FEICA The European voice of the **adhesive** and **sealant industry**

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Adhesives in the context of paper & board recycling – state of play

Contents

Background

Fibre-based products, in particular paper and board, play an important role in packaging and printing industries. In addition to the material properties that make fibre-based products very fit for this purpose, their biobased origin and the high recycling rates for paper and board[1] provide tangible sustainability benefits.

Many fibre-based product designs, in particular in the area of packaging, rely on adhesives. Adhesives are used in corrugation, bag and box making, box closing, lamination, sealing, labelling and many other applications.

Both statistical figures on paper and board recycling in Europe[1] as well as statements by stakeholders from the packaging industry[2], [3] confirm the successful recycling of fibre-based products, including those which contain adhesive applications. At the same time, a concern is regularly voiced over the presence of (certain) adhesives in fibre-based products with a view to their potential impacts on paper recycling.

This report seeks to summarise the current state of play in terms of how adhesives are reflected in design-for-recycling guidelines, and in test methods and assessment schemes for recyclability. It includes suggestions on how the specification and recognition of adhesives in these documents may be further improved while balancing their importance for the manufacture of fibre-based products with the needs of paper recycling mills.

Executive Summary

This document starts with a simplified description of the paper recycling process and explains in some detail how adhesives pass through paper recycling. Two possible pathways exist that adhesives in paper and fibre packaging applications can take during the recycling process – removal or incorporation into the recycled paper.

In the next chapter, the reader will find an overview of different existing design guidelines for fibre-based products and their advice as regards adhesives. It is shown that the advice of the different guidelines varies and some discrepancies become apparent.

An overview of paper recyclability test methods and assessment schemes is followed by a closer look at how adhesives are assessed in these schemes. Some weaknesses of the existing methods and possibilities for improvement will be discussed.

In the last chapter of the document, FEICA elaborates on some considerations and makes recommendations on how to approach adhesives in paper and fibre-based recycling.

What is the issue/legislation?

Simplified description of the paper recycling process

The process of paper recycling differs between graphical papers and fibre packaging but can in a simplified fashion be subdivided into the sequential steps of:

1. **(Re)pulping** to disintegrate recovered fibre-based products into a fibre slurry (the 'pulp')
2. **Screening** (filtration) of the pulp and possibly **additional cleaning steps** to remove non-fibre components and materials
3. **Deinking** to remove colour from the pulp and increase its whiteness (applied in case of graphical paper production, and potentially in tissue paper production from recovered paper)
4. **Papermaking**, which converts the cleaned pulp into reels of recycled paper

Recyclability of fibre-based products is determined by factors that impact these process steps in terms of their yield, productivity and the achievable purity and quality of the output, i.e., the recycled paper or board.

In addition to the primary material flow from recovered fibre-based products to recycled paper, side products/waste streams are created. The two main streams are **reject material** collected on filter screens,[1] such as non-paper parts of input materials (metal clips, plastic parts and films) and other materials such as adhesives if they can be retained on the filter screens[2], and **wastewater.**

Recyclability considerations may include these two side streams as well.

Adhesives in the paper recycling process

The aim of any recycling process is the recovery of a target material in highest possible yield and purity. Any material in the recycling input which is not target material would ideally be removed in the process, reducing yields somewhat but maximising the quality of the recycled output material. In the specific case of recycling of paper and board, i.e., fibre-based products, the target material is paper fibres.

Adhesives, just as other non-target materials, are therefore generally required to be compatible with the recycling process for the target material, rather than being the target material of the recycling.

Different adhesives technologies can be used in fibre-based products. For more details on which types of adhesives may be present in fibre-based products, please consult the FEICA paper on terminology and definitions to be used in the context of adhesives in the recycling of packaging.[4]

Removal of adhesives during recycling may occur by mechanical separation (by screening or other processes such as water cyclones) or by removing the adhesive with the process water during papermaking (in the case of water-soluble adhesive applications).

To a certain extent, recycling processes may also allow for non-target materials to become part of the recycled output material if the quality and performance of the recycled materials remain within

[1] Or in other additional cleaning steps, if present.

[2] Reject material is typically not sent to other recycling processes but disposed of. Certain materials, especially ferromagnetic metals, may still be recovered from this waste stream though. Efforts are underway to recover plastic films and aluminium foil from beverage carton rejects.

specifications. If adhesive applications are not (fully) removed before or during papermaking, adhesive fragments may become part of the recycled paper. The key criteria for the acceptability of their presence in the formed paper are the optical appearance of the paper and its potential stickiness. If the formed paper exhibits stickiness, defects in the paper reel and/or processing issues such as reel breaks may occur. The impact of adhesive particles on both aspects may depend, beyond their intrinsic properties, on the size of the adhesive application within the packaging item.

The two possible pathways that adhesives can take during paper recycling – removal or incorporation into the recycled paper – find their expression both in **design-for-recycling guidelines** for fibre-based products as well as in **test methods** and **assessments of recyclability** in practice. The order of preference between the two options of removal or incorporation, however, differs between guidelines and between test methods. The following section will provide an overview of existing **design guidelines** whereas the final section of this report will discuss **test methods** and **assessment schemes**.

Design guidelines for fibre-based products

Over recent years, several guidelines have been published which aim to describe design-for-recycling principles for fibre-based products such as graphical paper and paper and board packaging.

These design guidelines describe what elements and features of a finished product, such as inks, coatings, decorations and adhesives, are considered either preferable or discouraged from the standpoint of recyclability of the fibre product.

Design guidance is typically provided in terms of preferred and not preferred materials/components or in terms of the compatibility of certain materials/components with recycling, often distinguishing the three categories: '(fully) compatible', 'limited/conditional compatibility' and 'not compatible'.

Table 1 provides an overview of entities that publish design guidelines for fibre-based products in Europe and globally.

Table 1: Overview of publishers of design guidelines for fibre-based products (non-exhaustive list).

	Europe	Global
Graphical paper	EPRC[5]	WEF[6]
Packaging	4evergreen[7] ACE[8] Cepi[9] cerec[10] CPI[11]/WRAP&CPI[12] FEFCO[13] FH Campus Wien[14] FTI[15] RESY[16] Veolia[17]Zentrale Stelle, Germany[18]	AFPA[19] GreenBlue[20] PACSA[21] WEF[6] WPO[22]
Food service items	CPI[11]/WRAP&CPI[12]	

Adhesives in design-for-recycling guidelines for paper

Table 3 (see Annex) provides an overview of adhesive-related statements made in the guidelines listed above. This section will discuss the most common statements and requirements.

Several guidelines recommend the **minimisation of applied adhesive**. The reduction of non-target materials to the functionally required minimum is a general principle in design-for-recycling, with the aim to maximise yield and minimise burden on cleaning steps. This principle is therefore applicable not to adhesive specifically, but to all non-fibre components.

