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Graphic technology and deinked pulp — Guidance for assessing the deinking performance of printed paper products

Technologie graphique et pâte désencrée — Lignes directrices pour l'évaluation de la performance de désencrage des produits en papier imprimé

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, and ISO/TC 130, *Graphic Technology*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Printed graphic paper products play a key role in society. They are conveyers of information through newspapers and magazines and of culture through books. They therefore contribute to promote democratic debate and culture but also education and social inclusion.

Paper products are good examples for the circular economy since they are recycled after use already to a high extent, higher than any other post-consumer material. The recycling of paper products is beneficial because it allows the fibre to be used several times. However, a good balance between virgin and recycled fibres is necessary to compensate for losses of material within the paper loop and to avoid any forest depletion.

Within the paper value chain there are two main material loops – graphic products and packaging products. Optimum circularity is given if graphic paper products can be kept within the graphic loop. This document describes the common recycling processes for graphic paper for recycling and addresses the influencing factors from the product design. Further influencing factors – which are out of this document's scope – are collection and handling of used paper products.

Common recycling processes for graphic paper for recycling include deinking, the removal of ink from the pulp. The majority of paper for recycling that are deinked originates from households and is therefore a blend of various print products made with different printing and finishing technologies as well as a variety of paper types. The common deinking processes therefore have to be capable to treat this blend of paper products for producing quality pulp in an ecological and economical way.

This document mainly addresses stakeholders in the value chain of printing in order to make them aware about the life of their products after intended use and how they can contribute to the functioning of the cycle.

Graphic technology and deinked pulp — Guidance for assessing the deinking performance of printed paper products

1 Scope

This document provides guidance for representatives of the paper value chain for the design of printed paper products, with a view to deinkability contributing to recyclability in support of the circular economy.

It describes relevant deinking processes, and the deinking performance of printed paper products produced with different printing, finishing and converting technologies in those deinking processes.

It provides a list of relevant quality characteristics of industrial deinked pulps and a list of their possible usages based on those characteristics.

This document does not include guidance for paper-based products which are not intended to be deinked.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Terms related to material

3.1.1
recycled paper
paper incorporating fibres obtained from paper recovered after use

[SOURCE: ISO 5127, 3.3.5.2.10]

3.1.2
pulp
fibrous material, generally of vegetable origin, made ready for use in further manufacturing processes

[SOURCE: ISO 4046-2, 2.46]

3.1.3
deinked pulp
DIP
pulp (3.1.2) made from paper and board for recycling from which inks and other contaminants have been removed

3.1.4
printing ink
substance containing pigment(s) and/or dye(s), and carrier fluid(s)

Note 1 to entry: most inks contain additional functional components, such as resins(s), surfactants, stabilizers, etc., which can impact the deinkability and recyclability of the printed paper.

[SOURCE: ISO 16759, 3.6.3]

3.1.5
substrate
material, such as paper or board, onto which inks, coatings and varnishes are printed or laid down

3.2 Terms relating to paper recycling and deinking

3.2.1
recycling
process of converting used paper products, returns or residuals of finishing and converting operations into new paper or board

3.2.2
deinking
process of ink removal from *pulp* (3.1.2) during the *recycling* (3.2.1) process

3.3 Terms relating to quality requirements

3.3.1
dirt
any non-fibrous particle visible on a sheet in marked contrast or colour to the rest of the sheet

[SOURCE: ISO 4046-2 2.24 modified]

3.3.2
Fluorescent Whitening Agents
FWA
chemical compounds that absorb light in the UV and violet regions of the electromagnetic spectrum and reemit at different wavelength in the visible spectrum

Note 1 to entry: Fluorescent Whitening Agents are also sometimes referred to as Optical Brightening Agents (OBA).

