THE LCA CENTRE

PACKAGING LIFE CYCLE ASSESSMENT



Exploration of plastic-free coatings and barriers on (food) packaging made of paper and cardboard – commissioned by the Ministry of Infrastructure and Water Management

Project ID TLC 21-229
Date 23-12-2021
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Summary

Following the introduction of the European Single Use Plastic Directive 2019/904 (SUP Directive), the use of (disposable) plastic is now seen in a new light. While this directive aims to promote circular approaches in which sustainable and non-toxic reusable products and systems for reuse are prioritised over single-use products, many companies are focusing on replacing plastic with alternative materials.

The SUP Directive and associate guidance documents applies to all plastic containing single use products. In order to prevent unwanted shifts to non-plastic disposable items and evasion of the SUP regulations, the Ministry of Infrastructure and Water Management (the Ministry) has commissioned The LCA Centre to investigate the use of barrier techniques, specifically water dispersions in the context of SUP regulations, and to investigate “plastic-free” claims.

There is an essential difference between products without any addition of synthetic polymers, which can be called “plastic-free”, and products that fall outside the scope of the SUP directive. Products containing synthetic polymers excluded by SUP definitions (such as printed and treated cardboard, and paper) cannot technically be called "plastic-free", but they do fall outside the scope of the SUP directive. An example of such a products are paper straws.

The use of synthetic polymers is inherent in the production process of cardboard and paper. In addition to the process additives, other synthetic polymers are also used to provide cardboard and paper with certain technical properties, with the aim of making the packaging water and grease resistant, so that they are suitable for direct contact with food. The application of polymers can be carried out in three ways:

- Applying extrusion coatings and laminates that create a physical layer on the surface of the board and paper;
- Applying lacquers and/or water dispersions by means of coating methods and printing processes;
- Treating cardboard and paper by means of additions of various chemical substances, which takes place either during the paper making process or as post-treatment.

Techniques of this kind are also applied to other pulp packaging such as sugar cane bagasse.

The main difference between the standard plastic extrusion coating and the other barrier techniques, including water dispersion, is that the standard plastic extrusion coating has a solid shape before application. The material can be melted during application, but the layer that is applied to the fibre material also has a solid shape after cooling, which leads to the formation of a composite material.

Other barrier techniques, including water dispersion, work with liquids that are either partially or wholly incorporated into the fibre material. Depending on the method of application, these liquids can form a film layer on the surface after drying that cannot be physically separated from the substrate.

Virtually every type of material that can be used for the production of disposable packaging for (warm) food and drinks contains synthetic polymers that are either incorporated in the material itself or on its surface.

The materials not containing synthetic polymers that are suitable for packaging (warm) foodstuffs and drinks, such as glass and metal, are not suitable for single use due to their relatively high environmental impact.

Although the general recycling guidelines explicitly label the use of water dispersion for cardboard packaging as undesirable, field tests and information provided by a paper producer and processor of recycled material show a different picture.

These conflicting findings lead to the conclusion that it would seem useful to put in place the same recycling test requirements for cardboard and paper packaging with water dispersions as is required for cardboard packaging with a standard extruded plastic coating.

There seems to be two types of Plastic Free trust marks and certificates:

- Labels that verify the absence of plastic in a certain product (Plastic Free/Flustix)
- Certification schemes that mainly focus on making all activities of the company or event plastic free (Italian and Cypriot schemes)

Plastic Free from A Plastic Planet is the most well-known trust mark, but due to the definition conflicting with the legal plastic definition, it cannot be regarded as verification of compliance with SUP legislation. The same objection can be made for the Italian Plastic Free trust marks.

Of all the trust marks that have appeared on the market so far, Flustix seems to be the most meticulous and transparent. The definitions and the verification method are based on scientific insights and international guidelines and regulations. Although there is no official recognition by the authorities, this trust mark has the best chance of achieving that recognition.

This document is an English translation from the original Dutch language document submitted to the ministry on the 16/12/2021.

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1 Introduction

The introduction of the European Single Use Plastic Directive 2019/904 (SUP Directive) has put the use of (disposable) plastic in a new light. While this directive aims to promote circular approaches in which sustainable and non-toxic reusable products and systems for reuse are prioritised over single-use products, many companies are focusing on replacing plastic with alternative materials.

This can lead to a number of unwanted situations. One of these unwanted situations is that a coffee cup, that is coated with a water-based dispersion coating, is marketed with a 'plastic free' claim and is promoted as a product that does not fall under the SUP Directive.

The regulations state that all products containing plastic fall within the scope of the regulations. In order to prevent undesirable situations and evasion of the SUP regulations, the Ministry of Infrastructure and Water Management (the Ministry) first wished to gain more insight into this matter.

1.1 Exploratory questions

This exploratory study aims to answer the following questions posed by the ministry:

- What types of coatings and barriers are available to make cups and food packaging made of paper or other natural fibres water and grease repellent? **(Chapter 3)**
- How do these fit into the recycling chain/waste processing of packaging? / What effect does water dispersion have in waste treatment? **(Chapter 6)**
- How does water dispersion work? **(Chapter 3)**
- What is the difference between water dispersion and a standard plastic coating? **(Chapter 4)**
- Which materials are suitable to function without polymers as packaging for drinks and for hot meals and what waste processing route do these materials have? **(Chapter 5)**
- We understand that there are authorities that issue a 'plastic-free' certificate (e.g. in Germany). On what standard is this done? Are there other agencies that do this? **(Chapter 7)**

Each question will be answered in a separate chapter, with the order adjusted so that a logical structure is created. In addition to these questions, Chapter 2 deals with the plastic definition applicable within the SUP Directive in relation to water dispersions.

