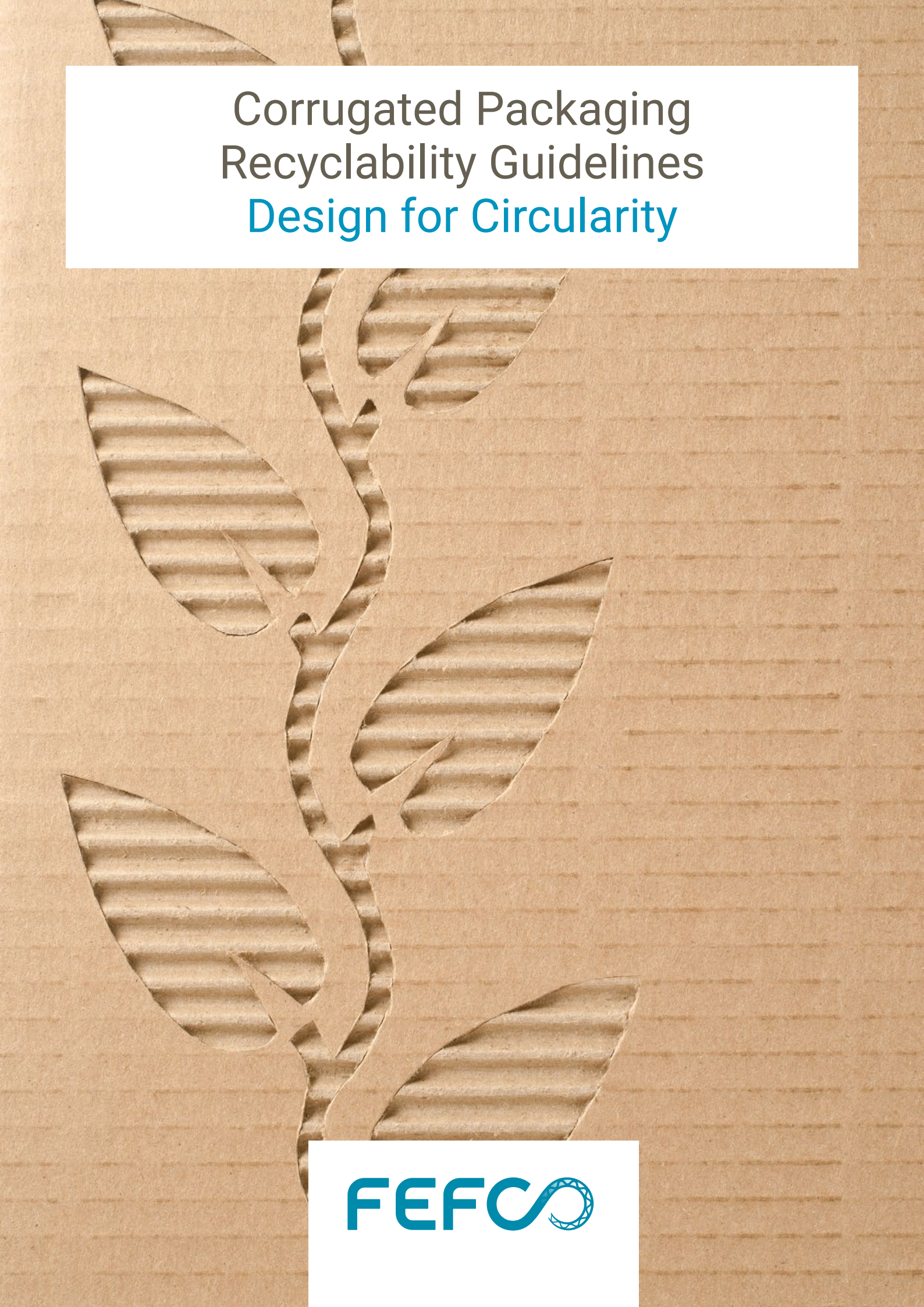
Corrugated Packaging Recyclability Guidelines

Design for Circularity



FEFCO

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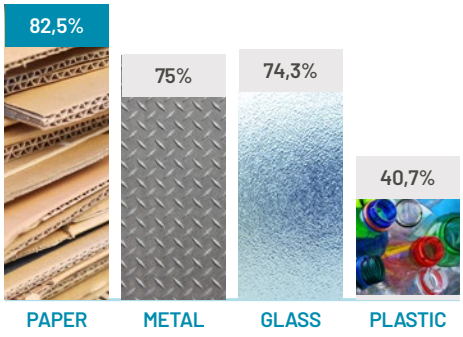
Acknowledgment

This document is based on the CPI Design for Recyclability Guidelines as a source and adapted to include the FEFCO scope.