Certain guidelines give preference to adhesive **removability** by filtration/screening (Cepi, EPRC, GreenBlue, RESY, Zentrale Stelle). This approach would see the adhesive mechanically removed after pulping but before papermaking.[3] In these guidelines, a preference may be expressed for dimensionally large adhesive applications which will lead to large adhesive particles being formed in pulping, which are readily removed by filter screens.

Other guidelines prefer **solubility of the adhesive in water** (AFPA, CPI, FEFCO, FTI, Veolia, WRAP), which would see the adhesive removed with the process water during papermaking rather than by filter screens.

A smaller number of guidelines (FEFCO, Zentrale Stelle) imply that '**redispersibility'** of adhesive applications is a preferred property, even though from a technical viewpoint this may lead to adhesive fragments passing filter screens more easily and therefore complicating complete removal.[4] Clarification should be encouraged as to under which circumstances or at which particle size, dispersing of an adhesive application will prove beneficial.[5]

Several design guidelines address the **'softness'** of adhesives, ultimately with a view to the presence or absence of tack of the adhesive application or adhesive fragments during recycling processes.[6] Tack is generally seen as detrimental due to the risk of deposits of adhesive particles forming on equipment and the risk of imparting stickiness to the produced paper. As such, pressure sensitive applications and adhesives with higher softness are regularly named as a concern, whereas high softening point adhesives or non-thermoplastic, crosslinked adhesive applications are considered the lowest risk. The specification of acceptable softening points or 'softness' is currently still rather qualitative in many guidelines.

The recommendations in these guidelines are often made without considering the adhesive technology and application in detail, as, e.g., removability is most relevant for hotmelt adhesive applications of a sufficient size, whereas solubility or redispersibilty is more relevant for smaller/thinner adhesive applications, such as water-based adhesives. All these approaches may be of use where packaging design and recycling technology match.

[3] In the case of graphical paper recycling, also before deinking.

[4] This can conceptually be more readily accepted if the adhesive does not negatively affect the stickiness of the produced paper, but the mentioned guidelines do not contain provisions related to stickiness.

[5] For example, at very low particle size, optical effects of adhesives entering the formed paper may be reduced; smaller particles with surface tack may lead to less inter-sheet adhesion.

[6] Softness is also at times considered as a proxy indicator of the deformability of adhesive fragments, increasing the chance of them being 'squeezed' through filter screens at the elevated pressures during processing.

Assessing paper recyclability

Test methods for assessing the recyclability of fibre-based products typically seek to mirror and simulate the process steps in an actual paper mill as described in the chapter 'Simplified description of the paper recycling process'. In particular, test methods typically seek to determine the following:

1. Successful **disintegration** of the test material under pulping conditions, typically by determining the mass of non-disintegrated material recoverable on a coarse screen after pulping. This rejected material is typically called 'coarse reject' and is considered as a yield loss.
2. **Screenability of adhesive applications and other additive materials** by determining the amount of material collected on one or two finer screening steps. This step is generally simulated using flat screens.[7] The reject from this stage is typically called 'flake content'. The reject found on the screens may, depending on the method, be analysed for its stickiness, or only weighed or photographed.
   Test methods may opt to simulate **additional cleaning steps** such as sedimentation, flotation and water cyclones, which may be installed in paper mills. As with screening, typically, the amount of reject as well as the quality of the 'accept' (in the form of hand sheets) is determined after each additional cleaning step.
3. **Deinkability of the product is evaluated through a simulation of the deinking process.** Even though this step may provide an additional removal of adhesive particles, the focus of assessment is generally the colour of the pulp/paper[23]. Deinking testing is therefore not covered in this document.
4. **Quality of the formed paper from the pulp obtained after the above steps.** This step simulates papermaking through the forming of paper 'hand sheets' from the screened[8] pulp. A formed small sheet of paper is evaluated visually for defects or impurities. Additionally, stickiness of the sheet at elevated temperature ('sheet adhesion') is typically evaluated to predict possible concerns for the practical operation of papermaking machinery.
   Further testing on (hand) sheets may include testing for mechanical properties, wetting behaviour and other performance metrics common for paper and board[24].

In addition to the above testing, the mass of material dissolved or dispersed in the process water across the above steps may be determined by calculation or measurement. Material which is not rejected by screening (or possible additional cleaning steps and deinking) undergoes standard wastewater treatment steps.

Available test & assessment methods

Several **test methods** have been established to test the recyclability of fibre-based products. Typically, they apply to one of two specific streams of recovered paper (or board), namely, graphical paper or fibre-based packaging.[9] This differentiation is due to differences in pulping conditions and the presence or absence of a deinking step in the respective paper mills. **4evergreen** will in the future consider additional cases as well, namely, beverage cartons and other composite materials.[10] These types of packaging are recycled in special paper mills, which are set up differently from mills for graphical paper or (general) packaging[7].

[7] Actual paper mills may use different geometries for the screens.
[8] In a certain method, the unscreened pulp, too, is formed into a sheet to serve as a control for determining the efficiency of removal of sticky materials in the screening step.
[9] While most methods focus on the determination of recyclability of a finished product design, adhesive-specific test methods do exist as well. See Table 2.
[10] A composite packaging material containing paper, polyethylene and in some cases aluminium foil.

To assess recyclability, in addition to the **test method**, which provides the procedure and defines the numerical results, an **assessment scheme** is required, which provides threshold values (pass/fail criteria). The two may be contained in one document or be published separately, including from different issuing entities. Table 2 provides an overview of test methods and assessment schemes for determining the recyclability of fibre-based products.

Table 2: Test methods and assessment schemes for determining the recyclability of fibre-based products (non-exhaustive list).

	Europe		**Global**	
	Testing	Assessment	Testing	Assessment
Graphical paper	— PTS-RH 021[25] Category I —			
	INGEDE12[26], using INGEDE4[27]	EPRC scorecard[28]		
Packaging	— PTS-RH 021[25] Category II —		— FBA[24], using TAPPI methods —	
	UNI 11743[29]	Aticelca 501		
	Cepi[30], using ISO 15360-2[31]	4evergreen evaluation protocol[32]		
	EcoPaperLoop Method 1[33]	EcoPaperLoop score card (draft)[34]		
	CTP REC21[35]	CTP assessment		
Adhesive-specific methods[11]	INGEDE12[26], using INGEDE4[27]	FINAT[37], based on EPRC scorecard[28]	TLMI LRP-2, MRP-2, IAP-2 [38], [39], [40]	TLMI RCA specification[29]

Adhesives in test methods & assessment schemes

When the four aspects are considered that recyclability assessments seek to investigate (pulpability, screenability, deinkability, quality of the output), adhesives are typically found to influence only two. In the step of pulping, adhesives themselves typically do not substantially impact pulpability.[12] Deinkability testing is typically focused on colour rather than adhesive properties. When recyclability testing methods are considered for fibre-based products in the context of adhesives, the focus should therefore be on screenability testing and the testing of hand sheets produced from the pulp after screening. It is noteworthy that the results of current hand sheet adhesion tests are subjective (visual evaluation) and a testing against a control sample is not part of European testing protocols.[13] Furthermore, peel angle and speed in these tests are not standardised, which may lead to variability in the results. Therefore, the results from sheet adhesion tests may not always be comparable.