2 Plastic definition within the SUP guideline

The scope of the SUP regulations is determined by two definitions, namely the definition of plastic and the definition of a disposable product that is partly or wholly made of plastic.

In the SUP Directive, plastic (plastic) is defined as follows in Article 3:

> *'plastic' means a material consisting of a polymer as defined in point 5 of Article 3 of Regulation (EC) No 1907/2006, to which additives or other substances may have been added, and which can function as a main structural component of final products, with the exception of natural polymers that have not been chemically modified;*

This definition is supplemented in point 11 of the preamble with further explanation and naming of the groups of substances excluded from the definition – ie inks, glues and paints.

> *" […] Plastics manufactured with modified natural polymers, or plastics manufactured from bio-based, fossil or synthetic starting substances are not naturally occurring and should therefore be addressed by this Directive. The adapted definition of plastics should therefore cover polymer-based rubber items and bio-based and biodegradable plastics regardless of whether they are derived from biomass or are intended to biodegrade over time.* ***Paints, inks and adhesives should not be addressed by this Directive and therefore these polymeric materials should not be covered by the definition****. "*

The interpretation guidelines published in June 2021 contain, on the one hand, further clarification regarding the use of polymeric substances:

> *"In the production of many materials, including non-plastic materials,* ***polymers*** *that meet the definition of plastic in this Directive are* ***often used to achieve specific material properties*** *as well as higher production process efficiencies. Those polymeric materials are often synthetic chemical additives.* ***The use of such polymeric materials, e.g. as retention agents or binders and processing aids*** *in the production of a material, which in itself is not plastic,* ***does not result in the single-use product made only of that material to be considered as being made partly of plastic.****"*

On the other hand, the guidelines introduce a condition that may cause confusion from a technical point of view.

> *"However,* ***when a plastic coating or lining is applied to the surface of a paper- or board-based or other material to provide protection against water or fat****, the final product is considered a composite product composed of more than one material of which one is plastic. In this case, the final product is seen as being made partly of plastic. Hence, single-use paper- or board-based products with plastic coating or lining are partly made of plastic and fall within the scope of the Directive."*

Reference is made to a protective function of layers applied to cardboard as being decisive for falling within the scope of the SUP guideline for cardboard and paper packaging. That while the previous paragraph mentions the exception for the use of technical polymers aimed at achieving specific material properties.

As an illustration, an example is given here of extruded plastic-coated paper cups and beverage cartons. It is typical for both types of products that the application of polymeric layers leads to the formation of a composite material, in which the individual layers can be clearly separated from each other.

The discrepancy in the explanations and definitions shown above creates ambiguity about the status of water dispersions under the SUP Directive. Technically speaking, these are techniques that are inherent in paper and cardboard production in which substances are used with a composition that is comparable to paint and binding agents, but because they are often applied as surface treatment and have a protective function, they could theoretically also be considered as a "plastic layer".

2.1 Conclusion plastic definition

There is an essential difference between products without any addition of synthetic polymers, which can be called “plastic-free” and products that fall outside the scope of the SUP directive.

All product types that are listed in the Annexes of the SUP guideline and that are made of materials that do not contain synthetic polymers (such as e.g. wood, glass, metal without coating, cotton, jute, bamboo, wood pulp or bagasse pulp without additives or coatings) are excluded from the scope of the SUP Directive and can be considered “plastic free”.

Similar products containing synthetic polymers excluded by SUP definitions (such as, for example, printed and treated cardboard and paper) cannot technically be called "plastic free", but they do fall outside the scope of the SUP directive. An example of such a product is a paper straw. The figure below illustrates the relationship between the two terms.

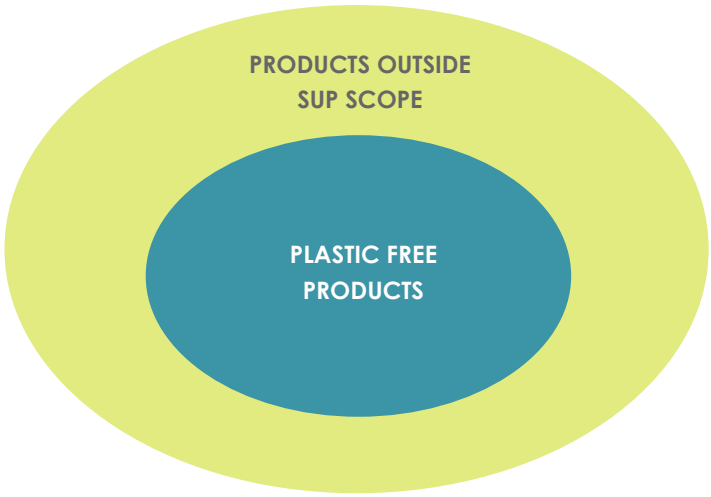

Figure 1 Plastic-free v/s outside the scope of SUP

3 Coatings and barriers for natural fibre materials

There are numerous ways to render cups and food packaging, made of paper or other natural fibers, water and/or grease repellent. Below the explanation of these techniques can be found.

3.1 Physical coatings and laminates

A barrier in the form of a physical plastic layer is one of the most common options. This is because paper itself does not have a water or grease barrier. Paper beverage cups and cardboard food packaging often have an extrusion coating. This means that the melted plastic is applied as a thin film to the paper or cardboard. The plastic coating is cooled by means of large cooling rollers and the paper or cardboard can be rolled up again. The plastic coating can be applied on one side or on both sides.

