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END-OF-LIFE

PRODUCT END OF LIFE

- End of life is a relevant part of product sustainability
  - **EU Circular Economy Directive (link)**
  - **EU Waste Packaging Directive (link)**

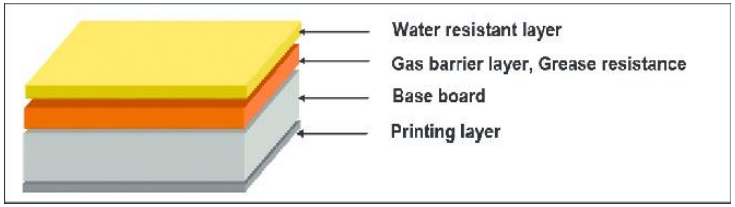
- Products with relatively short life cycle (e.g. packaging) shall be recycled as much as possible as a material to guarantee efficient use of primary raw material.
  1. Material recycling
  2. Organic recycling

PAPER/BIOPLASTIC MULTI-MATERIALS

→Multi-material paper based packaging is by large majority MADE OF PAPER

→COMMON COMPOSITIONS: 95/5.....85/15.....70/30

WHAT ARE THE PROPER END-OF-LIFE OPTIONS



- ✓ shall be recycled in the paper industry in order to guarantee the recovery of cellulose fibres in the same loop.
- ✓ may also be organic recycled whenever the specific application causes too many constrains to recyclability in the paper industry.

MULTI-MATERIAL RECYCLING CONCEPTS

Proper strategy for eco-design shall include:

- ✓ Choice of materials and additives as a function of recycling route
  - ✓ Recycling in the paper industry
  - ✓ Organic recycling in composting plants
- ✓ Validation of eco-design concept by laboratory testing
  - ✓ Official EU or international standard
  - ✓ Official national standard
- ✓ Certification of the product
  - ✓ Widely recognized end of life certification marks may help B2B business strategy

RECYCLING OF MULTIMATERIALS IN THE PAPER INDUSTRY

There is a growing expectation from consumers, brands and retailers that the packaging they use is recyclable.

Recyclability of paper-based packaging: The individual suitability of a paper-based packaging for its factual reprocessing in the post-use phase into new paper and board; factual means that separate collection (where relevant and followed by sorting) into EN 643 grades and final recycling takes place on an industrial scale.

