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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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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
$\mathbf{A_{50}}$
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
$\mathbf{A_{250}}$
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