Common plastic extrusion coatings for paper and cardboard are: Polyethylene (PE), Polypropylene (PP), Polyethylene terephthalate (PET) and Polylactic acid (PLA). Multi-layer extrusion coatings with barriers in the form of an EVOH or nylon layer are also possible with food packaging but are unlikely to be used for the simple takeaway food packaging or beverage cups.

Depending on the desired barrier, application and material, extrusion coatings can be applied in various thicknesses. The amount of coating applied is usually stated in grams per square meter. Paper beverage cups usually contain a one-sided PE-coating which is applied in grams varying between 15 and 20 grams per square meter (gsm). The bottom of a paper cup is typically coated on both sides and contains between 12-18 gsm PE per side. A much smaller part of the paper beverage cups on the market contains a PLA extrusion coating. PLA is usually applied in thicknesses between 30 and 35 gsm. It is not technically possible to substantially reduce that amount. Compared to PE coated packaging, PLA coated packaging therefore requires more plastic for the same functionality.

A plastic layer can also be applied to the paper or cardboard in a lamination process. A plastic film is glued to the paper or cardboard by means of a thin layer of glue. This is often the choice when the cardboard is first printed and then a plastic film is glued over it. The lamination process can also be used to combine different materials and types, such as paper, aluminium and plastic.

3.2 Chemical treatments of paper, cardboard and fibre pulp

Another way to make packaging resistant to the influence of water and fat is by making certain additions during the manufacturing process of the paper and pulp products. Various additives can be used to make paper and pulp water-repellent. The treatment of paper and pulp to make it more water or fat resistant is called sizing (Holik, 2013). The substances used for this process are called sizing agents.

Sizing can be done internally in the paper pulp or on the surface of the paper. Combinations of both internal and surface sizing are also possible.

3.2.1 Internal sizing

There are 3 different systems for internal sizing

- **Rosin**

Rosin is the oldest of the internal sizing agents. Rosin is made from renewable natural raw materials. For use as a sizing agent, the rosin is first chemically modified.

- **Alkyl Ketene Dimer (AKD)**

AKD has been used as a sizing agent since 1960. The basis is formed by vegetable and animal fatty acids. In the paper making process, AKD sizing products are often supplied in the form of a dispersion. These AKD dispersions often contain stabilizers based on synthetic polymers such as Polyamines, Polyamidoamines and Polyvinylamines.

- **Alkenyl Succinic Anhydride (ASA).**

ASA sizing agents are made from petrochemical ethylene. The ethylene is converted into Alkenyl Succinic Anhydride (ASA) oil in an oligomerization process and subsequent isomerization. In order to be used as a sizing agent, the ASA oil must first be emulsified. This can be done with cooked starch and if this is not available it can also be done with polyacrylamides or cationic starch-based biopolymers. Thus, there is a high probability that the internal sizing agents used in paper, cardboard and pulp making contain polymers.

3.2.2 Surface sizing

For surface sizing, there are two systems that are most common

- styrene-maleic anhydride copolymers (SMA)
- styrene-acrylic ester copolymers (SAE).

Both groups have their own advantages and areas of application. However, the basis of both is a polymer.

After the paper fibres have been treated internally or on the surface with a sizing agent, a coating is often applied to the paper. This is also called the “coating colours” or “coating pigments”. This type of coating consists of minerals such as clay, lime, talc and titanium dioxide, also referred to as pigments. The binding agents in the coating colours are starch and/or (synthetic) latex.

The coating colours are mainly applied to improve the surface and make it suitable for the printing process. The fillers in the coating colours are cheaper than the pulp, which is why their use also has an economic aspect.

For paper, the coating colours layer weight is 30 to 65% of the total weight of the paper, for cardboard this is 5 to 20%. It is expected that the use of fillers and coating colours will only increase in the future. The proportion of the binding agent in relation to the filler varies between 5 and 15%. The fillers are held together by a binding agent. 54% of the binders are styrene-butadiene based latex, 33% are starch based, 9% are styrene acrylate latex based and 4% are based on other monomers. For paper and

cardboard provided with a coating colour/pigment, it is likely that polymers are also used in 2/3 of the cases.

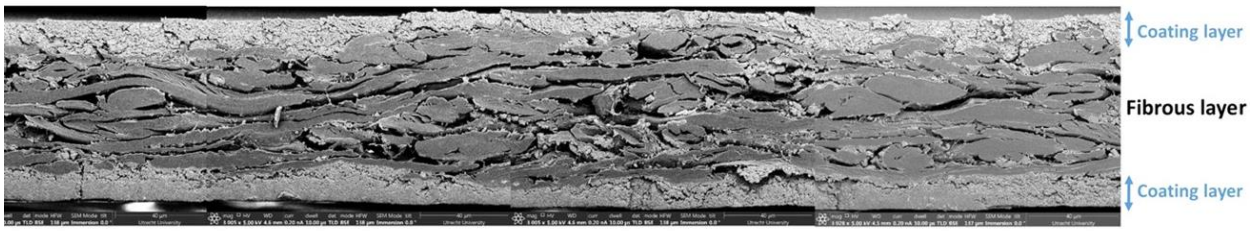

Figure 2 Source: (Aslannejad, Hassanizadeh, & S.M. & Celia, 2018)

In addition to all of the above systems, several other polymer types are used in the paper and cardboard manufacturing process. For example, retention and wet strength agents. The retention agent is used so that the filler adheres better to the fibre, and it also ensures that the water can be removed from the paper more quickly during the process.

3.2.3 Poly- and perfluoroalkyl substances (PFAS)

In addition to the rosin, AKD, ASA and coating colours, there are other substances that are regularly used to make paper, cardboard and moulded pulp products, water and grease resistant. Those are fluorochemicals added during the process. By adding only 1 percent of fluorochemical liquid, the paper becomes resistant especially to oil and grease. Fluorochemicals are typically also being used in food packaging made of bagasse pulp. These are the commonly used sugar cane plates and bowls. Fluorochemicals can also be found in paper and cardboard packaging that must be grease resistant.