3.3.3
A_{50}
dirt (3.3.1) particle area, expressed in mm^2/m^2, for particles with a size of at least 50 µm circle equivalent diameter and accordingly an area of at least 0,002 0 mm^2

3.3.4
A_{250}
dirt (3.3.1) particle area, expressed in mm^2/m^2, for particles with a size of at least 250 µm circle equivalent diameter and accordingly an area of at least 0,049 1 mm^2

3.3.5
CIELAB colour space and CIELAB values
three-dimensional, approximately uniform colour space, produced by plotting, in rectangular coordinates L*, a*, b*

Note 1 to entry: The quantity L* is a measure of the lightness, where L* = 0 corresponds to black and L* = 100 corresponds to the perfect reflecting diffuser. Visually, the quantities a* and b* represent respectively the red-green and yellow-blue axes in colour space, such that:

— +a* is a measure of the degree of redness;

— −a* is a measure of the degree of greenness;

— +b* is a measure of the degree of yellowness;

— −b* is a measure of the degree of blueness.

If both a* and b* are equal to zero, the test piece is grey.

[SOURCE: ISO 5631-2, 3.6 modified, ISO 15397, 3.17]

3.3.6
brightness (ISO Brightness and D 65 Brightness)
***R*457**
intrinsic diffuse radiance [reflectance] factor measured with a reflectometer having the characteristics described in ISO 2469, equipped with a filter or corresponding function having an effective wavelength of 457 nm and a half bandwidth of 44 nm, and adjusted so that the UV content of the irradiation incident upon the test piece corresponds to that of the CIE illuminant C/2° according to ISO 2470-1 (ISO Brightness, indoor conditions) or that of the CIE illuminant D65/10° according to ISO 2470-2 (D 65 Brightness, outdoor conditions)

Note 1 to entry: Brightness is subject to the intrinsic radiance reflectance factor as measured with a reflectometer and subject to the illumination source.

3.3.7
fibre yield
ratio of the oven-dry mass of organic material after flotation to the oven-dry mass of organic material before flotation

Note 1 to entry: Organic material is the total material, reduced by the oven-dry mass of its ash.

Note 2 to entry: The organic material mainly consists of cellulosic fibers and fines.

[SOURCE: ISO 21993:2020, 3.5]

3.3.8
ash content
ratio of the mass of the residue remaining after a test specimen of paper, board, pulp or cellulose nanomaterial is ignited at (525 ± 25) °C to the oven-dry mass of the test specimen before ignition

Note 1 to entry: This property has been referred to as either “residue on ignition” or “ash content”.

[SOURCE: ISO 1762, 3.1]

4 How deinkability contributes to recyclability in support of the circular economy

4.1 What is circular economy? The importance of recyclability

The concept of the circular economy comes from the idea that waste, once adequately treated, can become a resource again, thereby forming a loop in the production-consumption chain. The concept of the circular economy is rooted in the observation of physical phenomena and natural cycles. A summary of circular economy is given in Reference [13] inspired from "nothing is lost, nothing is created, everything is transformed", a quote from Lavoisier.

Value of product, materials and resources is maintained in the economy as long as possible and generation of waste is minimized.

The contribution of circular economy to sustainable development is environmental, economic, and social[14]. The following seven issues[15] have been identified:

— Sustainable procurement: aimed at reducing the impact of the raw materials supply or replacing non-renewable raw materials by renewable ones (resources/procurement management, logistic management).

— Ecodesign: aimed at taking environmental impacts into account throughout a product life cycle and integrating them from the very first design stages, (e.g. creation of biodegradable supermarket bags for businesses; manufacturing of machines which are easily repairable and, at the end of their life cycle, recyclable or with a reduced environmental impact) (life cycle cost/analysis, environmental information, sustainable use of raw materials).

— Industrial symbiosis: establishing a method of industrial organization characterized by an improved management of stocks and flows of materials, energy and services within the same geographic area (environmental management, interaction between organizations, economic valorisation of territories).

— Economy of functionality: focusing on usage rather than ownership; selling services rather than goods (use of products, substitution good services, life extension of products).

— Sustainable consumption: collaborative/participative consumption, purchase/use goods and services, enlarged responsibility of consumers.

— Life use extension: reuse, repair, reuse of second hands products.

— Material management and end-of-life of product: waste, recycling, characterization, management, treatment, etc.

In the field of paper, the life cycle of a paper product is composed of a series of value-adding steps, from the extraction of material resources until the end of the paper product's life.

Detailed information is given in [14] and [16].