[11] Additional methods for determining stickies exist, such as by TAPPI[36].
[12] Certain laminated structures may be difficult to pulp under conditions of a standard mill. This is however generally due to, for example, plastic layers blocking the access of water to the fibres rather than to the adhesive's properties.
[13] Testing against a control sample is part of the American Fibre Box Association standard part 2.

Considerations and recommendations

Related to design guidelines

In order to develop design guidelines further in terms of clarity, applicability and benefit to the quality of paper recycling, while recognising the importance of adhesives in fibre-based product manufacture, the following aspects should be addressed in pertinent guidelines and design for recycling criteria:

- **Acknowledge the minimisation approach for adhesive applications but ensure the approach is followed uniformly for all non-target material**, i.e., any non-fibre material. This would recognise universally valid principles which would ensure that all materials are held to a high standard

- **When establishing guidelines, describe adhesives characteristics and possible options for adhesive application behaviour during paper recycling, rather than describe or favour certain adhesives technologies**. Relevant characteristics are, for example, removability by screening,[14] solubility in water, fragmentation and dispersion in water

    - **With regard to removability by screening, acknowledge the preference for dimensionally large adhesive applications, which are easily screened** on the basis of available evidence [2], [41], [28]
    - **Acknowledge that dimensional preferences cannot reasonably be achieved for all adhesive applications,** such as corrugation, laminations, sealable coatings (i.e., heat seal, cold seal) – all of which are applied in thicknesses in the order of micrometres and might therefore fragment along the other two dimensions during pulping – and that such applications are regularly found to be compatible with paper recycling[2], [41] if they are either still removable on screens, water soluble or not detrimental to the finished paper (see the cases described above)
    - **With regard to solubility and dispersibility, it is important to define test methods.**

- **As a general principle, allow for testing as an additional way to demonstrate compliance as an alternative way to guidelines and recyclability criteria**. If a specific product design can be shown to meet all criteria of an accepted test method /assessment scheme, then this finding should be allowed to override the more generic statements in a design guideline, which, out of necessity, are provided for a whole group of materials/elements, which have not all been tested individually and may differ substantially in their properties. Allowing for testing to override guideline text will prevent unnecessary market barriers for well-designed adhesives

  For example, for materials/elements for which a 'full compatibility' or 'preferred' status cannot be obtained in design guidelines for the entire group, provide the option of obtaining 'full compatibility' for individual products that pass relevant testing. For example, if certain adhesive applications overall are to be recognised as having only 'limited compatibility' in a guideline, give consideration to recognising adhesive applications that pass relevant testing as 'fully compatible' (see 4vergreen guidelines[7] for an illustration of this principle)

- **Be aware that the technical data sheet or safety data sheet of an adhesive always describes its delivery form – these documents should not be used as the source of information on the**

[14] Papermaking temperatures should not be relevant at this stage as the screening occurs before papermaking; adhesive particles that are not sticky at pulping or screening conditions should not form deposits. Adhesive particles that are not sticky at the temperatures of pulping or screening but do become sticky at temperatures of papermaking would be discriminated from those that do not become sticky as part of the last bullet point.

solubility, dispersibility or any other property of the adhesive application that enters the recycling processes. The properties of an adhesive may change substantially between its delivery form and its final state on the fibre-based product which enters recycling. Differences arise, for example, in the form of removal of water, solvents, and additives from adhesives during application and drying as well as because of curing and setting processes. **Therefore, design-for-recycling criteria should explain the required performance characteristics during the recycling process (solubility, dispersibility, etc.) rather than choosing a preferred adhesives technology**

- **Avoid certain imprecise or not fully predictive terminology when specifying requirements on adhesive applications in design guidelines.** For example:
    - 'Plasticising': refer to 'softening' or 'tack' instead, particularly when the cause of softening and stickiness is temperature and not the incorporation of a plasticising substance
    - 'Reactive'/'curable': this characteristic does not predict the properties of the adhesive application in terms of removability, solubility, dispersibility or surface tack[15]
    - 'Cold-set': this property does not predict the properties of the adhesive application in terms of removability, solubility, dispersibility or surface tack[16]
    - 'Water-based'/'Solvent-based': neither the water nor the solvent contained in the adhesive's delivery form will be present in fibre-based products when they enter recycling,[17] and this property does not predict the properties of the adhesive application in terms of removability, solubility, dispersibility or surface tack

Related to test methods

In order to develop test methods and assessment schemes further in terms of clarity, applicability and benefit to the quality of paper recycling, while recognising the importance of adhesives in fibre-based product manufacture, the following aspects should be addressed by the supply chain:

- **Improve on reproducibility and quantifiability of the sheet adhesion test**
    - **Consider performing an automated sheet adhesion testing using a testing machine** rather than manual separation. The fixed peel/crosshead speed and a controlled peel angle can provide more consistent results versus manual peeling of lab sheets.[18] Automated adhesion force measurement after application of heat and pressure could provide a more granular result than visual inspection of fibre 'picking' or tearing of the lab sheet

    - Additional parameters of the test could be controlled more closely, in particular **ambient and sample temperature and ambient humidity**, both of which may influence adhesion force

    - **The exact material for the cardboard support and the cover sheet used in sheet adhesion tests should be specified to ensure reproducibility.** The existing standard EN ISO 5269-2, chapter 4.1.2.2 including the footnote, could add to reproducibility and

[15] For example, a UV reactive PSA will exhibit substantial tack whereas a reactive PU hotmelt bookbinding adhesive may be considered no longer thermoplastic after curing and therefore not at any risk of exhibiting tack under paper recycling conditions.
[16] For example, water-based adhesives can give rise to both water soluble and not water-soluble adhesive applications, depending on the properties of the adhesive. Both 'cold-set' as well as hotmelt adhesives exist in pressure sensitive and in not pressure sensitive forms.
[17] As there is no 1:1 or 1:N correlation between the delivery form of the adhesive and its polymer chemistry. For example, acrylic polymers may be applied from solvent or water. PU polymers may additionally be applied as hotmelts. The impact on recycling will be determined by the adhesive application as present on the finished fibre-based product.
[18] Changing the speed or angle of peeling can strongly influence the outcome of adhesive peel tests. Trying to peel a label off a product provides a good everyday example of how lower speed and different angle can lead to clean peeling rather than tearing off the label.