Those chemicals could also be present in cardboard take-away packaging for burgers and fries. The fluorochemicals are also referred to as PFAS which stands for Poly- and perfluoroalkyl substances. Several laws and regulations are currently being drafted to reduce or ban the use of PFAS. Even if these specific PFAS substances, used in paper and pulp products, are not seen as polymers, they are not seen as sustainable and a safe solution for packaging.

3.2.4 Treatments of paper and cardboard within printing processes.

A large percentage of the paper and cardboard packaging on the market is printed. Printing is primarily applied to communicate product information to consumers. Polymers also play a role in this area. Inks are generally complex mixes that are not free of polymers because, in addition to pigments, they are composed of polymer-based binders combined with many other additives.

In addition to ink, the protective lacquers (a.k.a. varnishes) used on top of the ink are also based on polymers. After the different colours have been applied to the substrate, one or more layers of lacquer can be applied to protect the inks and provide, for example, a glossy or matte surface appearance. Lacquers can be applied to achieve a soft-touch surface or to ensure that the material is sealable. These varnishes are called overprint varnishes (OPV). Varnishes are available for all common printing techniques such as offset, flexo and gravure.

In addition, there are lacquers that can be used to create a barrier against, for example, water vapour, oxygen or fats. These lacquers are then applied to the side of the cardboard which is in contact with the food. Common lacquers are based on styrene acrylate, polyesters or ethylene acrylates, all being polymers. Like inks, they are applied as a solution in water or solvent, after which the solvents or water are evaporated by means of heat. A thin film layer is then formed on the substrate leading to the required change in the properties of the packaging. These lacquers are not visible to a standard consumer with the naked eye. The product feels like regular cardboard. These types of lacquers have also been used in the paper and cardboard industry for decades.

3.2.5 Water dispersion treatment

The fourth category is the water-based dispersions. A water-based barrier coating is a polymer dispersion. In the dispersion, 40 to 50% colloidal polymers are dissolved in water. In addition to these particles, the dispersions also contain additives such as, inter alia, dispersants, thickeners, surfactants and mineral pigments. It is best compared to a water-based paint or varnish. After the dispersion has been applied to paper or cardboard, the moisture must be evaporated from the dispersion as quickly as possible so that the "paint" dries and a film forms. Dispersion resins can be made from different types of polymers, common ones are:

- Acrylic polymers,
- Ethyl acid acrylates,
- Ethylene methacrylate,
- Polyvinyl acetates,
- Styrene butadiene copolymers,
- Polyethylene dispersions
- Polypropylene Dispersions
- Polyester

Mixes can also be made of the above, or different dispersions can be applied in multiple layers to create the right properties. The use of water dispersions in the paper and packaging industry is not new. Water dispersions have been used for decades to give paper packaging better barriers and, for example, to make it sealable. Sometimes a barrier is necessary against grease and sometimes against water vapor or a combination of different properties.

Water dispersion coatings can be applied to the substrate by various methods. Some common methods are:

- curtain
- rod,
- reverse gravure,
- film press,
- roll and blade coating

Each method has its pros and cons. The above methods are all intended for applying a coating to a roll of paper or cardboard. The paper is unrolled, and the coating is applied to the paper at the coating station. After this, the paper with the wet coating goes through a drying tunnel, here the water is evaporated from the dispersion and a film layer is created on the paper. After the drying tunnel, the coated paper is cooled and rolled up again.

3.3 Conclusion coatings and barriers for natural fibre materials

The use of synthetic polymers is inherent in the production process of cardboard and paper. In addition to the process additives, other synthetic polymers are also used to provide cardboard and paper with certain technical properties, with the aim of making the packaging water and grease resistant, so that they are suitable for direct contact with food. The application of polymers can take place in three ways:

- Applying coatings and laminates that create a physical layer on the surface of the board and paper
- Applying lacquers and/or water dispersions by means of coating methods and printing processes;
- Treating cardboard and paper by means of additions of various chemical substances, which takes place either during the paper making process or as post-treatment

Techniques of this kind are also applied to other pulp packaging such as sugar cane bagasse.

4 Water dispersions vs other coatings and barrier techniques

4.1 Comparison of all barrier techniques

Although all the techniques mentioned in chapter 3 are used for almost the same purpose, there are differences between them. The table below shows these differences:

Table 1 comparison barrier techniques

	EXTRUSION COATING	LAMINATE	WATER DISPERSION	SIZING	VARNISH / PRINTING PROCESS	PFAS
Physical form for application	Solid in form of plastic pellets	Solid in form of plastic pellets	Liquid	Liquid	Liquid	Liquid
Fibre materials for which the technique is suitable	Paper & Board	Paper, Board & Pulp	Paper, Board & Pulp	Paper, Board & Pulp	Paper, Board & Pulp	Paper, Board & Pulp
Multiple layers possible?	YES	YES	YES	YES	YES	NO
Does a separate layer form on the substrate?	**YES**– the material forms an extra layer on the surface	**YES** – the material forms an extra layer on the surface	**NO**, the treatment penetrates the cardboard and forms a film layer on the surface	**NO**, the treatment penetrates the cardboard and can create a film layer on the surface depending on method	**NO**, the treatment penetrates the cardboard and forms a film layer on the surface	**NO**, the treatment is only applied as an additive to the pulp
Contains Polymers	YES	YES	YES	Very likely	YES	NO
Sealable	YES	YES	Depending on chemical composition	NO	Depending on chemical composition	NO

4.2 Conclusion comparison between barrier techniques

The main difference between the standard plastic coating and the other barrier techniques, including water dispersion, is that the standard plastic coating has a solid shape before application. The material can be melted during application, but the layer that is applied to the fibre material also has a solid shape after cooling, which leads to the formation of a composite material.

