001 ml.

NOTE If the inking device is equipped with a dispensing system with sufficient accuracy, no ink pipette is required.

4.2 Printing device

4.2.1 Printing device, having a sector with a radius of (85,0 ± 0,2) mm, incorporating a facility enabling a packing (see 4.2.2) to be mounted on the sector under tension, and a test piece to be mounted on the packing. The sector shall be capable of being driven over a distance of 200 mm at a uniformly increasing velocity:

$$\frac{\delta_v}{\delta_s} = \text{constant} \tag{2}$$

where

δ_v is the velocity increase;

δ_s is the distance increase.

The actual velocity shall not differ by more than 5 % from the theoretical value over the workable range, as specified for the tester.

The force with which the printing disc contacts the test piece on the sector shall be adjustable or fixed to the force specified in this International Standard. The actual force shall not deviate by more than ± 10 N from the set force.

It is important that the printing device be properly calibrated with regard to printing velocity and printing force between the printing disc and the sector (see Annex A).

4.2.2 Packing, consisting of 5 or 6 layers of paper with a total thickness of (1,5 ± 0,1) mm. Each layer shall have a grammage of approximately 150 g/m^2 and a thickness of approximately 0,3 mm.

4.3 Evaluation devices

4.3.1 Test-piece holder (for paperboard only) for delamination assessment, in the form of a semicircular trough, with an internal radius of 40 mm as shown in Figure 1.

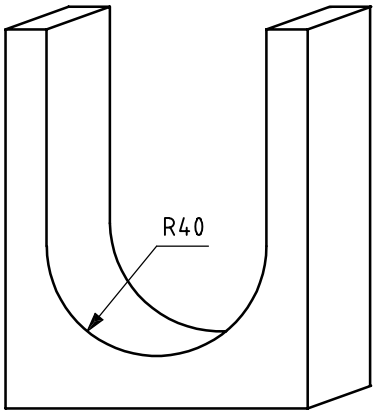

Figure 1 — Delamination viewer

4.3.2 Pick-start viewer[1)], to determine the starting point of pick. The pick-start viewer shall have a light source which provides grazing incident light to the test piece placed under this device, and a device enabling the test piece to be observed without magnification at an angle of 10° to the normal, opposite to the light source.

NOTE This device is meant to yield a quicker and less variable result than is obtained without this device. It is not intended that the user will search longer for isolated bad spots, and thus obtain a lower pick velocity.

4.4 Materials and aiding devices

4.4.1 Pick-test oils[1)], consisting of poly-isobutenes of known viscosity, as indicated in Table 1 (see Clause 7). The composition of each oil shall be finally adjusted so that its performance in a pick test is within 2 % of that of the corresponding standard oil provided by IGT.

NOTE A pick-test oil has a limited shelf life of approximately 3 years, and a maximum open life of 1 year. Storage or transport at temperatures below 5 °C may cause separation or disintegration of the components.

4.4.2 Cleaning aids, rags or tissues, lint-free, and mineral spirits or other solvents, as specified for the materials used.

NOTE The rollers made of, or covered with, rubber or plastic are sensitive to certain solvents. Contact the supplier for information concerning the correct solvents to prevent damage that can cause differences in pick-test oil transfer.

4.4.3 Thermometer, to read the ambient temperature near the printing device to the nearest 0,2 °C, with an accuracy of 0,1 °C.

4.4.4 A **ruler** with a minimum length of 200 mm, to measure the distance from the print starting point to the pick starting point, with an accuracy of 0,5 mm.

1) Accessories including a Pick-Start Viewer and pick-test oils can be obtained from IGT, P.O. box 12588, 1100 AR Amsterdam, The Netherlands (www.igt.nl). This information is given for the convenience of the users of this document and does not constitute an endorsement by ISO of the products from IGT. Equivalent products may be used if they can be shown to lead to the same results.

5 Sampling, conditioning and sample preparation

5.1 Sampling

If the mean quality of a lot is to be determined, sampling shall be in accordance with ISO 186. If the tests are made on another type of sample, report the source of the sample and, if possible, the sampling procedure used. Make sure that the test pieces taken are representative of the sample.

5.2 Conditioning

Condition the paper and pick-test oil in accordance with the standard conditions of ISO 187 (23 ± 1) °C and a relative humidity of (50 ± 2) %, and keep the paper, pick-test oil, inking device and printing device under the same atmospheric conditions throughout the test.