should be cited in pertinent testing protocols

- **In conjunction with the prior point, investigate the thresholds for hand sheet adhesion testing by correlating test results with practical experience of recyclability in paper mills.** Materials which are not problematic in paper mills should not give rise to 'fail' results in sheet adhesion tests. A series of lab testing of known-good fibre-based product designs may serve to refine the score allocation

- **Investigate current test procedures**[19] **for determining 'macrostickies' and their assessment.** The macrosticky test recovers the reject from fine screening and determines its sticky particle size distribution and overall sticky surface on a sheet. This test is used to evaluate the sticky load, which is retained in lab-scale testing but would eventually pass filter screens in paper mills due to higher operating pressure

  The method presents several challenges:
  - All the rejects are measured. This is problematic for materials, which would have been eliminated in a paper mill at an early stage, e.g., metallised particles. Also, particles between 2 and 5 mm will be tested although their presence on the final paper in a real-life paper production process is excluded
  - Overlapping particles are counted as one bigger particle, which improves but falsifies the overall result. This risk is mitigated by reducing the amount of reject material to be tested. If less material is tested, representativity is at stake, though
  - Reflecting (but not sticky) particles such as metallised structures and plastics are counted. These are supposed to be taken off the sheet by hand under a microscope or concealed with text markers. Not only is the time needed questionable, but also the error rate can be high
  - It is supposed that sticky particles have a spheric form, which is not always true
  - The method's underlying calculations need to be regularly checked

References

[1] 'Key Statistics 2021 - European Pulp & Paper Industry'. Cepi, 2022.
[2] 'Recyklierbarkeit von Verpackungen aus Vollpappe'. vvk, 2021.
[3] 'Die Recyclingfähigkeit von Faltschachteln'. Fachverband Faltschachtel-Industrie, 2019.
[4] 'Terminology and Definitions to Be Used in the Context of Adhesives in the Recycling of Packaging'. FEICA, 2021.
[5] 'Guide to an Optimum Recyclability of Printed Graphic Paper'. European Paper Recycling Council, 2017.
[6] 'Design and Management for Circularity – the Case of Paper'. World Economic Forum, 2016.
[7] 'Circularity by Design Guideline for Fibre-Based Packaging'. 4evergreen, 2022.
[8] 'Beverage Cartons Design for Recyclability Guidelines'. Alliance for Beverage Cartons and the Environment (ACE), 2022.
[9] 'Paper-Based Packaging - Recyclability Guidelines'. Cepi, 2019.
[10] 'Recyclability table'. cerec, 2021.
[11] 'Paper and Board Packaging Recyclability Guidelines'. Confederation of paper industries, 2019.
[12] 'Paper and Card Packaging - Design Tips for Recycling'. WRAP & CPI, 2019.
[13] 'Corrugated Packaging Recyclability - Guidelines Design for Circularity'. FEFCO, 2021.
[14] 'Circular Packaging Design Guideline (Version 4)'. FH Campus Wien, 2021.
[15] 'Paper Packaging - a Recycling Manual'. FTI, 2019.
[16] 'Erläuterungen zur Recyclingfähigkeit von Verpackungen aus Papier, Karton und Pappe'. RESY, 1998.
[17] 'Design for Recycling Guidelines for Packaging'. Veolia Circpack, 2022.

[19] INGEDE4 method (also replicated in EcoPaperLoop method 1) and ISO 15360-2, used by the Cepi method and UNI 11743.

[18] ‘Mindeststandard für die Bemessung der Recyclingfähigkeit von systembeteiligungspflichtigen Verpackungen gemäß § 21 Abs. 3 VerpackG’. Stiftung Zentrale Stelle Verpackungsregister, 2021.
[19] ‘Design guidance for recyclability’. American Forest & Paper Association, 2021.
[20] ‘Design for Recovery Guidelines: Paper Packaging’. GreenBlue, 2011.
[21] ‘Design for Recycling for Packaging and Paper in South Africa’. PackagingSA, 2017.
[22] ‘Packaging Design for Recycling - a Global Recommendation for Circular Packaging Design’. World Packaging Organisation (WPO), 2020.
[23] ‘Assessment of Printed Product Recyclability - Deinkability Score (Issue 2)’. EPRC, 2017.
[24] ‘Voluntary Standard for Repulping and Recycling Corrugated Fiberboard Treated to Improve Its Performance in the Presence of Water and Water Vapor’. Fibre Box Association (FBA), 2013.
[25] ‘Test method PTS-RH 021:2019’. Papiertechnische Stiftung, 2019.
[26] ‘INGEDE Method 12: Assessment of the Recyclability of Printed Paper Products’. INGEDE, 2013.
[27] ‘INGEDE Method 4: Analysis of microstickies in pulp’. INGEDE, 2013.
[28] ‘Assessment of Printed Product Recyclability - Scorecard for the Removability of Adhesive Applications’. EPRC, 2018.
[29] ‘UNI 11743:2019 Paper and Board - Determination of Parameters of Recyclability of Cellulose-Based Materials and Products’.
[30] ‘Cepi Recyclability Laboratory Test Method (version 1)’. Cepi, 2020.
[31] ‘ISO 15360-2:2015: Recycled pulps — Estimation of Stickies and Plastics — Part 2: Image analysis method’.
[32] ‘Fibre-Based Packaging Recyclability Evaluation Protocol (beta release)’. 4evergreen, 2022.
[33] ‘Recyclability Test for Packaging Products (Ecopaperloop Method 1)’. ecopaperloop, 2014.
[34] ‘Assessment of Recyclability of Packaging Products – Recyclability Score – 6th draft’. ecopaperloop, 2014.
[35] ‘Recyclability CTP Test Method CTP-REC21’. Centre Technique du Papier (CTP), 2021.
[36] ‘TAPPI T 227 - Macro stickies content in pulp: the “pick-up” method’. TAPPI, 2007.
[37] ‘FTM19 Recycling compatibility of self-adhesive labels’. FINAT, 2012.
[38] ‘RCA LRP-2 Laboratory Testing Protocol for Paper Labels Coated with Recycling Compatible Pressure Sensitive Adhesives’. TLMI, 2012.
[39] ‘RCA MRP-2 Mill Recycling Trial Protocol (draft)’. TLMI, 2007.
[40] ‘RCA IAP-2 Determination of Adhesives in Paper Handsheets by Image Analysis’. TLMI, 2007.
[41] ‘Kurzbericht FFI/PTS-Projekt „Recyclingfähigkeit von Faltschachteln und Materialkombinationen“’, Fachverband Faltschachtel-Industrie, 2020.
[42] ‘Cepi Recyclability Laboratory Test Method (version 2)’. Cepi, 2022.