Other barrier techniques, including water dispersion, work with liquids that are either partially or wholly incorporated into the fibre material. Depending on the method of application, these liquids can form a film layer on the surface after drying that cannot be physically separated from the substrate.

5 Material used in packaging for hot food and drinks

At the time of writing, there are actually no materials available that are capable of functioning as hot beverage packaging without the use of polymers in one form or another.

5.1 Durable materials such as glass, ceramics and metals

There are materials in which a hot drink can be consumed, such as heat-resistant glass, ceramics and stainless steel. These materials do not contain polymers. The glass and ceramics should both be disposed of with residual waste as they cannot be recycled. The stainless steel can be recycled with metal. However, these alternative materials without polymers will not be developed for single-use as they will have a higher environmental impact if they are only used once.



Figure 3 source: www.ecomondo.nl / www.promostore.nl/ www.deschenker.nl / www.kitchenhugs.nl/



Figure 4 source:catalog.depa.eu/

For hot meals, the available materials are the same as for hot drinks, in addition, an aluminium tray could be used for a take-away meal. If these aluminium trays are thick enough, they can be recycled.

However, aluminium as a packaging material is not suitable for contact with acidic foodstuffs and is therefore not suitable for general use without a polymeric coating, as was also shown in an earlier study into the presence of polymers in beverage cans that was carried out by The LCA Centre on behalf of Rijkswaterstaat in 2020.[1]

5.2 Paper, cardboard and (bagasse) pulp

Paper, cardboard and pulp packaging for drinks and hot meals almost always derives the functionality and suitability for direct food contact from the addition of polymers in one form or another.

Whether in the form of an extrusion coating/laminate, an addition to the paper (chemical treatment), a layer of lacquer applied with a printing process or a water-based dispersion coating.

[1] https://www.tweedekamer.nl/kamerstukken/brieven_regering/detail?id=2020Z18440&did=2020D39856



Figure 5 Source: fonkels.com/ conpax-shop.nl/www.moonendirect.nl/ www.nisbets.be/ www.vanhattemhoreca.nl

All four options do not necessarily have an adverse effect on the recycling of these products. They have been used for decades and factories that process recycled paper and cardboard are designed to remove these contaminants in their process.

The polymers in these products partly remain in the recycled paper/cardboard/pulp product, or they are filtered out.

Processing the filtered polymers and plastics into new products is very difficult and is not done on a large scale because these residues are highly polluted and consist of many different types of polymers. For the time being, the best solution for this material stream is incineration with energy recovery. If this combustion takes place on site, the energy is used, for example, to produce steam for drying the paper in the paper machine.

5.3 Conclusion material use

Virtually every type of material that can be used for the production of disposable packaging for (warm) food and drinks contains synthetic polymers that are either incorporated in the material itself or on its surface.

The materials that are suitable for packaging (warm) foodstuffs and drinks that can function without synthetic polymers such as glass and metal are not suitable for single use due to their relatively high environmental impact.

6 Recycling (food) packaging with water dispersion

Recycling of paper and cardboard food packaging has many limitations. Although cardboard and paper are generally considered to be easily recyclable, contamination with food waste is usually a problem. Furthermore, there are also limitations with regard to so-called foreign material. This includes all additions of synthetic polymers such as inks, adhesives, coatings, windows, tape, etc.

6.1 Paper waste separation guide

The amended separation guide for paper waste that has recently been published by PRN (Papier Recycling Nederland – Paper Recycling Netherlands, allows single-sided plastic-coated clean food packaging in the recycling stream, but used coffee cups (regardless of the coating) are explicitly excluded from the collection. Food packaging without grease stains and food residues is allowed. However, it should be noted that most direct contact food packaging will contain some form of food contamination.



Figure 6 Separation guide for old paper

6.2 KIDV recycle check paper and cardboard

In the KIDV (Netherlands Institute for Sustainable Packaging) recycling check, a distinction is made between traditional plastic coatings and water dispersions.

Plastic coatings (single-sided) are permitted provided that a recycling test performed by a recognized laboratory demonstrates that the packaging concerned does not disrupt the standard recycling process. The water dispersions are by definition considered undesirable due to the formation of so-called "stickies" – these are polymeric residues that remain in the pulp.

This approach is remarkable due to the fact that like in the case of inks and adhesives that also cause polymer residues, water dispersions is a collective term for many different substances. The chemical composition and the amount of water dispersion applied can also differ considerably per product.

As the figure below illustrates, for adhesives in contrast to water dispersions, a distinction is made between different types of adhesives and the amounts applied.

Tabel 2: The effects of various adhesive types on the recycling process

Type of adhesive	Explanation	Effect on the recycling process
Form retaining (cold-set and hardening)	Those adhesives don't change in form and viscosity in the recycling process under pressure in temperatures 35-60°C	Not disturbing
Form changing (hotmelt*, pressure sensitive)	Those adhesives change in form and viscosity under the process conditions (pressure and/or temperatures 35-60°C). They penetrate through the process which makes the removal of the residues difficult. **Avoid using hotmelts with melting temperature below 68°C) as well as pressure sensitive adhesives.**	Slightly disturbing
Water soluble	Those adhesives dissolve in process water and penetrate into the process. Once dissolved, those adhesives can be removed with help of dispersion additives.	Not disturbing

**) Should a hotmelt adhesive be applied, then a long strip is preferred over small adhesive dots. The chances of successful removal of the strip are higher compared to the removal of small dots.*

Figure 6 Translation of the explanation of adhesive use KIDV recycle check

6.3 *Practical recycling testing*

The LCA Centre has conducted extensive research over the past two years into the application and technical properties of water dispersions in food and beverage packaging. As part of this research, several external recycling tests were also performed. In all tests, used paper beverage cups were applied as test samples. Cups with the same specification were sent to an accredited lab and to a Dutch paper and board processor, which is known for its ability to process coated board and paper as mono-fraction into hygienic paper.