4.2 Specific recommendations for printing

a) Minimize the need to downcycle the paper.

b) Order paper with near net size.

c) Recycle trims/scraps and sort them by homogeneous grades to optimize recycling.

d) Adjust the number of copies to real needs. The required quantities should determine the choice of printing technology, not the opposite.

e) Adjust the paper's grammage to the product's objective.

f) Choose printing processes and materials that can be removed efficiently. Gravure printing and huge majority of offset prints are known as easily deinkable in industry. Other printing techniques need evaluation and the deinkability of these prints do depend of the raw materials used and equipments/facilities in the deinking and recycling operations.

g) Use ink with good deinkability performance which will allow recycling in graphic papers or tissue paper industry.

h) Use elements for binding that can be easily removed from paper pulp or if not, then without detrimental impact on pulp quality and waste water treatment.

i) Use inks with low migration for packaging and graphic paper.

j) Minimize the use of UV inks and UV varnishes.

4.3 Specifics recommendations for converting

a) Order paper with near net size.

b) Recycle mis- and overprints and sort them by homogeneous grades to optimize recycling[17].

c) Adjust paper and board weight or thickness with the packaging objectives.

d) Minimize adding non-paper material.

e) Added material should be easily separated from paper.

f) Use adhesives that can be easily removed from paper pulp or if not, then without detrimental impact on pulp quality and waste water treatment.

5 Relevant deinking processes

5.1 General

An industrial deinking process is regarded as relevant if it is widely used and documented.

The effectiveness of the deinking process depends on a number of factors, the most significant of which is whether the material to be recycled can be pre-sorted prior to deinking. One of the goals of the sorting process is to remove materials which may interfere with the recovery and fibre yield of clean cellulose fibres. However, pre-sorting constraints may discourage overall recycling of the broader waste stream by end consumers and in many parts of the world "zero sort" recycling is the norm. This is one reason why deinking processes need to be adapted or modified to reflect the composition of the local and/or regional recycling content.

Deinking is a three-step functional process. The steps are as follows:

— Detachment of inks from repulped substrate;

— Fragmentization of the particles into a suitable size range;

— Remove of pigment particles (predominantly by flotation) from the pulp slurry.

NOTE 1 In practice, a deinking plant is more complex, since it also deals with materials other than pigment-based inks which have to be removed or modified (screening of adhesives and decolouration of dyes).

NOTE 2 Industrial processes can be reproduced in pilot plants.

Production of printed paper products may intentionally add other components, besides ink and toner, such as cover foils, staples, varnishes and adhesives. To impede the deinking process as little as possible, the following characteristics are important:

i) Ink and toner particles should be removable.

ii) Other non-paper product components should be large enough and mechanically stable such that they survive as large particles without being broken down under process conditions into very small parts, and allow mechanical separation by means of punched screens, slot screens, and centrifugal cleaners.

iii) Materials applied in very small dimensions or disintegrated into very small parts are less desirable because they need to be removed by additional technologies e.g. washing which a) uses more water, and b) will also remove fines, fillers, starches, and other small particles along with toner etc.

NOTE 3 Particularly fines and fillers are substances which are intended to remain in the pulp in most cases.

Components in paper for recycling, which dissolve or become colloidal under standard deinking conditions (e.g., pH 7 - 10), and reach the process water, pose a risk of unintended spreading to all parts of papermaking processes or paper fibres. It is recommended that printed paper products contain as few components as possible that dissolve or disperse in weakly alkaline media and form sticky residues or cause undesirable colour staining.

5.2 Pulping

Pulping is always the first technological step in a paper recycling process. In a big vat pulper, equipped with a rotor, or in a rotating drum pulper, paper for recycling is mixed with water, chemicals and agitated, thus losing its structure and disintegrating into individual fibres.

During pulping, the printing ink film should detach from the paper surface – fibres or coating – and fragment into a size range suitable for separation in subsequent processes. The adhesion of printing ink to paper depends mainly on ink chemistry and on the drying and/or curing mechanism of the chosen printing process and additionally on paper properties such as surface structure, fibre type, filler contents, and so on.

Other additional factors can also impact detachments and fragmentation of ink particles such as aging of prints.

5.3 Flotation

Flotation, common to most deinking processes worldwide, is used to remove printing ink components from the pulp. Supported by surface-active substances, printing ink particles gather on the surface of air bubbles. This process works optimally with hydrophobic printing ink particles sized between 10 and 150 µm. Thus, the ink-loaded air-bubbles stream upwards through the pulp slurry.