Annex I. Adhesive-related statements made in design guidelines

Table 3

Adhesive-related statements found in design guidelines (excerpt)

Entity	Preferred/compatible	Not preferred/ limited or not compatible
4evergreen[7]	Starch-based, PVA, hotmelt non-PSA (according to EPRC exemption conditions); PU hotmelt (according to EPRC exemption conditions); PSA (if tested); HMPSA (if tested); Natural rubber latex (if tested); Acrylic (if tested)	PSA and HMPSA if no test results are available
AFPA[19]	'Easier to recycle: [...] water soluble adhesives [...] pressure sensitive labels'	'Recycling challenges: […] hot melt adhesives'
Cepi[9]	'Minimise certain "soft" adhesives such as those adhesive tapes and self-adhesive labels with an adhesive film that cannot be separated in the recycling process'. 'Give preference to adhesives that can be applied in a way that they can be easily removed from the pulp at typical temperatures in the packaging recycling mill environment'	
CPI[11]	'Water-soluble adhesives assuming they are not detrimental to water treatment' 'adhesives that do not plasticise at temperatures above 35' 'cold set, curable or water-soluble adhesives' 'adhesives that do not plasticise at temperatures of 35 degrees celsius and above'.	'Not water soluble hotmelts'
EPRC[5]	'Non-paper components should be dimensioned and mechanically stable in such a way that they survive as large particles, without being comminuted, in the conditions of pulping and allow mechanical separation by means of punched screens, slot screens and centrifugal purifiers'.	
FEFCO[13]	'Water soluble adhesives are preferred assuming that the chemicals formed when the glue dissolves are not detrimental to the mill waste water treatment system. These should be assessed from information provided on the data sheet of the proposed adhesive in	'The industry prefers to receive adhesives that do not plasticise at temperatures above 35 degrees celsius (a typical pulper temperature). This means that the industry favours cold

	conjunction with the Paper Industry'.	set, curable or water-soluble adhesives over hot melt adhesives'.
		'Hot melt glues that are not fully water soluble should be avoided if possible'.
		'Hot Melt and pressure sensitive adhesives are generally insoluble in water and very difficult to disperse during the pulping process'.
FH Campus Wien[14]	In process of being updated	In process of being updated
FTI[15]	'Reduce the amount of glue and other adhesives. Use water soluble adhesive. If hot melt adhesive is required, heat resistant types should be used'	
GreenBlue[20]	'Pressure-sensitive and cold-seal adhesives are the most difficult to deal with'	'Hot-melt adhesive is less difficult to deal with, but it presents challenges of its own. It has a density similar to that of water, which makes it especially difficult to screen out if it fragments'
	'Hydrophobic adhesives are easier to separate from both the pulp and the wastewater during the flotation cleaning process'	'Water-soluble adhesives are more difficult to separate out and can build up on equipment'
		"Could a hot-melt adhesive with higher-than-typical melting temperatures be used, so that it can remain solid in heated water used for the pulping process?"
PACSA[21]	'The system deals with water-based adhesives without difficulty'	'latex/hotmelt adhesives can stick to the cylinders on the paper machines'
	Self-adhesive labels on corrugated boxes	Self-adhesive labels on graphical paper
Veolia[17]	'Hotmelts with a softening point > 68°C and layer thickness of > 120µm'	'Water soluble adhesives' 'Insoluble adhesives; heavy foils; Latex/Hotmelt; Self-Adhesive; PolycoatWax'
cerec[10]	'screenable adhesives', 'Dispersable'	'Partially dispersable or non screenable adhesives'
RESY[16]	‚Klebstoffe, die für die Herstellung von Verpackungen (nicht gemeint sind Packstoffe) eingesetzt werden, sollten nicht redispergierbar und in der Schichtdicke groß genug sein, damit sie separierbar sind'.	
World Economic Forum[6]	'Limit the use of adhesives'	
World Packaging Organisation[22]	'Adhesive applications that do not lead to the formation of problematic stickies'.	'Adhesive components such as viewing windows, labels and other plastic components should be avoided'.
WRAP[12]	'Adhesives with repulp certification'	'Those which plasticise above 35 degrees C '
	'Water soluble adhesives are preferred, assuming that when they dissolve the chemicals formed don't	'Avoid hot melt glues that are not fully water soluble'.

	contaminate the mill waste water treatment system'. 'Use cold set, curable or water-soluble adhesives that do not plasticise at temperatures above the typical pulper temperature of 35 degrees Celsius'.	
Zentrale Stelle[18]		'Water-insoluble or non-redispersing adhesive applications where it has not been specifically proven that they can be removed'. (Methods: PTS or modified INGEDE12; EPRC exemptions apply)

Annex II. Overview of common paper and board recyclability test methods

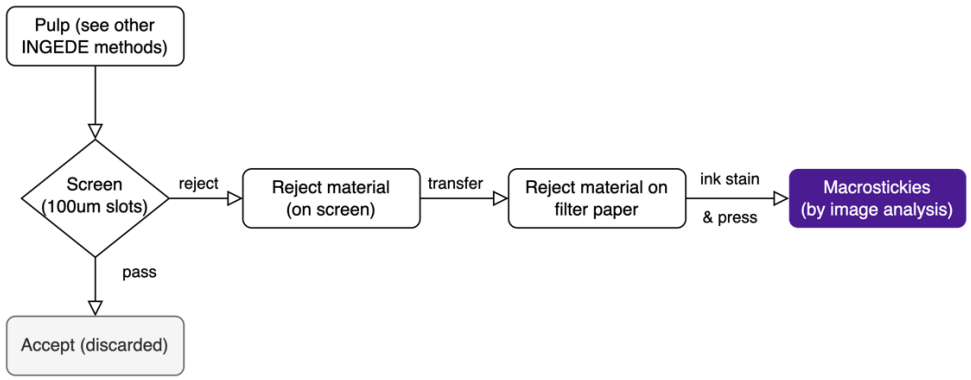

Figure 1: Flow of the INGEDE4[27] test method. Data endpoints forming part of the test report shown in coloured boxes.