5.3 Sample preparation

From each sample, cut an amount that is sufficient for at least five test pieces per side and per test direction to be tested. The preferred size is 55 mm × 340 mm, or as otherwise indicated by the instrument maker, free from watermarks, creases, wrinkles, etc. Handle the pieces only by the edges so that the surface is not contaminated with fingerprints. Mark the pieces by top, bottom, both cross-directions, machine direction (MD) and counter-MD.

If testing is limited to one side and/or one direction only, select the side and direction based on the end use of the paper or paperboard. Paperboard is usually tested only on the printing side and across the machine direction. If the top/bottom or machine/cross-direction cannot be determined, test both sides and all four directions.

A minimum width of at least 20 mm is required for each test piece. Test pieces shorter than 320 mm can be mounted onto the packing with adhesive tape.

6 Procedure

6.1 Preparation and adjustment of apparatus

6.1.1 Selection of pick-test oil and end-velocity

The choice of pick-test oil and the choice of maximum print end-velocity depend on the surface strength of the test piece.

To determine which pick-test oil and which end-velocity are most suitable, choose a combination of pick-test oil and end-velocity and make preliminary tests as described in 6.2.

If pick or delamination occurs within 50 mm of the start or close to the end of the print, the test shall be repeated at a lower or higher end-velocity, respectively. If the lowest end-velocity is already being used, change to a pick-test oil of lower viscosity. If the highest end-velocity is already being used, change to a pick-test oil of higher viscosity.

6.1.2 Ink pipette (if applicable)

Fill the ink pipette with about 2 ml of the required pick-test oil. Check that no air is included by watching whether, after filling, closing and zeroing, pick-test oil comes out of the nozzle. If this occurs, clean the pipette and refill.

6.1.3 Preparation of inking device

Apply an 8 μm film of pick-test oil to the inking device. Calculate the required volume, V_a, of pick-test oil to be applied for the 8 μm film thickness from the total surface area, A, of the inking rollers from

$$V_a = A \times 8 \tag{3}$$

or consult the documentation supplied with the inking device.

Allow the pick-test oil to distribute on the inking device for a sufficient time, following the instructions of the manufacturer.

The number of tests which can be made without adding pick-test oil depends on the type of inking device and on the method of distribution applied and should be stated in the documentation with the inking device.

The pick-test oils do not contain solvents and do not evaporate at the temperatures relevant for the scope of this International Standard. However, the use of high speeds for the distribution should be limited to the initial phase of distribution because of the risk of misting. For this reason, the pick-test oil should not be left for more than 1 h on a running inking unit, as the amount of pick-test oil in the system will then decrease and the layer thickness can no longer be guaranteed.

If the inking device lacks temperature control, it is very important for the accuracy and repeatability of the test to distribute the pick-test oil for a time sufficient for it to reach temperature equilibrium on the inking device.

6.1.4 Preparation of the printing device

Some of the steps in this clause are not applicable to all instruments, since the degree of automation of the testers varies. For details of the operation of the tester, consult the manual for the instrument or the manufacturer.

a) Mount a packing (see 4.2.2) on the sector (see 4.2.1). Stretch the packing sufficiently by hand or use a torque wrench to stretch it until a moment of 0,4 Nm is reached.

b) If necessary, place a test piece on the packing, and set the gap between the printing disc and the test piece on the sector to 1 mm (especially important if paperboard is tested).

c) Set the printing force to 350 N.

d) Set the instrument to the increasing velocity mode.

e) Set and record the end-velocity v_e (m/s).

f) Record the ambient temperature, T_a, to the nearest 0,2 °C in the direct vicinity of the printing device.

6.2 Testing of test strips

Carry out the test five times per side and direction.

a) Place the printing disc(s) on the inking device; allow the pick-test oil to transfer to the printing disc(s) for the time recommended for the inking device used.

b) Mount a test piece on the sector.

c) Remove the printing disc from the inking device and place it on the (top) printing-disc shaft.

d) Start the sector and make a test.

e) Remove the test piece from the sector and assess the result immediately.