At the surface of the pulp slurry, dark foam containing printing inks, fragments of paper fibres, fillers, and paper-coating pigments segregates. Particles smaller or bigger than the optimum particle size range are floated with lower efficiency.

In some case water-based printing inks are used (e.g. flexographic newspaper printing). These particles are hydrophilic, partially adsorbed on fibres and much too small for flotation. These inks may contain binders soluble in the alkaline range. Consequently, in deinking such inks break up into particles smaller than one micron in size. These particles are hydrophilic, partially adsorbed and much too small for flotation. The non-adsorbed inks can be partially removed by washing of the pulp. See 5.4.

Printing ink particles too large for the flotation process occur in cases of tenacious, crosslinked ink films in thick layers on paper. For example, this could be paper with UV inks. If such coarse printing ink particles are obtained, the paper mill needs a disperser for comminuting them and subjecting them to the flotation process. Since this second deinking loop has to treat the complete pulp, it makes the process more complex and expands the environmental footprint because it requires more energy, and decreases the fibre yield. One of the reasons is a higher security towards print products which are difficult to deink in a one-loop plant. Particularly if the quality requirements of the end product are high, even a two-loop plant cannot produce a high-quality pulp from raw material containing too many print products which are difficult to deink.

5.4 Washing

Wash deinking is a separation by particle size, retaining large particles, predominantly fibres, on a wire and washing small particles through the mesh. This process can remove small ink particles, but also mineral fillers and fines from the pulp. The low fibre yield of wash deinking is prohibitive for most operations. Therefore, deinking by washing is commonly used for the production of hygiene/tissue papers and market DIP where, for quality reasons, most of the minerals have to be removed.

5.5 Dispersing

Dispersing is a high-speed kneading of heated pulp. It does not belong to the key processes of deinking and is not a necessary process step if quality requirements for the deinked pulp are low and if all processed print products are easily de-inkable. Since this is not the case in most plants, operating dispersing stages became common. The shear forces in the disperser detach inks which hadn't been detached in the pulper and fragmentise those which were too large for efficient flotation. Deinking processes with dispersing need additional dewatering and thickening stages as well as heating. In order to remove the newly detached and fragmentised ink particles, dispersing shall be followed by an additional flotation stage.

5.6 Bleaching

Bleaching is common for the production of higher quality grades where it is necessary to achieve higher brightness from a given raw material. Equipment for either oxidative and/or reductive bleaching is not the same. Bleaching is an optional step not found in all deinking plants.

6 Deinking performance

6.1 Principles for assessment of deinking performance of printed products

To support the circular economy, print products should be capable of being recycled and deinked to produce a paper on a similar quality level as their substrate.

When a print product is produced, its fate after its use cannot be predicted normally. In nearly all cases, industrial deinking operations use a blend of various printed products and the deinked pulp quality normally does not allow an allocation to an individual print product. Therefore, the deinkability assessment shall be done by laboratory or pilot plant tests. Laboratory tests are usually simplified versions of the process, whereas the significantly more extensive pilot plant tests can provide a simulation of the industrial process.

The measurements performed on the deinked printed material after laboratory or pilot deinking tests should be capable of providing data for the application of this document. In particular, they should align with anticipated quality parameters of the deinked material.

A suitable deinkability test method should be accepted as relevant by the deinking industry and at least give the brightness, colour and cleanliness of the deinked pulp as well as data on fibre yield of the process. Print products ideally should be capable of being recycled and deinked to produce a paper on a similar quality level as their substrate. An assessment, consisting of a suitable laboratory method and target values, should be chosen to give a proper indication whether or to which extent this objective will be reached.

Pulp derived from printed paper products is produced using various deinking processes around the world, according to the make-up of the recycled paper stream in a given locality and demands for DIP.

Therefore, the deinking method used to deink sample printed matter should be specified: the deinking procedure to assess deinkability in laboratory or pilot facilities should be defined, documented and reported and should indicate that values related to the industrial deinking processes in Table 1 can be achieved. (See Clause 9 Reporting).

Assessments of deinking performance can be compared provided they are based on the same deinkability test method.

NOTE For further details please see Annex A, which lists potential test methods.