Corrugated Packaging Recyclability Guidelines Design for Circularity

Paper and board is a sustainable material, based on a renewable source and used to make recyclable products like corrugated packaging. In practice, the recyclability of packaging products will be determined by composition and design, and the way they are collected, sorted and presented for reprocessing. Corrugated products are easily recyclable.

Packaging Recycling Rates



Data source: Eurostat 2021

Paper & board is the **most recycled** packaging material in Europe!

Paper recycling in the EU is a success story, with over 80% of paper and board packaging recycled. Paper for recycling used to make new corrugated products is collected after use as primary, secondary or tertiary packaging or as cuttings from packaging production so the fibres can be used again in the manufacturing process to make new paper for packaging, thus prolonging the life of the fibre replacing virgin materials e.g. wood pulp. Recent studies by the TU Darmstadt and TU Gratz have proven that fibres from carton and corrugated packaging can be recycled over 25 times[1] without loss in quality.

As society evolves, different applications are found for corrugated which sometimes require changes to its design. This is done for good reasons by creating moisture or gas barriers to protect the content. These changes may prove challenging for recycling, and in some instances can increase the costs of reprocessing and of waste disposal, or lower the quality of the finished product.

The potential for increases in this type of material in the future requires designers to look for creative alternatives, and explore new materials and techniques while ensuring paper & board packaging is recyclable.

FEFCO guidelines are intended to assist corrugated packaging producers, converters and customers, (e.g. retailers and brands) to specify and design packaging that can be recycled at standard paper mills.

A ‘standard paper’ mill refers to a paper mill for packaging that operates on a continuous flow basis and can handle a range of paper for recycling grades as its raw material.

[1] https://www.fefco.org/sites/default/files/2022/Myth_of_Limited_Fibre_Cycles.pdf

Such mills produce high-quality end-products typically using Paper for Recycling specified according to EN 643 groups 1 to 4 with a classic low-consistency pulper (5% fibre concentration). Often such processes operate deflakers to separate fibre bundles into individual fibres, as well as coarse and fine screening cleaners. The aim is to separate the fibre from the other material. The final result is fibrous material suspended in water ready for papermaking (=recycled pulp).

This document aims to serve as a guide to optimise the quality and quantity of paper recycling by further improving the recyclability of corrugated packaging on the market and thus contributing to the EU Green Deal and circular economy.

These guidelines are complementary to the European List of Standard Grades of Paper and Board for Recycling EN643.[2]

Non-Fibrous Content

How much non-fibrous material can the Paper and Board mills handle?

There are various paper and board recycling mills that can process different grades of Paper for Recycling (PfR) (specified in grades of EN 643). Standard paper recycling mills prefer receiving optimally designed products for their process, generally preferring to receive only fibrous material in the packaging. Fibrous material can be defined as papermaking fibres and other ingredients such as filling material, starch, coating colourands, binding material and additives (wet-strengh agents, sizing agents, bound water).

Therefore, when packaging components other than fibrous material, such as plastic or metal are used to bring functionality, repulpability of the packaging must also be ensured in recycling mills. This ensures sustained efficiency and prevents economic challenges.

Many of the non-fibrous components used in fibre-based packaging do not cause any problems in recycling, while some coatings, films and laminates can create challenges.

The paper and board recycling mills would prefer to receive fibres of high quality into the recycling stream to ensure process efficiency, low energy consumption and good overall environmental and economic performance. Rejects in the reprocessing can however increase losses of fibres if the packaging is not well designed.

From the perspective of both standard and de-inking mills, EN643 is regarded as the applicable industry standard providing a detailed grading list for bales of collated PfR, entailing:

For all grades

- Hazardous waste tolerance (zero tolerance)
- Moisture tolerance (maximum 10%)

For each grade

- Content description
- Tolerance level for non-paper components (e.g. plastic, metal, not part of the product material)
- Tolerance level for other unwanted material (e.g. material detrimental for production)

The maximum tolerance level in EN643 for non-paper components for many of the grades of paper for recycling (eg 1.01, 1.02, 1.04) is 1,5% weight for weight.