6.3 Assessment of results

6.3.1 Assessment of the result on paper

a) Place the test piece under the opening of the pick-start viewer.

b) Using the viewer, study the test piece, mark the point where pick begins and record the type of pick. Reference can be made to Annex C: Appearance of pick.

Especially in coated papers and paperboards, initial minor deformation or delamination may occur in the test piece, followed by loosened coating particles or fibres, before the actual overall damaging of the paper surface takes place. Ignore such minor damage.

6.3.2 Assessment of the result on board

a) Place the test piece with its “unprinted” side against the inside of the test piece holder so that the long side of the piece forms a semicircle.

b) Determine and mark the position where the liner lifting becomes continuous (ignoring previous isolated areas lifted at lower velocities).

c) Remove the test piece and place it under the opening of the pick-start viewer.

d) Using the viewer, study the test piece and mark the point where pick begins.

6.4 Completion of the test

a) After each test, remove the printing disc from the printing device and clean it with the cleaning solvent and rags. Dry the surface or give the solvent sufficient time to evaporate.

NOTE Evaporation draws most of the required energy from the printing disc, so that an excess of solvent may cause the disc to cool down so much that it needs to be given time to reach temperature equilibrium again.

b) Repeat steps 6.2 and 6.3 for each test piece. Repeat the test until five valid results have been obtained on each side and in each direction to be tested.

c) As soon as the test series is complete, record the ambient temperature, T_b to the nearest 0,2 °C. Clean the inking device, the top-roller(s), the printing discs and the ink pipette thoroughly with cleaning solvent and rags, as specified by the manufacturer.

Evaporation of the solvents will draw most of the energy from the drums of the inking device. If the device lacks temperature control, allow sufficient time for the device to reach temperature equilibrium before starting a new test. Give the system sufficient time to dry before starting another test. Make certain that the rubber roller(s) of the inking device are not in contact with any other surface.

7 Expression of results

7.1 On each test piece, measure, to the nearest millimetre, the distance from the starting point of the print (the middle of the initial print contact region) to the point where pick begins.

7.2 Calculate the pick velocity, ν_p, in metres per second (m/s), according to:

$$\nu_p = 0{,}005 \times \nu_e \times d_p \qquad (4)$$

Or the delamination velocity, ν_d, in metres per second (m/s), according to:

$$\nu_d = 0{,}005 \times \nu_e \times d_d \quad (5)$$

where

0,005 is a constant, in millimetres^{-1}, 1/200 of the total print length of 200 mm;

ν_e is the set end-velocity, in metres per second (m/s);

d_p is the pick distance, in millimetres (mm);

d_d is the delamination distance, in millimetres (mm).

The use of the velocity table supplied with the instrument is not in accordance with this International Standard, since some of those supplied with older instruments are known to be in error.

7.3 Calculate the mean pick velocity $\bar{\nu}_p$ and its standard deviation $\sigma(\nu_p)$ and/or the mean delamination velocity, $\bar{\nu}_d$, and its standard deviation $\sigma(\nu_d)$ for each side and for each direction.

7.4 Note and record the appearance of the surface at the pick-start point (delamination, blistering, etc.).

7.5 Calculate the mean temperature T during the test series from the initial temperature T_a and the final temperature T_b during the test according to:

$$T = \frac{|T_a - T_b|}{2} \quad (6)$$

7.6 Obtain the viscosity V_T of the pick-test oil at temperature T from Table 1.

Table 1 — Viscosity vs. temperature of pick-test oils of low, medium and high viscosity

Oil type	Viscosity* V_T in pascal seconds (Pa·s) for different temperatures										
	Temperature (°C)										
	22,0	22,2	22,4	22,6	22,8	**23,0**	23,2	23,4	23,6	23,8	24,0
Low viscosity pick-test oil	19,2	18,9	18,5	18,2	17,8	**17,5**	17,2	16,9	16,6	16,3	16,0
Medium viscosity pick-test oil	57,4	56,3	55,2	54,2	53,1	**52,0**	51,2	50,4	49,6	48,8	48,0
High viscosity pick-test oil	121,7	119,4	117,0	114,7	112,3	**110,0**	108,2	106,4	104,6	102,8	101,0
* These viscosities were measured on a Laray viscometer.											

NOTE Table 1 is given for reference to recalculate the pick velocity to the normalised temperature of 23 °C; it cannot be used for the production of pick-test oils or for checking the viscosity.