The aim of the test at PTS lab was to gain insight into suitability of the cups coated with water dispersion for a standard paper waste recycling process (so-called mixed paper waste stream).

The internal tests at the Dutch processor were intended to determine the suitability of the waste stream from used coffee cups for separate collection and processing as mono-fraction.

- **Results of external lab recycling test, PTS-Report AB.0002674 of 1 December 2020**

The test has shown that the recycling of the water dispersion coated drinking cups guarantees a high fibre recovery percentage, but also creates impurities (polymer residues) in the paper. As a result, the cups would only be recyclable to a limited extent. This means that the cups could not be used as a mono-fraction, but are suitable for processing in the "mixed fraction", that being the standard paper waste recycling stream of households and companies. In short, the test shows that the cups can be recycled in a paper waste stream.

Sample code		**Sample 1: Cup**
Disinte-gratability	Non-paper constituents[1]	One-side barrier coating (unknown material) – not quantified.
	Total reject[2]	7.1 %
	Recyclable percentage[3]	92.9 %
Sheet formation	Adhesive impurities	Present and damaging.
	Optical Inhomogeneities	Present and disturbing.
OVERALL RATING Recyclability		**Limitedly recyclable due to optical inhomogeneities in the prepared fibre stock.* AND Limitedly recyclable due to tackiness in the prepared fibre stock.***

* Recyclable in a mixture like the household collection. Cannot be used as a mono-fraction without additional treatment.

Figure 8 results of a recycling test at PTS Lab

- **Results of an internal lab recycling test at a hygienic paper producer, dated 31-03-202**

This test is a part of a standard procedure that the manufacturer uses to assess to what extent a certain quality of offered material can serve as raw material for their production process. This test has shown that the company in question can use the water-dispersed coated cups as raw material.

In addition, a comment was also made that they can only process the cups because the company has specialized equipment. Processing is then only possible if the cups are presented as a mono-fraction in a separate stream. However, mixed in normal paper waste, the cups would certainly cause problems in the material preparations that are only suitable for clean paper waste such as typically processed at large cardboard recycling facilities.

This conclusion is at odds with the findings of an external lab, which in fact advises that the cups should only be disposed of in the mixed flow of household paper waste.

Date	31-3-2021	**File number**	**0**
Description material		used coffee cups white	

Analyses			**Notes**
Material recyclability	Wet strength	N	
	Recyclability	Y	
Ash content	%ash	3,22	
Stickies	mm2/m2	650	
non-paper rejects	%	5,48	
Colour measurement	L*D65/10	94,14	
	a*D65/10	-1,48	
	b*D65/10	7,73	
	Whiteness	76,51	
	Whiteness UV	76,47	
COD	kg COD/Adt	38,375	
Additional notes			
Ok for recycling			

Figure 7results of an internal recycling test

6.4 Recycling claims made by the suppliers of paper beverage cups with water dispersion

One of the most well-known and largest suppliers of water-dispersion cardboard packaging is a Finnish cardboard factory, which has been a part of one of the largest cardboard producers in Europe since August 2021.

On the website of this company, we found the communication below:

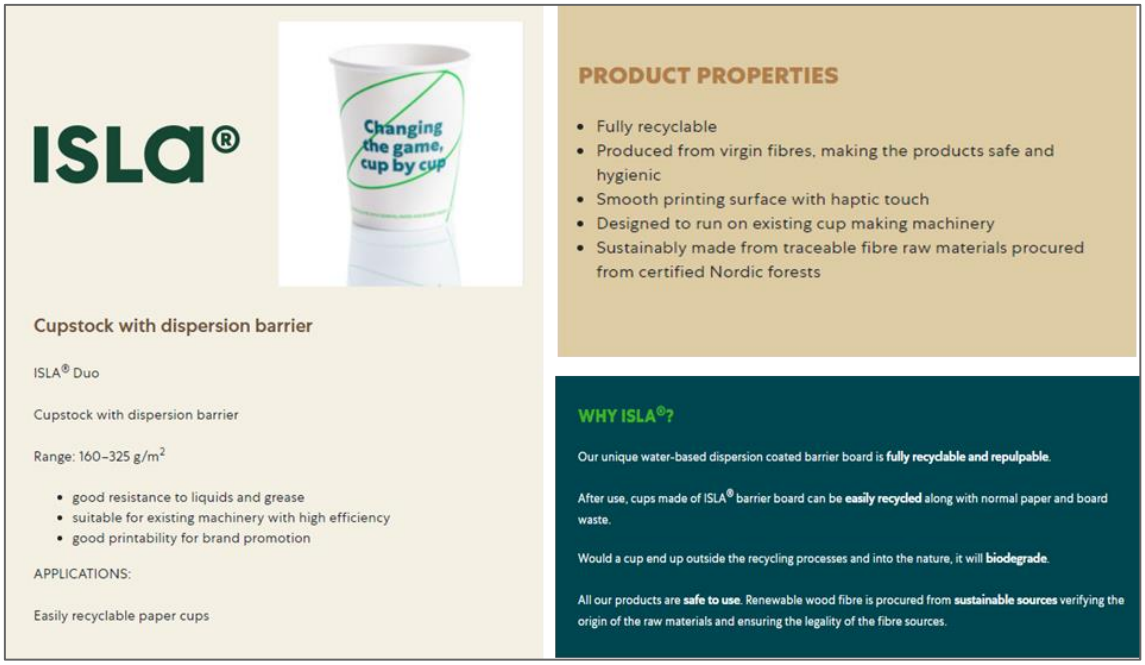

Figure 8 Product information ISLA cardboard with dispersion

The information reinforced by the fact that this paper producer also processes paper and pulp from recycled material, shows that the water-dispersion treated paper cups could be recycled "easily" and "completely". That while the official reporting from KIDV and the Foundation Knowledge Centre Cardboard and Paper[2] (*Stichting Kenniscentrum Karton en Papier)* indicates that dispersion coatings are undesirable because they interfere with the recycling process.

6.5 Recycling Conclusion

Although the general recycling guidelines expressly label the use of water dispersion for cardboard packaging as undesirable, field tests and information provided by a paper producer and processor of recycled material show a different picture.

These conflicting findings lead to the conclusion that it makes sense to set the same recycling test requirement for paper and cardboard packaging, using standard plastic with those applying water dispersions.

[2] https://prn.nl/wp-content/uploads/2019/10/Recycling-van-papier-en-karton-in-Nederland-in-2019-10-09-2019.pdf

7 “Plastic-free” certifications and labels

The public debate surrounding the negative effects of plastic and the increasing consumer demand for alternatives to plastic has created a need for external verification of “plastic-free” claims. The most well-known trust marks and certificates are explained below.

7.1 PLASTIC FREE from A Plastic Planet

This “PLASTIC FREE” seal of approval was introduced by the UK based non-profit organization, A Plastic Planet. It was the first and is also the most well-known plastic-free label, which can be obtained through official certification bodies such as Control Union. The two founders of A Plastic Planet have been very successful in conducting large-scale, international plastic awareness campaigns in recent years.

The trust mark is issued at product level. The problem, however, is that the plastic definition used by A Plastic Planet does not match the legal definitions of plastic. A Plastic Planet does not regard compostable plastics such as PLA as plastic. Products and packaging made from compostable plastic or containing compostable plastic are therefore designated as “plastic free”.

Companies that opt for this trust mark can therefore make an incorrect assumption that certified products automatically fall outside the scope of the SUP regulations.

An example of this is a Dutch supermarket that was praised worldwide in the media with the message about the first "plastic-free" store shelf, and subsequently encountered criticism because the "plastic-free" claim was rightly questioned.

This Plastic Free trust mark consists of 3 modules:

- Material of the product
- Packaging material
- Retail ready products

Individual products or product series can be certified. It is not clear how the verification process works. The information on this is missing.

7.2 FLUSTIX plastic free from DINCerto (TUV Rheinland)

The trademark Flustix was taken over by DINCerto in 2018 from the original creator of the trust mark. In 2020, new, tightened criteria for obtaining this trust mark was introduced. Products certified before November 2020 do not comply with this marking. The question is, for how long do these trust marks remain valid?

Definitions within Flustix:

3.3 Polymer

The term polymer is used to describe chemical compounds consisting of chain or branched molecules (macromolecules), which in turn consist of a large number of identical or similar units known as monomers.[1]

Polymers that occur naturally and have not been chemically modified (other than by hydrolysis) are excluded from this certification scheme as well as polymers that are (bio) degradable.[2]

3.4 Plastics

Plastics are organic macromolecular compounds obtained by polymerization, polycondensation, polyaddition or a similar process of molecules with a lower molecular weight or by chemical modification of natural molecules. Other substances or materials may also be added to these compounds. The starting materials for plastics have a natural basis (fossil raw materials), which are specifically produced by chemical reactions to form polymeric materials. A distinction is made between elastomers, thermoplastics and duroplastics.[3]

The term synthetic material means plastic.

Furthermore, there is mention of unavoidable residues of plastic that, for example, end up in the product due to contamination. This plastic contamination may not exceed 0.2% of the total weight of the product or packaging eligible for the plastic-free claim **(section 3.8).**

An exception is also made for the presence of plastic components that cannot technically be avoided, such as in the case of recycled cardboard and paper. For the tolerances and maximum limits, reference is made to DIN EN643 **(section 3.9).**

Paper and cardboard manufactured from new fibres are listed separately. For these materials, a maximum plastic content limit of 0.75% of the total weight of the product or packaging is accepted as being necessary, for the proper functioning of the product or packaging from a technical perspective. As an example of such a technically necessary plastic content, glue in the back of a book is mentioned **(section 3.9.1).**

Criteria for awarding the label are defined as follows:

4.1 Plastic-free total product, plastic-free packaging

A consumer good or packaging according to section 3 shall be deemed to be free of plastics if, taking into account sections 3.8 and 3.9, it consists of components, materials, ingredients and/or materials that do not contain plastics within the meaning of section 3.4.

4.2 Plastic-free product

A product as defined in section 3.1.1 is considered to be free of plastics if, taking into account sections 3.8 and 3.9, it consists of components, materials, ingredients and/or materials that do not contain plastics as defined in section 3.4.