This implies an average across all material delivered to the mill, but in practice is assessed by sampling individual loads upon delivery at the mill. Non-paper components according to EN643 are not a constituent part of the product and can be separated by dry sorting. Contrary laminates and barrier coatings made of polymeric materials are paper constituents which cannot be separated by dry sorting. EN643 also defines prohibited materials which are not allowed at all, for example if diapers or some other hazardous materials are in the bale the whole load will be returned.

Non-paper components are limited for each individual grade, for example 1,5 % maximum for grade 1.02.00. Paper packaging with one or two side polymeric coating does not fall in this category of non-paper components but could still be considered as unwanted material if not included in the individual grade specification in EN 643.

There is also a limit, in this case of 2,5%, for total unwanted material. Next to the non-paper components, this mostly concerns paper-based products which can be detrimental for recycling in standard mills (e.g. liquid packaging board, wet-strength paper) and/or not according to description.

[2] CEPI Guidance to EN 643

Recommendation

The non-fibrous content of any board packaging product should be minimized to comply with EN643 tolerance.

How much non-fibrous material per packaging?

In the production of fiber-based packaging, different non-fibrous materials may be used to ensure safe and compliant transportation, containment, and protection of goods. These can include process additives such as retention and dewatering additives to improve production efficiency, binders and strength additives to improve mechanical properties, and polymers added to the surface of the paper in the form of a coating, film or lamination, to provide barrier protection against water, oxygen or fat. Polymeric materials may also be used for ancillary packaging components such as windows or handles. In general, most process and strength additives do not pose serious risks to recycling (exception can be with Wet Strength Additives if added at too high levels, see corresponding section below). However at higher levels, polymers applied to the surface of paper for barrier functionality, or ancillary packaging components, can become problematic. Many new water-based barrier coatings are being developed which do not pose significant challenges to recycling while still maintaining good barrier performance.

The industry would prefer that paper coated or laminated with higher amounts of polymers is collected separately or sorted and sent to dedicated mills for more effective reprocessing.

To encourage packaging target producers and designers to, optimise packaging for recycling process, the industry suggests an aspirational ambition to reduce polymer-based coatings/films/lamination to as little as possible of pack weight on single-sided laminates.

Designers should also take care to ensure that when non-fibrous components are present, the consumer can remove these and dispose of them into the correct recycling or residual waste stream (if heavily contaminated with product residues). It is important also to have good separability of laminate face and containerboard during pulping so that material passing into the reprocessing system is easily separated from the fibre suspension by mechanical processes.

Maximizing the recycling potential of fibre-based packaging

Standard Paper recycling mills would prefer to receive paper with as little non-fibrous material as possible. When processing paper with polymer-based components that are not soluble in water, it makes little difference in the recycling process if the polymeric material is conventional, biodegradable or compostable, as the degradation mechanism will not have sufficient time to cause any significant degradation of the material before it passes through the paper recycling process. For example, conventional PE coating and PLA behave similarly as their conventional equivalents.

In general, polymeric components that have potential to cause environmental pollution or damage to recycling systems should be avoided. For instance, solid, polymer components with low shear strength that break down in the pulper should be avoided to prevent possible contamination of the finished product or discharge with the waste water.

In simple terms, non-fibrous components should be:

- Designed out altogether (or reduced to an absolute minimum).
- Designed to be easily separated by sorting or recycling so it can be rejected in the system at the beginning of the paper recycling process.
- Designed to deliver minimal impact, both to the environment and to existing recycling systems.

Where polymeric components are included, it is recommended to use a polymer type that does not readily degenerate or break for several reasons:

- During repulping, solid, polymeric components can disintegrate into smaller fragments. It is important to ensure that any fragments remain large enough to be easily separated with screening elements in stock preparation. They should also not be too "flexible" and thin – "two dimensional" (foil particles), to avoid risk of passing through even low slot width screens.
- The choice of polymer should also have a density different from that of fibre so they can easily be separated with the hydro cleaners that are used in paper mills. For example, polymeric material with a density in a range of 0.95 to 1.15 g/cm, e.g. similar density as fibres should be avoided.

The development of innovative barrier systems that could be recycled with the packaging is receiving considerable attention within the fibre-based packaging industry.

Recommendation

The Paper industry would like to eliminate the usage of all unnecessary plastic. Designers should aim to achieve a minimum fibre content of at least 95% of pack weight.

