

Assessment of Printed Product Recyclability

Deinkability Score

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1. Introduction

Deinking, the removal of printing inks, is a major step in the recycling process of printed graphic products to produce a bright pulp suitable for a wide range of recycled paper and board.

For an efficient functioning of the circular economy it is valuable that products can be recycled to similar quality levels as the original products. It is therefore desirable that printed products are deinkable. If they are not deinkable according to the thresholds set by this scorecard, they can still be recycled and the fibres used for other grades of paper and board.

The deinkability of a printed product as a whole can only be assessed by looking at its Deinkability Score, which can range from -100 to +100. For individual products this is done by using the rating of the test results given in this specification or by comparing the Deinkability Scores of several printed products.

If a more thorough technical/scientific evaluation has to be made, the individual scores or the measured values of the deinkability parameters can be used.

Ecolabels for printed matter at European and National level require a positive deinkability result. In many cases, this can be achieved by choosing the proper printing technology and material combination. For these cases, exemptions for deinkability tests are defined in an annex to this scorecard. The annex is subject to review and revision according to new knowledge gained.

2. Scope

This document of the European Paper Recycling Council provides an assessment of the deinkability of a printed product by evaluating results of a laboratory scale test procedure for deinkability. It is applicable to all kinds of printed graphic products on white paper.

3. Principle

Results of deinkability tests achieved by means of INGEDE Method 11 are converted into Deinkability Scores. For each of the five parameters – luminosity, colour, cleanliness, ink elimination and filtrate darkening – threshold and target values are defined. Cleanliness is measured as dirt speck area in two particle size classes. The threshold and target values depend on the category of the printed product. If the result meets the target value or is better, it scores the maximum points allocated to this parameter. The maximum points achievable for each parameter are different thus indicating the importance of each individual parameter. A score below 0 in one or more parameters leads to the overall assessment “not suitable for deinking”.

4. Determination of the Deinkability Score

In this chapter, particularly in the tables, abbreviations for the assessment parameters are used:

Y: Luminosity

a*: Colour a* (green – red) of the CIELAB system

A: Dirt particle area

- A_{50} :** Dirt particle area for particles larger than 50 µm (circle equivalent diameter)
 A_{250} : Dirt particle area for particles larger than 250 µm (circle equivalent diameter)
IE: Ink elimination
 ΔY : Filtrate darkening

Rounding of the parameters: Y, IE and ΔY to whole numbers, a^* to one decimal and A to one decade. The individual scores of each parameter are rounded to whole numbers as well. Method: financial rounding.

4.1 Source of the deinkability results

The results of deinkability tests have to be obtained according to INGEDE Method 11. The fibre yield of the laboratory flotation, determined as yield of organic components, should be at least 65%. If that value is not reached, the test has to be repeated with reduced flotation time. For the determination

of IE the parameter R_{700} has to be used with the term $\left(\frac{(1 - R_{\infty,unpr})^2}{R_{\infty,unpr}} \right)$ set to 0. For the image analysis, DOMAS or Simpalab are allowed.

4.2 Weighting of the parameters

The assessment of deinkability consists of five parameters. Three of those – luminosity, colour and cleanliness – refer to the quality of the deinked pulp, the other two – ink elimination and filtrate darkening – are process parameters. The quality parameters have a higher maximum score than the process parameters, which serve as auxiliary parameters for the assessment. The split of the evaluation of cleanliness in two size ranges of the dirt speck area gives a total of six single scores.

Parameter	Y	a^*	A_{50}	A_{250}	IE	ΔY	Total
Maximum Score	35	20	15	10	10	10	100

Table 1: Maximum score for each parameter

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4.3 Threshold values

For a good deinkability, the values for Y and IE have to be high, the values for A and ΔY have to be low. The parameters with a desired high value have a lower threshold, the parameters with a desired low value an upper threshold. The a^* value has both thresholds because the result should be within a target corridor. Falling below a lower threshold, exceeding an upper threshold, as well as falling out of a threshold corridor, results in a negative score for this parameter.

The thresholds are not comparable to the actual industrial quality requirements; they are by far less challenging due to a wide safety margin. This is because INGEDE Method 11 is not a complete simulation of the industrial deinking process; the assessment is to determine the relative challenge a printed product means for a flotation deinking plant. This margin also takes variations in the test procedure into account.