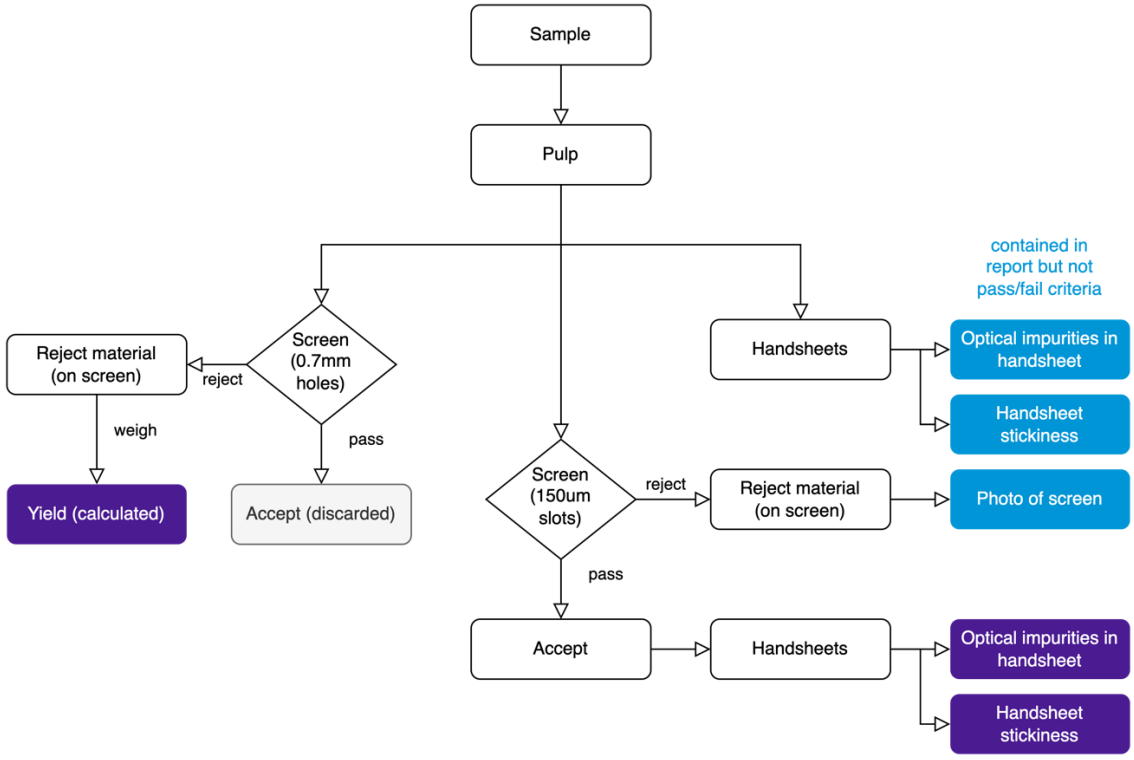

Figure 2: Flow of the PTS[25] test method. Data endpoints forming part of the test report shown in coloured boxes.

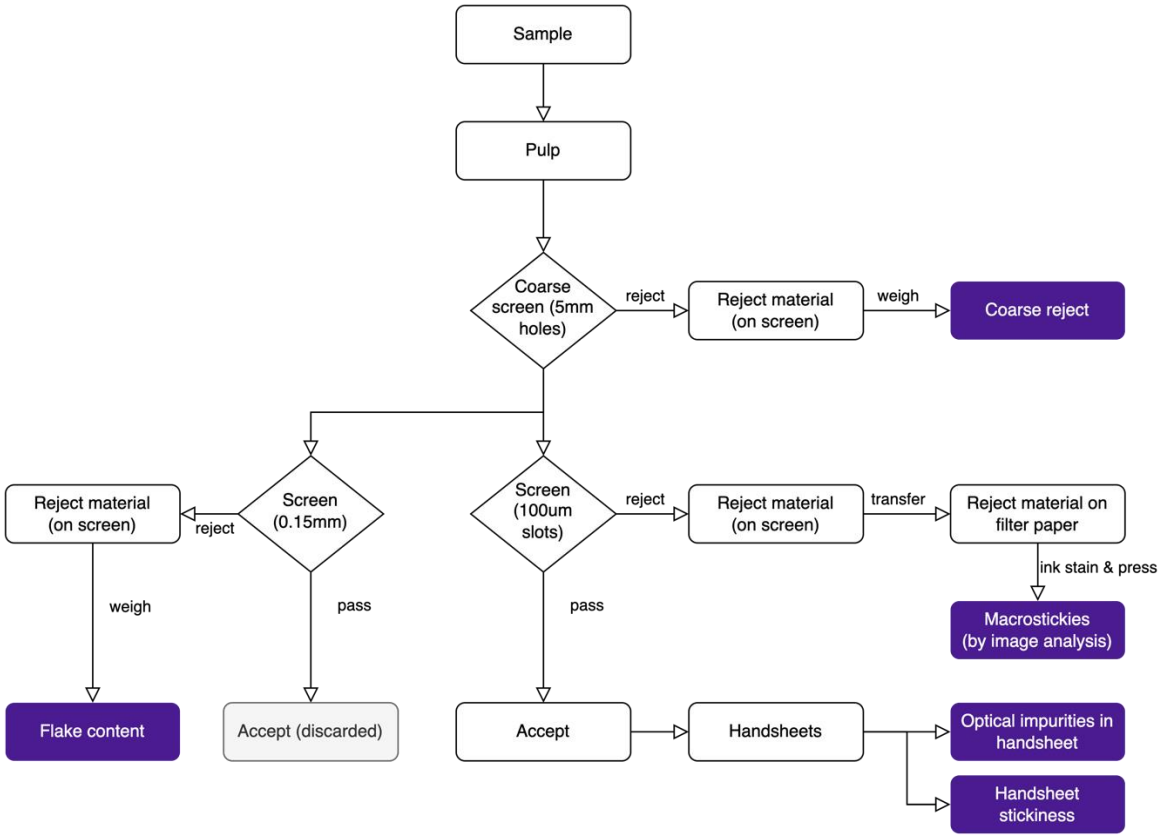

Figure 3: Flow of the UNI 11743:2019[29] test method. Data endpoints forming part of the test report shown in coloured boxes.