Coatings, Laminates

'Coatings' is a term used to describe a variety of materials applied to a paper surface to impart specific properties. These can create different challenges in the recycling process. Coatings can be either inorganic inclusions or printed or varnished coatings and can be applied at different stages in the paper making and converting process. Printing processes define lacquering, coating or varnishing.[3]

Films / Laminates

Lamination is a term used when a layer of a non- cellulose fibre-based material (such as a polymer-based film or aluminium foil) is combined with paper or board, usually with some form of adhesive extrusion layer to adhere the two materials together.

Depending on the strength of the adhesion between the film/lamination and paper, it may become more difficult for fibres to be pulped and released from the film during pulping. There is a preference for light bonding with an adhesive agent so that the lamination layers separate easily in the paper pulping process.

Providing the film does not interfere with the separation of the fibre, most fibre should be recovered. This will be determined by the degree of adhesion between film/ lamination and fibre. Lamination on both sides should be avoided as this will prevent water to access the fibres during repulping. It is strongly recommended to conduct recyclability testing to ensure a suitable packaging design.

If the plastic film can be separated as relatively large particles, it can be removed easily using conventional mechanical screening technology. However, the removed material will typically have to be disposed of and currently very few recycling technologies exist for reprocessing removed material which typically is a mix of fibres and various types of non-fibre materials.

Metallised films/Aluminium films are usually less tightly bound to the paper substrate (in some cases a polymeric film may be applied over the surface for durability or other purposes) and fibre can be recovered from them.

It is however important to ensure that small 'metallic' particles are not generated in significant quantities during repulping, since these can interfere with equipment used to measure flows in paper mills, cause quality issues of the produced pulp and be deleterious to the end use in packaging due to metal contamination (visual and metal

[3] In printing: lacquering, coating or varnishing refers to the application of a liquid or paste, unpigmented ink like product, which after drying is mostly transparent. Thereby, certain surface properties are obtained, as for example protection against mechanical damage, gloss or matt surface effects, and/or specific slip or adhesion properties.

detector activation, and quality issues). In severe cases, this can cause machine downtime and increase waste.

Recommendation

- **Standard recycling mills would prefer not to receive significant shares of laminated or metallised laminated board.**
- **Coatings that are soluble in water can typically be treated in a paper mill effluent treatment processes and are preferred.**

Ink and Varnishes

Inks are a mixture of colorants with other substances (e.g. resins, solvents, additives) applied on paper & board by printing or coating to provide information/ decoration.

Varnishes are thin layers of a non-fibrous material coated onto the surface of paper that has usually been printed with water-based inks. They are typically used to protect the ink film and provide a degree of robustness to the print.

The 'active component' (typically a resin) is thinly applied onto the surface of the paper and a carrier medium evaporates or is absorbed into the sheet, or hardened (solid inks), leaving a film of the active component. In some cases, where a more robust surface is required, the resin may then be cured by the application of heat and/or UV radiation.

Depending on the resin used, the thickness of resin applied and the degree of curing that takes place, these films can vary from very easy to very difficult to remove or fragmentize below the visible limit. Even if the film is detached, the resin particles may be problematic in further processing.

In some cases, the film may contain extremely fine dispersions of solid materials to provide key properties and some varnishes are known to contain finely dispersed polymers which may or may not cause a problem during reprocessing and may or may not pass into the product or mill effluent.

UV Inks and Varnishes

UV inks and varnishes may cause technical issues within some recycling processes and quality issues with the final product. Where it is used in packaging it can be recycled, albeit it can cause visual impurities on the new paper sheet. For this reason, the industry would prefer to keep to a minimum the quantities of cured varnished material (either conventional or UV cured) specified in packaging products.

Recommendation

- **Inks and varnishes that are soluble in water can typically be handled by a paper mill effluent treatment processes and are preferred.**

Adhesives

Adhesives are integral to the manufacture of packaging and standard paper recycling mill technology is designed to separate and remove these during the paper recycling process. However, some adhesives found on some tape, labels and in the closing of packaging have potential to soften or plasticise under typical recycling process conditions to form "stickies" that can end up on the finished paper,

spoiling the performance of the paper making process and appearance and runability of the paper during converting.[4]

Most hot melt and pressure sensitive adhesives, among many other adhesives are typically non-soluble in water and thus do not disperse during the pulping process.