Printed products in the category “Low ink coverage products (Brightness of base paper > 75%)” are typically produced using woodfree uncoated or coated papers. They usually end in grades of paper for recycling of groups 2 and 3 – medium and higher grades – according to EN 643. These grades are used by mills producing deinked pulp with high optical quality requirements. Products in the categories “Newspapers”, “Magazines, uncoated”, “Magazines, coated” and “Low ink coverage

products (Brightness of base paper $\leq 75\%$)” are typically produced using mechanical pulp-based or recycled papers. After use, these products predominantly end in grades of paper for recycling which are used in deinking plants with lower optical quality requirements. Therefore it is possible to have the same threshold in these four categories but necessary to adapt the thresholds for the high quality requirements.

Parameter	Y [%]	a* [-]	A ₅₀ [mm ² /m ²]	A ₂₅₀ [mm ² /m ²]	IE [%]	ΔY [Points]
Lower Threshold	47	-3,0			40	
Upper Threshold		2,0	2.000	600		18

Table 2: Threshold values for “Newspapers”, “Magazines, uncoated”, “Magazines, coated” and “Low ink coverage products (Brightness of base paper $\leq 75\%$)”

Parameter	Y [%]	a* [-]	A ₅₀ [mm ² /m ²]	A ₂₅₀ [mm ² /m ²]	IE [%]	ΔY [-]
Lower Threshold	67	-3,0			40	
Upper Threshold		2,0	2.000	600		18

Table 3: Threshold values for “Low ink coverage products (Brightness of base paper $> 75\%$)”

4.4 Target values

Each parameter has a target value depending on the product category.

Category of print product	Y [%]	a* [-]	A ₅₀ [mm ² /m ²]	A ₂₅₀ [mm ² /m ²]	IE [%]	ΔY [-]
Newspapers	≥ 60	$\geq -2,0$ to $\leq +1,0$	≤ 600	≤ 180	≥ 70	≤ 6
Magazines, uncoated	≥ 65				≥ 70	
Magazines, coated	≥ 75				≥ 75	
Low ink coverage products (Brightness of base paper $\leq 75\%$)	≥ 70				≥ 70	
Low ink coverage products (Brightness of base paper $> 75\%$)	≥ 80				≥ 75	

Table 4: Target values

Note: Brightness measurement is done according to ISO – R₄₅₇ (without UV).

Definitions and examples for the product categories:

Newspapers:

Newspapers: Written publication containing news, information and advertising, usually printed on low-cost paper called newsprint paper

Inserts, flyers & brochures – with an ash content of less than 22%

Directories: Telephone books and similar types of printed products

Magazines:

This category comprises a variety of printed products. They are distinguished into two sub-categories, depending on whether the base paper is uncoated or coated

Magazines: Illustrated publications which are generally published on a regular schedule, containing a variety of articles, generally financed by advertising, by a purchase price, by pre-paid subscriptions, or all three

Inserts, flyers & brochures – all coated ones; if uncoated, with an ash content of 22% or higher

Catalogue: Publication containing a list of merchandise from a company, often in a similar fashion as any magazine

Books with high ink coverage

Low ink coverage products:

Products which are typically printed on high-grade paper and/or with significantly lower ink coverage than magazines

This category includes text-only prints, transactional and transpromotional prints, formal or personal correspondence, one-side printed products, low ink coverage books and the like

In case of doubt whether a printed product is a Low ink coverage product, the determination can be made by measuring the grey scale value, if necessary as an average of several pages which should be representative for the printed product. If the grey scale value is above 200 (on a scale of 0 to 255), the product is regarded as Low ink coverage product. Procedure: A print sample is scanned by the scanner used for dirt specks with the equipment's scan software. For the scan 24 bit and 600 dpi (all other settings: standard settings) will be used and the file is saved in jpeg format. The median grey value of the complete scan (sample with paper margin but no scanner header) is measured (e. g. with the freeware "imagej"). Calculation of the grey scale value is done by an arithmetic average of the RGB values.

4.5 Determination of the Deinkability Score

It is recommended to use spreadsheet software to calculate the score. The INGEDE Office can provide the formulae in Microsoft Excel® format.