6.2 General experience

This sub-clause describes the general industrial deinking performance of various categories of printed paper products.

The vast majority of printed material for the deinking process are printed graphic paper products collected from households. They consist predominantly of newspapers, brochures and magazines printed with offset and rotogravure. In addition, the blend of material contains some other printed graphic paper products such as office papers, although most of the products are printed on papers containing mechanical pulp. In printing technologies, digital processes are increasing but the analogue techniques are still predominant and will be for the foreseeable future.

Most of the industrial deinking processes were designed for and have to cope with this blend of printed paper products. In addition, there are processes using paper for recycling from more defined sources, e. g. wood free office papers and overprints from print shops, for which a specialized process may be appropriate.

As discussed in Clause 5, the key elements of typical industrial deinking processes are pulping under alkaline conditions (where detachment and fragmentation takes place) and flotation (for the removal of ink particles). ISO 21993 is a laboratory test method based on these key elements[12]. A deinking plant contains multiple process steps depending on the composition of the incoming printed paper products and the intended downstream applications of the deinked pulp.

If the ink film particles are too small or too little hydrophobic for flotation deinking, the consequence is low brightness, sometimes also fibre staining. Particles which are too large mainly affect optical homogeneity and are visible as dirt specks.

A good deinkability can be found with printing technologies and ink/substrate combinations which provide hydrophobic ink film particles in the proper size range. This is typically the case with:

— heat-set offset inks with mineral oil-based inks on coated paper,

— rotogravure inks on coated and uncoated paper (if the ink does not contain soluble dyes),

— dry toner prints. The latter can show small dirt specks in some rather rare cases.

A fair to good deinkability is typical for:

— heat-set offset with mineral oil-based inks on uncoated paper,

— aqueous pigment-based inkjet – if they are agglomerated or used on primed and/or on inkjet treated papers,

— cold-set offset inks with mineral oil-based inks on newsprint paper. Not very much experience is yet existing for coldset offset printing with mineral oil free inks, but the first results indicate that the deinkability is worse.

Some printing and drying/curing technologies and ink/substrate combinations usually show an insufficient deinkability. Among those are:

— most of the radiation curable inks and coatings, independent of the printing technology or substrate due to dirt specks,

— aqueous flexographic prints (low brightness),

— pigment-based inkjet inks on standard paper (low brightness),

— aqueous dye-based inkjet inks (low brightness and fibre staining),

— liquid toner prints (dirt specks).

With regard to those categories of printed paper products that are categorized as insufficiently deinkable, it should be pointed out that in industrial deinking processes, these problems are not necessarily visible because:

— the content of problematic print products is very low, and/or

— the deinking plants typically comprise process steps designed to increase the security level for these products.

Not all of these cases can be taken into account by the printer, because at the time of the production of a printed graphic paper product, its fate after use is not known. Even if the market share of problematic printing technologies is low, a temporary or locally high concentration in paper for recycling can't be excluded, e. g. mis- or overprints from a large print shop.

Varnishes and other post-print protective layers, as well as other materials used in the converting process, such as adhesives, can change the overall behaviour of printed paper products in any deinking process.

7 Quality characteristics of industrial deinked pulps

7.1 General

The purpose of the assessment study is to evaluate the quality of pulp obtained from printed paper products after deinking. This evaluation determines the suitability of the DIP for use as raw material for producing new recycled paper products according to the possibilities summarized in Tables 1 and 2.

The ranges in Tables 1 and 2 are based on values expected for the stated paper grades and are classified according to the optical characteristics specified in this Clause and measured respectively with C/2° settings in Table 1, and D65/10° settings in Table 2. The assessment study should be performed by testing laboratories or pilot facilities capable of capturing and providing the data proposed by this document. The degree to which the quality of the pulp obtained from printed paper products after deinking is suitable for use as a raw material for recycled paper products is assessed by evaluating its optical properties.

Quality characteristics are based on the relevant properties of recycled paper substrates derived from deinked pulp. They are based on optical properties which provide reference values for the quality of deinked pulp and can indicate the efficiency of deinking processes. Parameters include brightness values, colour values and dirt specks.

NOTE Further details are provided ISO 15397, *Graphic technology — Communication of graphic paper properties*[10], and ISO 21993[12].