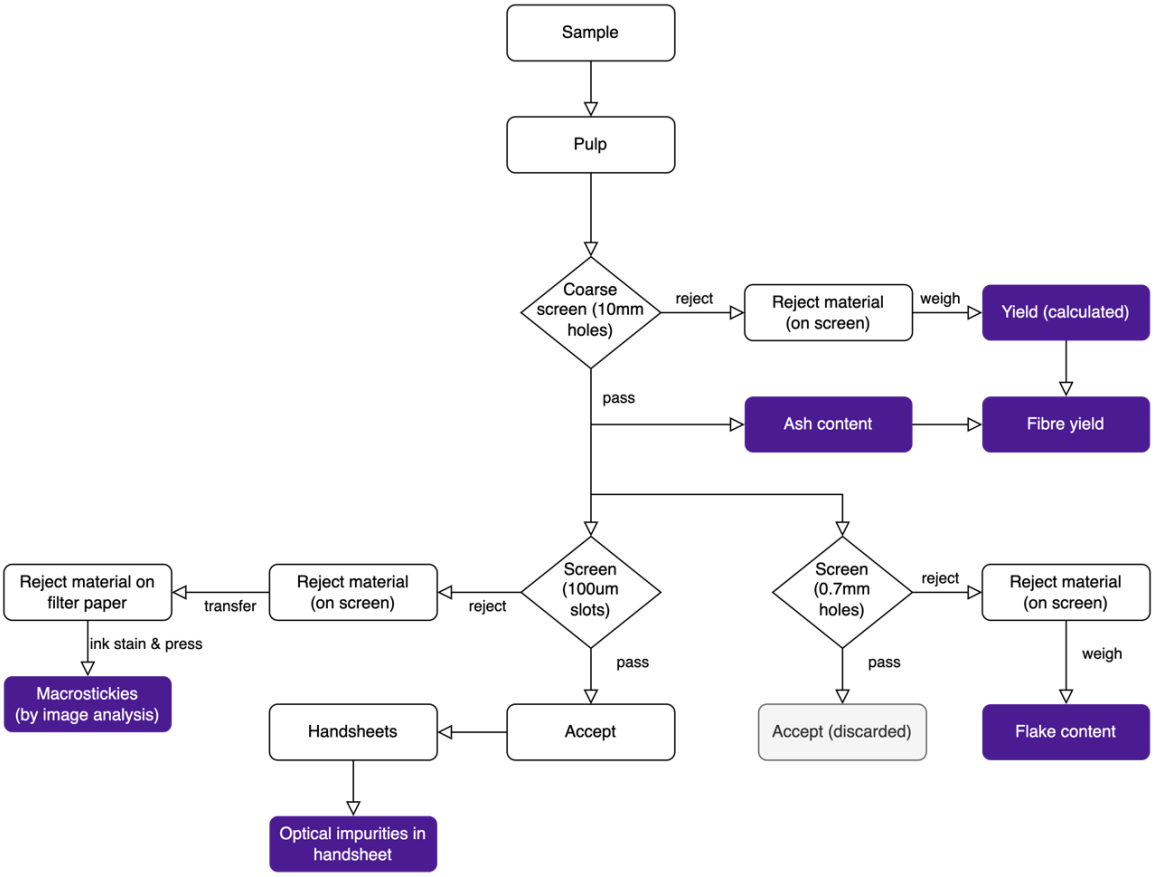

Figure 4: Flow of the EcoPaperLoop Method 1[33] test method. Data endpoints forming part of the test report shown in coloured boxes.

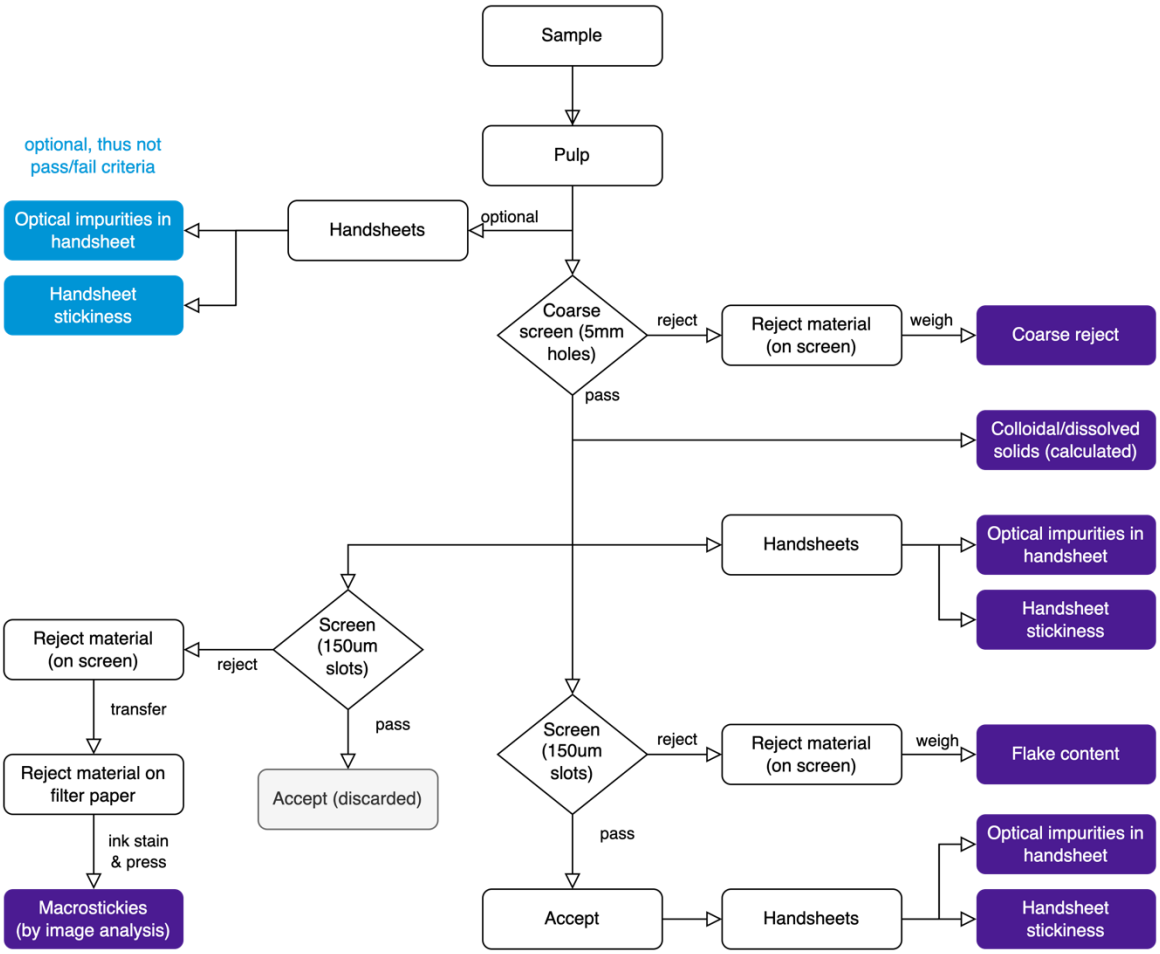

Figure 5: Flow of the original Cepi test method[30] (now replaced by version 2). Data endpoints forming part of the test report shown in coloured boxes.