Ref: Paper based packaging Recyclability Guidelines, 2019. CEPI

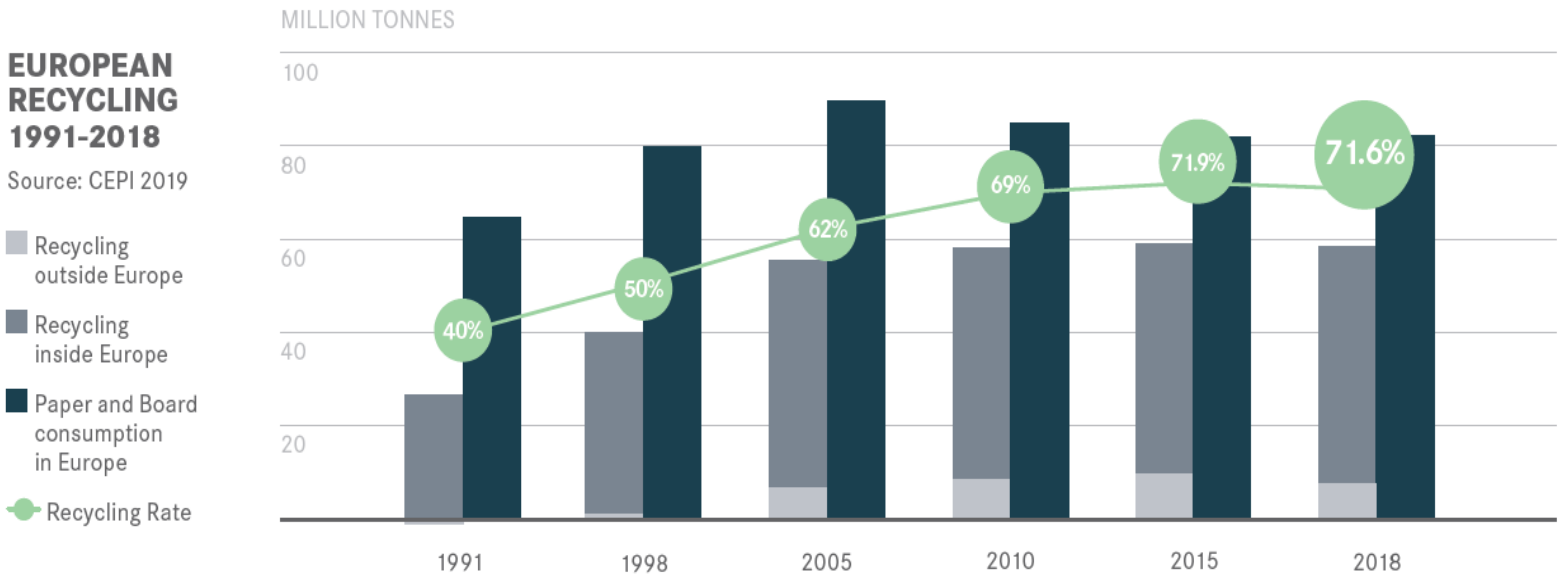
REGULATORY AND NORMATIVE FRAMEWORK

Directive 94/62/EC : Packaging and Packaging Waste and following amending acts.
Targets for the recycling of paper-based packaging: 75% by 2025 and 85% by 2030.

EN 13430 : Requirements for packaging recoverable by material recycling.

EN 643 : European list of standard grades of paper and board for recycling.
Describes the grades of paper and board which, after their use, disposal, collection and sorting, can be used by paper recycling mills.