7.2 Pulp Brightness

ISO Brightness is typically used for newsprint and medium brightness grades. ISO Brightness should be communicated on the basis of measurements made in accordance with ISO 2470-1[3].

D65 Brightness is typically used for medium to high brightness products. D65 Brightness should be communicated on the basis of measurements made in accordance with ISO 2470-2[4].

If a product is most likely to be used in circumstances in which the illumination contains a UV component, optical characteristics values should be determined using D65 illuminant as Fluorescent Whitening Agents present in papers may influence brightness.

7.3 Pulp Colour

L*a*b* coordinates should be communicated on the basis of measurements made in accordance with ISO 5631-1[8] and ISO 5631-2[9] for respectively the pulp where brightness was measured with C/2° (ISO 2470-1)[3] and D65/10° (ISO 2470-2) settings[4].

7.4 Dirt Particles

For the determination of dirt particle areas A_{50} and A_{250}, a scanner-based image analysis system is needed for optical analysis. The scanner should be calibrated to ensure reproducibility of the measurements.

Dirt speck measurements should to be made in accordance with ISO 5350-4[7].

8 Possible usages of industrial deinked pulps (based on Clause 7 characteristics)

Table 1 and Table 2 describe the achievable paper grades that can be produced from the deinked pulp. It indicates for printers, publishers, technology developers and others how their printed paper can eventually be used for new products, once it enters the recycling process from the printed product. The values expected for the stated paper grades are classified according to optical criteria. In Table 1, reported results are based on C/2° illuminant/observer settings and in Table 2, results are based on D65/10° illuminant/observer settings.

Table 1 — Quality for industrial deinked pulp (based on data compiled from bespoke paper mill and research institutes in Asia and Europe) — C/2° illuminant/observer

Grades to be produced	Brightness (ISO, with UV) ISO 2470-1[3]	CIELAB L* ISO 5631-1[8]	CIELAB a* ISO 5631-1[8]	CIELAB b* ISO 5631-1[8]	Dirt specks A_{50} ISO 5350-4[7] mm²/m²	Dirt specks A_{250} ISO 5350-4[7] mm²/m²	Relevance of the data, remarks
Market DIP (High quality)	80 to 98	n/a	n/a	n/a	10 to 30	3 to 5	
High quality graphic and hygiene, white top layers of paper and board	72 to 99	85 to 94	−2,0 to 3,3	−10,0 to 6,0	25 to 250	15 to 60	Hygiene papers with creped surface can tolerate higher dirt speck levels than papers with smooth surfaces
Improved newsprint, SC and LWC	60 to 74	82 to 90	−2,0 to 0	1,4 to 7,2	50 to 600	15 to 200	
Standard newsprint	53 to 61	76 to 85	−1,4 to 1,5	2,0 to 6,0	100 to 650	50 to 250	
Low quality hygiene	45 to 70	78 to 86	−1,0 to 1,5	2,0 to 10,0	100 to 650	50 to 250	

NOTE Production of coated papers and boards sometimes tolerate lower brightness and higher area of small dirt specks than uncoated.

Table 2 — Quality for industrial deinked pulp (based on data compiled from bespoke paper mill and research institutes in Asia and Europe) — D65/10° illuminant/observer

Grades to be produced	Brightness (ISO, with UV) ISO 2470-2[4]	CIELAB L* ISO 5631-2[9]	CIELAB a* ISO 5631-2[9]	CIELAB b* ISO 5631-2[9]	Dirt specks A_{50} ISO 5350-4[7] mm^2/m^2	Dirt specks A_{250} ISO 5350-4[7] mm^2/m^2	Relevance of the data, remarks
Market DIP (High quality)	80 to 99	n/a	n/a	n/a	10 to 30	3 to 5	
High quality graphic and hygiene, white top layers of paper and board	75 to 110	85 to 95	0,0 to 3,6	−12,0 to 4,0	25 to 250	15 to 60	Hygiene papers with creped surface can tolerate higher dirt speck levels than papers with smooth surfaces
Improved newsprint, SC and LWC	65 to 81	86 to 93	−1,5 to 1,0	−5 to 5,5	50 to 600	15 to 200	
Standard newsprint	55 to 65	76 to 85	−1,0 to 4,0	0,0 to 5,5	100 to 650	50 to 250	
Low quality hygiene	47 to 71	78 to 86	1,0 to 4,0	0,0 to 8,5	100 to 650	50 to 250	
NOTE Production of coated papers and boards sometimes tolerate lower brightness and higher area of small dirt specks than uncoated.							