They can be removed by mechanical screening very efficiently. Adhesives soluble or dispersable under pulping conditions, may release during pulping and may form jelly like globules that can travel through mill screening systems and stick to the finished paper product.

Using water soluble adhesives requires special considerations ensuring that the chemicals formed when the glue dissolves do not impact the mill waste water treatment system. The development of relevant standardised test and assessment schemes can support this.

Recommendation

The industry would favor adhesives that are easily removable or water soluble. In any case, intermediate behaviour of adhesive particles in fragmentation needs to be avoided.

Alternative Barriers

The industry welcomes and supports research to develop alternative barrier technologies. By its nature, and because Intellectual Property considerations prevent description here, it is impossible to list or judge the recyclability of these technologies. However, in general terms, recyclability in any alternative barrier system will be achieved where:

- The board or paper within the packaging, when exposed to water, is capable of being repulped into single fibres in suspension.
- Polymer based barrier and other agents can be removed from the fibre during the papermaking process if they are water soluble.
- Polymers and agents can be dealt with efficiently by paper mill effluent systems (if they are dissolved in the water) and do not compromise the finished product, the production process or the environment whilst fibres being recycled.

Fillers and Mineral Coatings

Fillers comprise during paper making inorganic materials, which are added to paper and board to provide enhanced surface qualities or other purposes (opacity). In order to achieve proper adhesion to the surface of the paper, they are often combined with “binders”.

- Filler (also called “Ash”) is often comprised of Calcium Carbonate (CaCO3) and is typically used to improve printability in graphics papers and a percentage will be removed in the paper recycling process. Calcium Carbonate (CaCO3) coating does not add strength to recycled fibre-based products.
- “Binders” used with some coatings can create “stickies” which can potentially affect the runnability of the paper both at production and converting machines (“black spots”).

[4] “Stickies” are a tacky substance contained in the paper and pulp and process water systems of paper machines. They have potential to contaminate machinery and the finished sheet and are transported within the pulp and can agglomerate causing problematic deposits.

Other Fibrous Materials

Bagasse, Palm Fibre, Rice Straw, Wheat Straw, Barley Straw, Oat Straw, and other plant fibres

Most recycling mills are set up to reprocess cellulose fibre derived from trees. The industry acknowledges that there is increasing use of alternative fibre sources, particularly those derived from agricultural residues.

Subject to fibre having been prepared for use in papermaking and presented in a form suitable to be utilised in the papermaking process, these fibres can be recycled.

The industry recognises the urgent need to investigate recyclability. The varying properties of alternative fibres could mean they are to be separated out in the process at the mill or affect the pulp quality.

Pulp products such as egg boxes and molded fibre packaging can be recycled and should be placed with paper and board for recycling.

Materials made of fibrous content which is neither prepared for papermaking nor able to be presented for recycling in an appropriate manner should be labelled non-recyclable.

Suitably prepared and presented alternative fibres can be recycled along with other paper for recycling but designers and specifiers (customer ordering packaging) are asked to consider carefully what benefits derive from using these fibres. Fibrous matter which is neither prepared for papermaking nor able to be presented for recycling in an appropriate manner should be discarded with general waste.

Recommendation

Packaging designers and specifiers are encouraged to use cellulose fibre derived from trees.

The use of other fibres should be subject to having been prepared for use in papermaking and suitable for recycling.

Speciality Paper Products

Silicone, Waxed, Greaseproof, Wax coated

Papers for use in certain food related applications can require additional functionality to provide resistance or protection from water or grease which can make them more difficult to recycle. It is recommended that such products are sent to specialised recycling mills. Specifically,

- Waxed or waxed coated papers should be avoided. Wax cannot be removed efficiently by standard recycling mill systems and passes into the finished product.
- Silicone, wet strength and greaseproof papers, whilst not damaging to the process, typically require extensive time or special process conditions for pulping and therefore may end in the mill waste stream.
- (Hard)-sized products are papers and boards treated with starch and other sizing agents to make them moisture resistant and printable. A typical example is the surfaces of some frozen food packaging. These products require significantly more time to pulp but can be recycled in most standard paper mills.

Recommendation

- The use of wax should be minimised.
- Moisture resistant papers can be dealt with by standard recycling mills.
- Hard sized and wet strength are not preferred feedstock for standard recycling mills since they require longer pulping times unless separately collected, sorted and processed.