4.5.1 Calculation of the score per parameter

Results of the individual parameters, which meet or exceed the target values, receive the maximum scores for these parameters (according to Table 1). “*Exceeding the target values*” means:

- In case of Y and IE: higher than the target value
- In case of A and ΔY : lower than the target value
- In case of a^* : between higher and lower target value

If this is not the case, the score has to be calculated. For each individual parameter, the ratio of units better than the threshold value, divided by the range between threshold and target values, multiplied by the maximum score for this parameter, gives the Deinkability Score for this parameter. All individual scores are rounded to whole numbers by financial rounding.

Calculation for one individual parameter:

$$DS_P = \frac{(R_P - TH_P)}{(T_P - TH_P)} \cdot MS_P$$

Where

The index letter P stands for one of the six parameters Y, a^* , A_{50} , A_{250} , IE and ΔY

DS_P is the Deinkability Score of the parameter P

R_P is the result of the parameter P

TH_P is the threshold value of the parameter P (according to Table 2 or Table 3)

T_P is the target value of the parameter P (according to Table 4)

MS_P is the maximum score of the parameter P (according to Table 1)

Example: Deinkability Score DSY for the luminosity of DP from newspapers

Luminosity Y of D_P : 55

Threshold TH_Y : 47

Target T_Y : 60

Maximum score MS_Y : 35

$$DS_Y = \frac{(55 - 47)}{(60 - 47)} \cdot 35 = 22$$

The DS is limited to the maximum score MS for each individual parameter, even if the calculation gives a higher result. In that case it is not possible to compensate a weak deinkability in one parameter with a very good deinkability in another parameter.

If the result is worse than the threshold, the score is negative for this parameter. In that case the absolute number is limited to the same value as the maximum score for this parameter.

If the value for a^* is above the higher target value, the upper thresholds and targets have to be used in the formula – and vice versa if it is below the lower target value.

4.5.2 Calculation of the Deinkability Score

For a complete evaluation of deinkability, the six individual scores are added. If one or more of them are negative, the assessment of the printed product is “not suitable for deinking”. However, the product may be well recyclable for a process without deinking.

If a product is assessed as “not suitable for deinking” due to negative scores of one or more parameters, the scores of the parameters with positive results are not displayed.

Note (Ink Elimination):

In case of low ink coverage products the determination of the Ink Elimination (IE) can become inaccurate. If IE is the only parameter which causes a printed product to fail, the ink coverage should be artificially increased and the test repeated. Increased ink coverage with analogue prints can be achieved by cutting unprinted portions off from the test samples. In case of digital printers a print pattern with higher ink coverage should be chosen. In rare cases in which the ink coverage cannot be increased, e. g. on note pads with ruling only, the assessment should be done with the help of the other parameters. In these cases, the score for IE will be set to 10 points.

Parameter	Y (%)	a* (-)	A ₅₀ (mm ² /m ²)	A ₂₅₀ (mm ² /m ²)	IE [%]	ΔY (-)	Deinkability Score / Assessment
Threshold	47	-3 / +2	2.000	600	40	18	
Target	60	-2 / +1	600	180	70	6	
Maximum score	35	20	15	10	10	10	
SAMPLE A							
Result	55	-2,5	450	220	60	8	good
Score	22	10	15	9	7	8	71
SAMPLE B							
Result	45	-2,0	200	120	32	12	not suitable for deinking
Score	-5	20	15	10	-3	5	-8
SAMPLE C							
Result	60	-1,6	150	90	75	5	good
Score	35	20	15	10	10	10	100

Table 5: Examples (Newspapers)

5. Rating of the results

In order to give the user an idea of the relevance of the Deinkability Scores, they should be assessed according to the following table:

Score	Evaluation of deinkability
71 to 100 Points	Good
51 to 70 Points	Fair
0 to 50 Points	Tolerable
negative (failed to meet at least one threshold)	Not suitable for deinking (may be recyclable without deinking)

Table 6: Rating of the Deinkability Scores

Experience has shown that in cases of “tolerable” deinkability the results of the individual parameters often range from weak to good. If the most critical parameter is just slightly better than the threshold, the scores of the other parameters usually result in a sum of about 50 points. A Deinkability Score of up to 50 points is therefore regarded as “tolerable”.