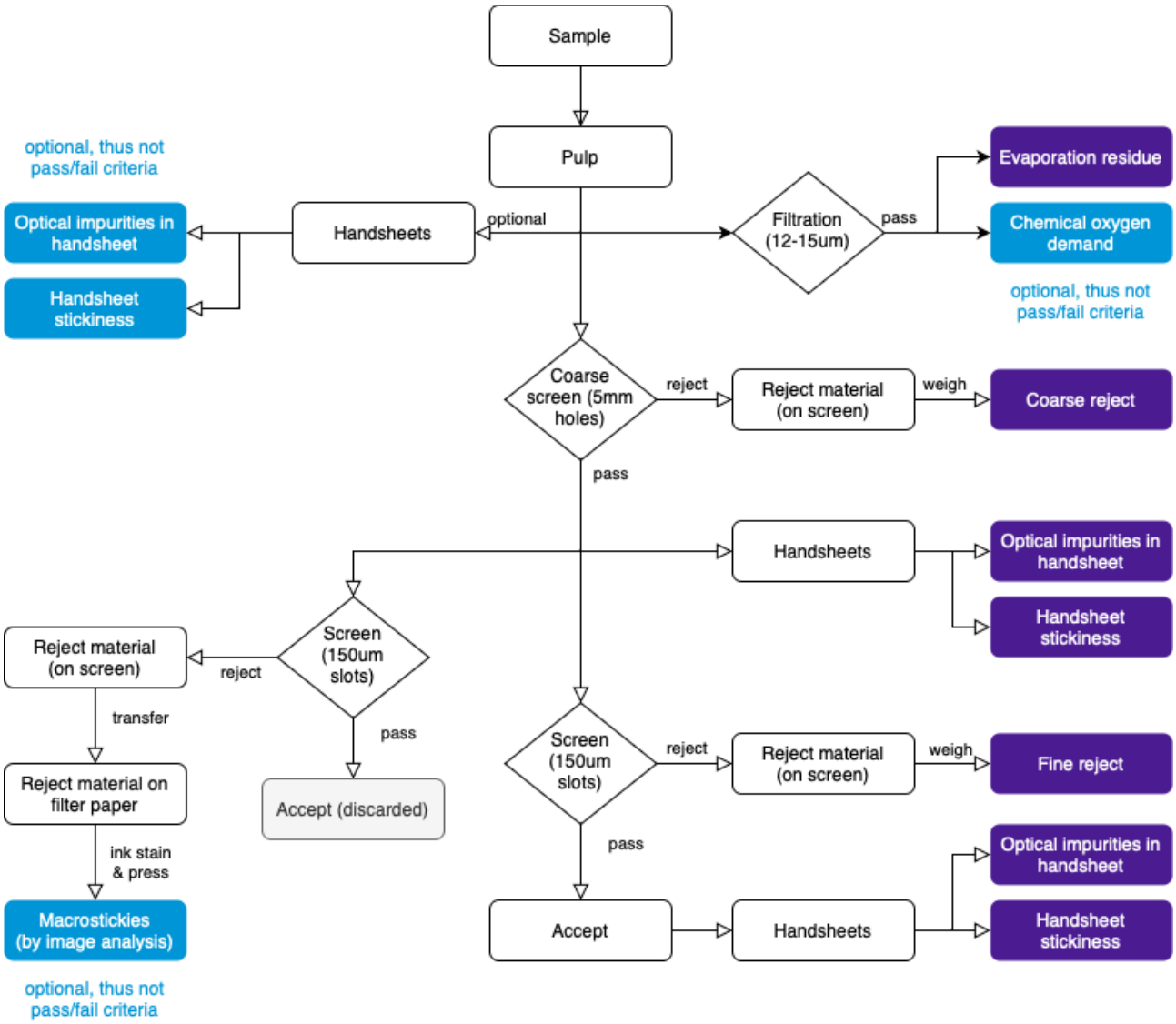

Figure 6: Flow of the version 2 Cepitest method[42]. Data endpoints forming part of the test report shown in coloured boxes.

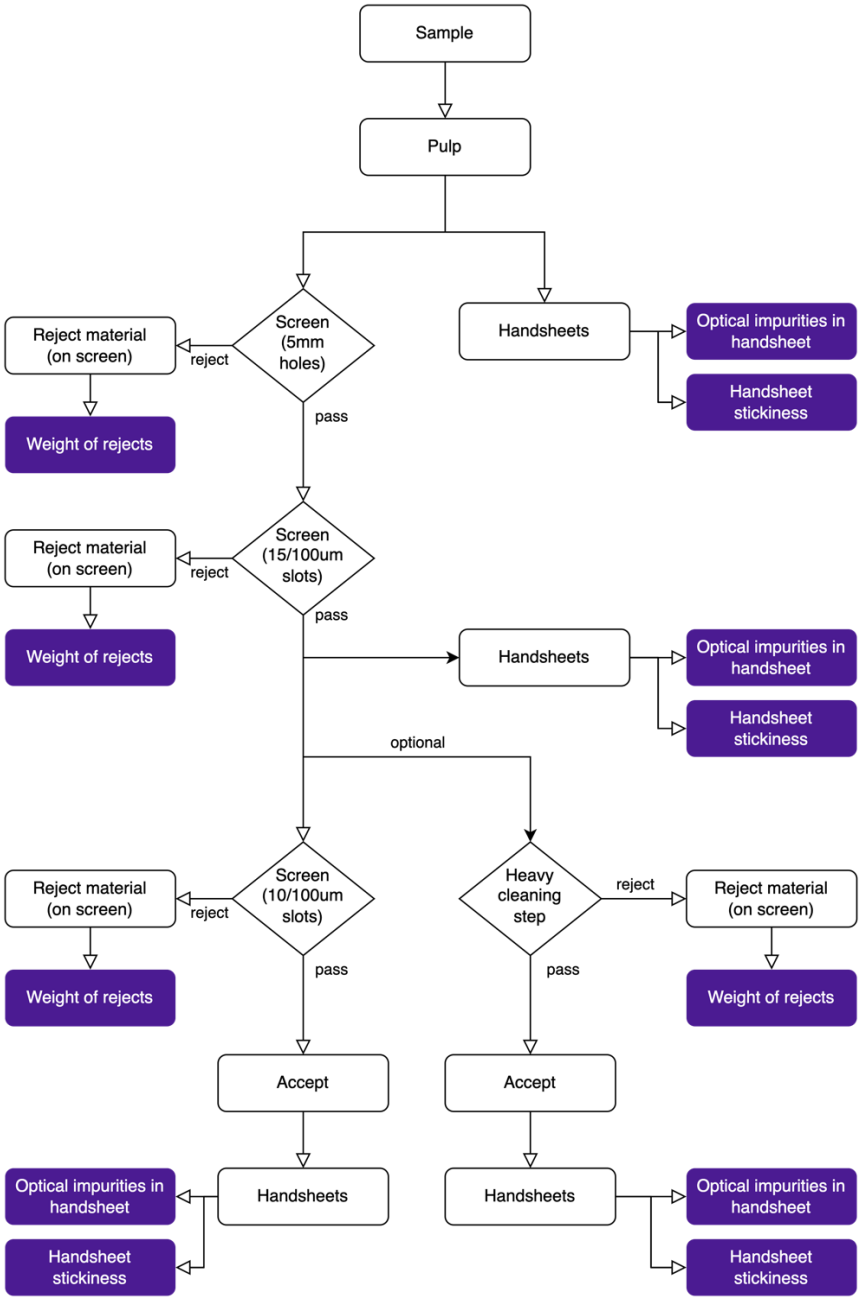

Figure 7: : Flow of the CTP test method[35]. Data endpoints forming part of the test report shown in coloured boxes.

Contact

This document was developed by FEICA's Technical Task Force on the Sustainability & Recycling of Adhesives in Paper and Packaging Applications.

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