This document describes the testing of individual types of printed product. Readers should be aware that in typical industrial deinking practice a number of different printed products are deinked together and so products which have poor deinkability may reduce the overall quality of the deinked pulp. For example, since the majority of print to be deinked is offset lithography, one aim could be to ensure that the level of deinkability of the product being tested does not reduce the overall quality of the deinked pulp. It should also be noted that a poor deinkability assessment of a given combination of print materials (substrate, coatings, ink, resins, etc) which make up only a small percentage of the incoming waste stream, may not or can have a significant impact on the overall quality of the DIP produced from that waste stream.

9 Reporting

The report includes data relating to the following:

a) reference to this document, i.e. ISO 21331:2020;

b) date and place of evaluation;

c) identification of the printed matter;

d) a complete description of the deinking laboratory or pilot test method and its relevance to the production process, as specified in 5.1;

e) the results, expressed as indicated in Table 1 or Table 2 together with fibre yield and ash content and any circumstances which may have affected the result.

Annex A

Deinking methods

Since industrial deinking nearly always treats blends of printed products in large quantities, it is not easy to allocate a specific deinking behaviour to an individual print product. Small scale laboratory tests or midscale pilot plant trials allow the investigation of individual print products (or even parts of it) or of defined blends.

A.1 Objectives for assessment of deinkability

This document does not propose a specific deinking method to be used, as deinking practices vary from region to region and deinking technology are continually improving.

It is recommended that users select a laboratory deinking method or pilot deinking method that reflects current industrial deinking processes and that to report details of the method selected.

This document is primarily aimed at printers and manufacturers of printing systems who in general are not experts in the area of deinking methods. An objective of this document is to encourage print professionals to adopt best practice when assessing deinkability of printed products.

Current industrial processes vary significantly from region to region. Over the past decades industrial deinking processes have improved and this trend is expected to continue in the future.

A.2 Laboratory deinking methods

There are standardized procedures for testing deinkability, see (ISO 21993[12]).

As it is not practical to assess deinkability-effectiveness of industrial deinking processes for each type of printed material, it is recommended to use a laboratory method. It is important that such a laboratory method is clearly specified and gives a good indication for the behaviour of printed products in industrial deinking processes. Lab scale experiments are less expensive and can be used to find optimum conditions for a pilot trial if necessary.

The test method should be publicly available and sufficiently well-defined such that tests performed independently achieve the same results within expected tolerances.

Since industrial deinking methods vary from region to region, it is important that there is a good correlation between the laboratory process selected and the typical deinking process in the region in which the prints are to be made and recycled.

A.3 Examples of commonly used deinking tests

This is a partial list of the many deinking methods used around the world, many of which are particular to specific mills.

A.3.1 Tests operated in Pilot plants (usually testing blends of Paper for Recycling)

See Table A.1.

There are several pilot plants available worldwide proposed by universities, institutes and machinery suppliers. Some of them are running in successive batch processes or in continuous and include all the main equipment of deinking lines (pulping, screening, flotation, washing, dispersion and bleaching) allowing to provide flexible and unique tools to reproduce industrial recycling and deinking lines. The most sophisticated are able to simulate two deinking loops with internal recirculation of process water (close loop) as done in the mills. They can then anticipate the consequences of difficult to deink material on the final pulp quality for example[18][19][20][21][22] and are well correlated with industrial reality as demonstrated in past studies.

Table A.1 — Deinkability Test Matrix Pilot facilities at publication date

Tests may be performed using all available process steps: pulping, screening, main flotation, dispersing, post flotation, washing, bleaching (oxidative), bleaching (reductive)	
Test method	**Geographic coverage**
Western Michigan University, Recyclable Logo Certification	North America For graphic paper
CTP Pilot test (Centre Technique du Papier, France)	Worldwide
Voith Pilot test (Germany)	Worldwide

A.3.2 Tests operated in Laboratory (usually testing pure product)

See Table A.2.

There are several established test methods or testing references from literature.