In charts, coloured backgrounds as in the table above should be used whenever possible. In order to reflect the assessment above, the colours should be set as follows:

- Below 0 points: red
- 0 to 40 points: orange
- 40 to 50 points: transition orange to yellow
- 50 to 70 points: yellow
- 70 to 80 points: transition yellow to green
- 80 to 100 points: green

6. Generic testing

Typically for the assessment of print product recyclability in the case of the EU Ecolabel licencing and similar (including R&D purposes), it is not always possible or appropriate to provide a genuine print product for testing. A generic test can therefore be performed on reference products¹. Results of the assessment for the reference product will be valid for all related print products bearing the same features as the tested reference product, i.e. the same technical data and material combination with the same or lower ink coverage (for each ink). The related printed products will therefore not require further laboratory deinking test procedures.

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For the use of the tested printed product as a dummy, all certificates will state the following:
“These test scores are also valid for printed products with the same or lower ink and varnish coverage.”

Generic tests can be performed on combinations of inks and types of paper, allowing printers to select pre-tested combinations suitable for deinking according to the EPRC scorecard.

7. Exemptions to the deinkability test

Many printed products are deinkable and will pass the deinkability test. The criteria for which printed products can be exempted from testing are defined in the annex of this document. This annex is subject to review and revision according to new knowledge gained.

8. Report

The report should contain detailed data of the printed product, the printing process and the deinking test:

- Identification of the printed product as to name, publishing company, date of issue, product category, print process and paper quality.
- Printing parameters and press settings.
- Name and exact identification of inks or toner.
- Results of the deinking test according to INGEDE Method 11.
- The laboratory equipment used for the deinking test and deviations from INGEDE Method 11, if any.

¹ European Commission’s Ecolabel User’s Manual for the application for printed paper of March 2013 refers to a “reference case, which will allow to submit further orders under the limit set by the reference case”.

- Deinkability Scores for every parameter and total (total only if all six individual scores are 0 or higher). The results can be provided either numerically or as graphics. For a graphic presentation column stacked charts are recommended. If at least one element of the stacked columns points to the negative side, this product is rated “not suitable for deinking”, even if the other elements are positive. In order to avoid confusion, in case of “not suitable for deinking”, only the negative columns are displayed in charts.
- Assessment of the deinkability according to Table 6.
- Optional but desired: Any interpretation of the result which is possible with the help of the technical data.

9. References

- EN 643 – European list of standard grades of paper and board for recycling
- INGEDE Method 11 - Assessment of Print Product Recyclability – Deinkability Test

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ANNEX: Exemptions to the deinkability test

The majority of printed products are deinkable and will pass the deinkability test. For some printing technologies and material combinations there is sufficient experience and confidence that they will deliver good deinkability results and will be exempted from testing. This annex lists these exemptions. If a printing technology or a material combination is not listed in this annex, it does not allow any conclusion about its deinkability behaviour but can mean that more experience needs to be gathered to be exempted. A qualification for exemption is reached if at least 20 deinkability test results of this printing technology and material combination are available with 95% positive results and 90% uncritical results.

Print products containing any parts where inks or varnishes are cured with radiation technologies, e. g. UV, are not exempted from the laboratory deinking test procedure.

The following printed products are exempted from the laboratory deinking test procedure and will be considered as suitable for deinking according to this EPRC scorecard:

- Graphic products printed in heatset offset presses on coated paper, provided that the ink composition is according to the following specification:

Pigments	10–25%
Rosin-based resins and hydrocarbon resins	20–48%
High boiling mineral oils (boiling range 250–310 °C)	25–45%
Oxidative drying oils (e. g. vegetable and modified vegetable oils)	< 10%
Additives	1–12%

- Graphic products printed in rotogravure presses on coated paper provided that no soluble dyes were added to the ink and its composition is according to the following specification:

Pigments	5–10%
Rosin-based resins and hydrocarbon resins	15–30%
Toluene	30–70%
Additives	3–5%

- Graphic products printed in rotogravure presses on uncoated paper provided that no soluble dyes were added to the ink and its composition is according to the following specification:

Pigments	5–10%
Rosin-based resins and hydrocarbon resins	15–30%
Toluene	30–70%
Additives	3–5%

For the time being, only print products which are solely produced with one or more of the listed printing technologies and material combinations are exempted from the test procedure. Minor additions of other print products, e. g. reply card(s) in a magazine, are allowed. In order to exempt also print products with covers in a different printing or finishing technology, more test results and technical data are needed.

The annex will be reviewed annually by the European Recovered Paper Council, starting in spring 2018. Should there be evidence that an exemption is no longer justified or that a new exemption is eligible to be added to the annex, the European Paper Recycling Council can decide to revise the annex at any time.

SIGNATORIES

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