Food Contamination

Food Contamination is prohibited in Paper for Recycling by EN643

Food packaging products such as **pizza boxes** and **sandwich packs** can be fully recyclable. There is a difference between contamination by food, and staining. Surface staining of paper is acceptable, but food waste sitting in the pack (Free Moving Food) or food attached to the surface (3D Residue), and traces/stains that fully soak in the paper is regarded as unacceptable. Careful consideration should be given to the proposed application of fibre-based packaging to prevent inadvertent contamination by food substances. There should be clear information on the packaging that any food residue should be removed prior to recycling, and removable layers would help reduce the potential for contamination.

See the technical standard CEN/TS 17830 which provides guidance on the application clause 2.2 of EN 643:2014. Paper and board - Guidance on the application of Term 2.2 “Prohibited materials” of EN 643:2014.

Recommendation

- Packaging should be scraped clean of food by users. It should have clear instructions to encourage consumers to clean it.
- Food packaging can be fully recyclable if there are no food residues.

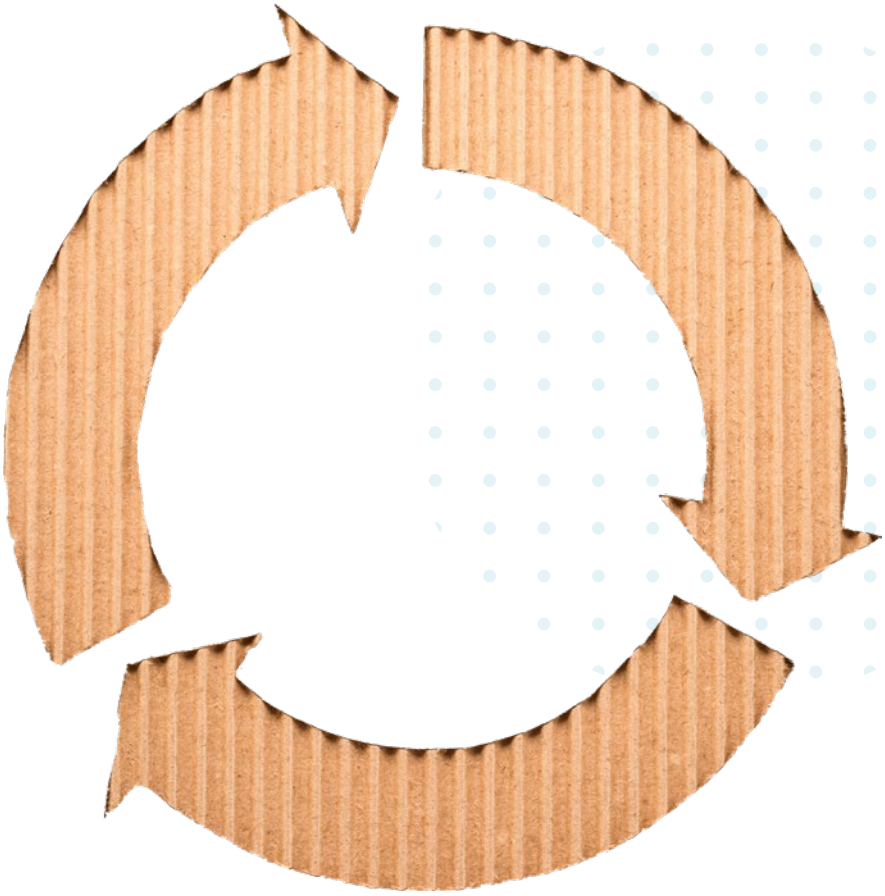
Other Contaminants

Packaging intended to be in direct contact with potentially harmful contaminants such as medical waste, animal products or toxins shall be considered not suitable for recycling and disposed of in a safe manner and never via paper recycling.

Standards, Tests or Protocols for Recyclability

There are a number of test and evaluation protocols, standards and laboratories engaged on assessing recyclability of paper & board packaging, including corrugated. In many cases the acceptability of a product for recycling depends upon a wider range of factors such as the way it is collected and sorted, its application and the likelihood of contamination.

The paper & board industry has initiated harmonisation of recyclability testing of fibre-based packaging and assessment in Europe. The CEPI recyclability laboratory test method is valid for any product going to a standard mill such as corrugated https://www.cepi.org/cepi-recyclability-test-method-version-2/.



The document will be reviewed when needed along with further developments.

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