For the verification of the claims, DINCerto works together with a specialized laboratory – Wesselink that uses analytical methods to determine the plastic content.

flustix PLASTIKFREI	**FLUSTIX completely plastic-free.** For a plastic-free product / packaging combination	flustix NO PLASTICS PRODUCT	**FLUSTIX plastic-free** product. For all types of products that do not contain plastic (e.g. toys)
flustix NO PLASTICS PACKAGING	**FLUSTIX plastic-free packaging.** For packaging that does not contain plastic	flustix NO PLASTICS CONTENT FREE FROM MICROPLASTICS	**FLUSTIX micro-plastic free.** For liquid and semi-liquid products that would typically contain microplastics such as cosmetics, toothpaste and abrasives.

On the Flustix website a statement is made that the Plastic Free trust mark demonstrates that a product falls outside the scope of SUP Directive, however no evidence pointing at the official accreditation by the EU Commission is present.

7.3 Plastic Free Certification Standard from Plastic Free Certification (PFC)

The Plastic Free Certification, founded in 2018, is an Italian consultancy agency supporting companies in eliminating disposable plastics from their activities and the supply chain. They focus mainly on disposable plastic packaging (primary, secondary and tertiary).

The certificate is issued by the PFC Certification Committee in relation to a whole company or a specific product line. PFC claims to cooperate with qualified European auditors who have completed a dedicated PFC training. There are 5 certification levels corresponding with the 5 step approach applied by PFC.

Lower compliance levels (E, D and C) demonstrate that a company has completed an inventory of all disposable plastic products and packaging within the supply chain, but no reduction plans are yet available with regard to direct purchase of single use plastic packaging and internal plastic use. Higher compliance levels (A and B) demonstrate that a company has implemented a policy eradicating disposable plastic from the whole operation. The whole process consists of 5 steps:

- **Plastic assessment** - **Plastic reduction plan** – **Implementation**– **Audit** – **Issuing Certificate**

This certification is therefore not aimed at demonstrating that a product does not contain plastic but demonstrates that a company has succeeded in eliminating single-use plastic packaging from all activities. It is not clear which definition of plastic or plastic single-use packaging is used here.

A reference is made to the standard plastic recycling symbols (triangles from 1 to 7) but at the same time plastics made from "fossil raw materials" are mentioned, which implies that bioplastics are excluded from plastic definitions. Since this is an Italian company, this assumption may be correct, as explained in the next subchapter.

7.4 Plastic-free Certificate from Sfridoo® (Italy)

The Sfridoo certificate for disposable plastic-free products and services is presented as a process management scheme aimed at continuous improvement within a company. It is supposed to be in line with the policy of the Italian Ministry of the Environment. As with PFC, an emphasis is placed here on the company's activities and, to a lesser extent, on the verification of the material composition of a particular product. While this certification would be widely available across Europe, most of the information is only available in Italian. It is not clear which definition of plastic or plastic single-use product is used here.

It should be mentioned here that the definition of plastic and the delineation of the scope of the SUP Directive included in the Italian implementation proposal differ fundamentally from the original definitions. Not only is a 10% plastic content allowed under the scope but are biodegradable and compostable products excluded from the scope. It is very likely that Italian "plastic free" certification and trust mark schemes will follow this line of thought.

a) 'plastic' means: material consisting of a polymer as defined in Article 3(5) of Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 to which additives or other substances may have been added, and which may function as the main structural component of the finished products, with the exception of natural polymers which have not been chemically modified; materials such as paints, inks, adhesives and ***plastic coatings weighing less than 10 % of the total weight of the product****, which are not the main structural component of the finished products, are excluded from this definition.*

ARTICLE 5

(*Placing on the market restrictions*)

[…]

3. ***The placing on the market of products made of biodegradable and compostable material,*** certified in accordance with the European standard of UNI EN 13432 or UNI EN 14995, with percentages of renewable raw material equal to or greater than 40 % and, from 1 January 2024, more than 60 %, ***shall not be covered by the prohibition*** referred to in subparagraph 1, […]

In view of the precedent of the scope changes previously announced by France, it is unlikely that this legislation will be accepted by the EU Commission.

7.5 Plastic Free Certification from The Plastic Free Company (Cyprus)

The Plastic Free Company is a Cypriot organization said to be founded by (former) employees of recognized nongovernmental environmental organizations. It is not known which organization(s)those are. Just like the Italian trust marks, this one is mainly aimed at awareness of single-use plastic use. It is also not clear which definition of plastic and single-use plastic product is used. The 5-step scheme is similar to the approach used by the Italian namesake (Plastic Free Certification Standard). The certification is available in 3 modules:

EVENT	WORKPLACE	PRODUCT
For festivals and events	For office buildings and other workplace related facilities	Divided into 1. **Entirely Plastic Free** (product/packaging combination). 2. **Plastic Free Packaging** 3. **Plastic Free Content** (applies only to products that are legally required to be packed in plastic

7.6 Social "plastic free" initiatives

In addition to the trust marks and certifications, local initiatives also emerge aiming at encouraging consumers, companies or local institutions to adopt a plastic-free policy. Below are two recent examples of such actions:

Plastic Free Schools (UK)

Plastic Free Balearics (Spain)

7.7 Conclusion trust marks

Two sorts of trust marks and certificates are emerging:

- Labels that verify the absence of plastic in a certain product (Plastic Free/Flustix)
- Certification schemes that mainly focus on making all activities of the company or event plastic free (Italian and Cypriot schemes)

Plastic Free from A Plastic Planet is the best-known trust mark, but due to the conflicting definition, it cannot be regarded as verification of compliance with the SUP Directive. The same objection can be made for the Italian Plastic Free trust marks.

Of all the trust marks that have appeared on the market so far, Flustix seems to be the most thorough and transparent. The definitions and the verification method are based on scientific insights and international regulations. Although there is no official recognition by the authorities, this trust mark has the best chance of actually getting that recognition

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