7.7 Calculate the pick resistance or delamination resistance at 23 °C.

$$P(23) = \bar{\nu}_p \times \frac{V_T}{V_{23}} \quad (7)$$

$$D(23) = \bar{\nu}_d \times \frac{V_T}{V_{23}} \quad (8)$$

where

$P(23)$ is the pick resistance at 23 °C, in metres per second (m/s);

$D(23)$ is the delamination resistance at 23 °C, in metres per second (m/s);

V_T is the viscosity of the pick-test oil used at average temperature T during the test, as derived from Table 1, in pascal seconds (Pa·s);

V_{23} is the viscosity of the pick-test oil at 23 °C, as derived from Table 1, in pascal seconds (Pa·s);

$\bar{\nu}_p$ is the mean velocity at the point where pick begins, in metres per second (m/s);

$\bar{\nu}_d$ is the mean velocity at the point where delamination begins, in metres per second (m/s).

8 Precision

Tests were executed in Europe by a total of 12 qualified laboratories on test samples distributed every 6 months by CEPI Comparative Testing Service. All laboratories use an IGT AIC2-5 or an older version of this tester. The number of tests in the period 1999-2003 was 64 for the Ka paper and 61 for the P paper.

The Ka paper is a 150 g/m^2 Art paper, the P paper is a 60 g/m^2 gravure paper, and both are coated.

For the delamination, no round-robin results are yet available.

Table 2 — Repeatability and reproducibility

	Average $P(23)$ within laboratory m/s	**Standard deviation $P(23)$ within laboratory** m/s	**Average $P(23)$ between laboratories** m/s	**Standard deviation $P(23)$ between laboratories** m/s
Paper P	0,37	0,04	0,37	0,06
Paper Ka	1,46	0,17	1,46	0,21

9 Test report

The test report shall contain at least the following information:

a) the date of the test;

b) a reference to this International Standard;

c) any deviation from the test method specified;

d) all details necessary to identify the product tested;

e) the side and the direction of the test pieces tested;

f) type and brand of tester;

g) the pick-test oil used: low, medium or high viscosity;

h) the end-velocity ν_e used, in metres per second (m/s);

i) the results of the test, as indicated in Clause 7, for paper $\bar{\nu}_p$, $\sigma(\nu_p)$ and $P(23)$; for board $\bar{\nu}_p$, $\sigma(\nu_p)$, $P(23)$, $\bar{\nu}_d$, $\sigma(\nu_d)$ and $D(23)$;

j) type of pick observed;

k) the mean ambient temperature T during the test.

Annex A
(informative)

Checking the printing device and the inking device

A.1 General

Calibration of the printing device is very important for obtaining correct, reliable and repeatable results. For details on calibration, consult the supplier and the documentation supplied with the instrument. The items below are not meant as a guide to calibration, but to give some information for consideration.

A.2 Calibration of force of the printing device

For a consistent result, the following shall be taken into account.

— The printing force shall always be measured in a static situation. Never run the tester with the force-calibration set mounted!

— Do not use a packing, since deformation of the packing will influence the result.

— Make sure that the contact line of the force is on the straight line between the centre of the sector and the centre of the printing shaft. Any deflection will influence the result dramatically.

— On instruments with backlash compensation, set the backlash so that there is a 1 mm gap between the force-measuring device and the sector when the printing shaft is in the lifted position. This is not the position to make a print!

— If an original IGT Printing Force Meter is used, check whether the protective spring blade is in place. Without this protection, a dent will be caused in the sector.

A.3 Calibration of velocity of the printing device

The best method is to measure the velocity on the circumference of the sector with its packing.

— Use a measuring device with sufficient resolution: at least three measurements between 100 mm and 200 mm, and at least ten measurements between 0 mm and 100 mm.

— Use a paper packing.

— Use an aluminium printing disc at 350 N during calibration.

A.4 Checking the inking device

Most inking devices need no calibration. The following shall be considered.

— If a temperature-controlled inking device is used, the thermostat shall be calibrated regularly.

— Check that all accessories are mounted properly. The inking tables for equipment with extra distribution devices assume that the extra distribution device is mounted.

— Check that the top-roller touches the metal drums evenly over the full width.

— Check that the oscillating rollers move smoothly.