PAPER RECYCLING STATISTICS

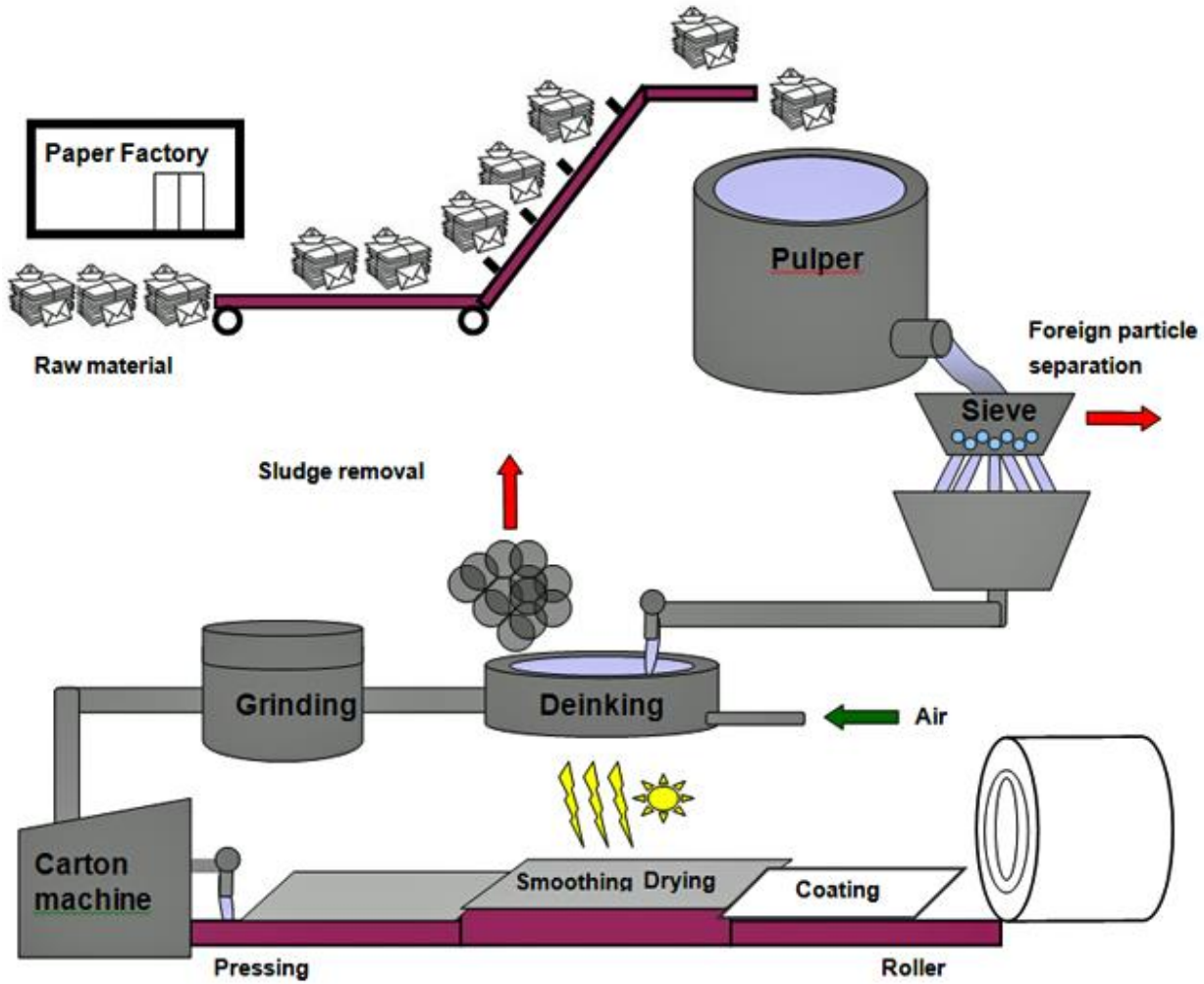


Souce: CEPI statistics

EU Target 2025: 75%

Paper recycling chain is a key driver for meeting these targets.

PAPER RECYCLING PROCESS SCHEME



COARSE AND FINE REJECTS

Non paper components

- Plastic
- Metal

WHAT ARE THE MOST CRITICAL ASPECTS IN A PAPER PACKAGING RECYCLING MILL?

1 - Paper packaging products should be repulpable within standard operating time and equipment. Otherwise the industrial process becomes inefficient (e.g. high amount of coarse reject).

- If non-paper constituents are needed for the intended use, the separation of the different elements should be as easy as possible.

- Plastic lamination layers should not readily degenerate or break into very small pieces in the pulping stage.

WHAT ARE THE MOST CRITICAL ASPECTS IN A PAPER PACKAGING RECYCLING MILL?

2 - It is important that the resulting recycled pulp is optically and mechanically homogeneous.

- Optical and mechanical homogeneity ensures use of the recycled pulp for high quality products.
- Identify varnishes that break down into large, discrete particles.
- When using polymers, sealing agents, water soluble or non-water soluble coatings, consider the performance in the process and the effect on quality of finished products.

WHAT ARE THE MOST CRITICAL ASPECTS IN A PAPER PACKAGING RECYCLING MILL?

3 - It is important that the load of the industrial fine screening process is not too heavy
Otherwise the industrial process becomes inefficient (e.g. too energy consuming).

- Ensure that paper fraction of the packaging breaks down into single fibres when pulped within a specified time frame.

- pay attention to the amounts of substances used that make these papers greaseproof or water-resistant. e.g. special papers such as wet strength, waxed or wax coated papers, siliconised papers, or papers treated with fluorochemicals

WHAT ARE THE MOST CRITICAL ASPECTS IN A PAPER PACKAGING RECYCLING MILL?

4 - It is important that adhesive impurities do not lead to small stickies particles.
Otherwise they can't be easily removed from the pulp at typical process temperatures.

- Adhesives should not fragment in small particles at pulping stage.
- They can cause problems in the paper machine equipment and affect the quality of the recycled paper product
- Optimize the quantities of adhesives to fulfil the expected sealing of the packaging.

WHAT ARE THE MOST CRITICAL ASPECTS IN A PAPER PACKAGING RECYCLING MILL?

5- Consider the effect of water soluble substances.
They tend to accumulate in the process water loop and interfere with papermaking chemistry.

- In general, non-paper materials which can be screened out should be privileged as opposed to materials leading to fine particles accumulating in mills.

- When using polymers, sealing agents, water soluble or non-water soluble coatings, consider the performance in the process and the effect on waste water treatment.

RECYCLING PROCESS: MOST IMPORTANT PARAMETERS

- **Re-pulpability.** Good separation of the components.

Good separation of the paper in single cellulose fibers.

- **Yield of fibrous material**. Target is to recovery as much cellulose fibers as possible.

- **Coarse reject.** Special waste to be disposed, should be minimum possible.

- **Flake content.** Require extra energy for process recycling,

- **Stickies and pulp cleanliness.** Low amount of detrimental adhesive particles and contaminants means high quality of recycled pulp and final products.

HOW TO MEASURE RECYCLING PARAMETERS AND RECYCLABILITY?

There are different national protocols for assessing recyclability of packaging in EU and globally (where established).

National protocols are divergent due to the presence of different collection systems and requirements for collection in the paper and board stream.

Efforts towards a harmonization of recyclability test methods are underway in EU.

HOW TO MEASURE RECYCLING PARAMETERS AND RECYCLABILITY?

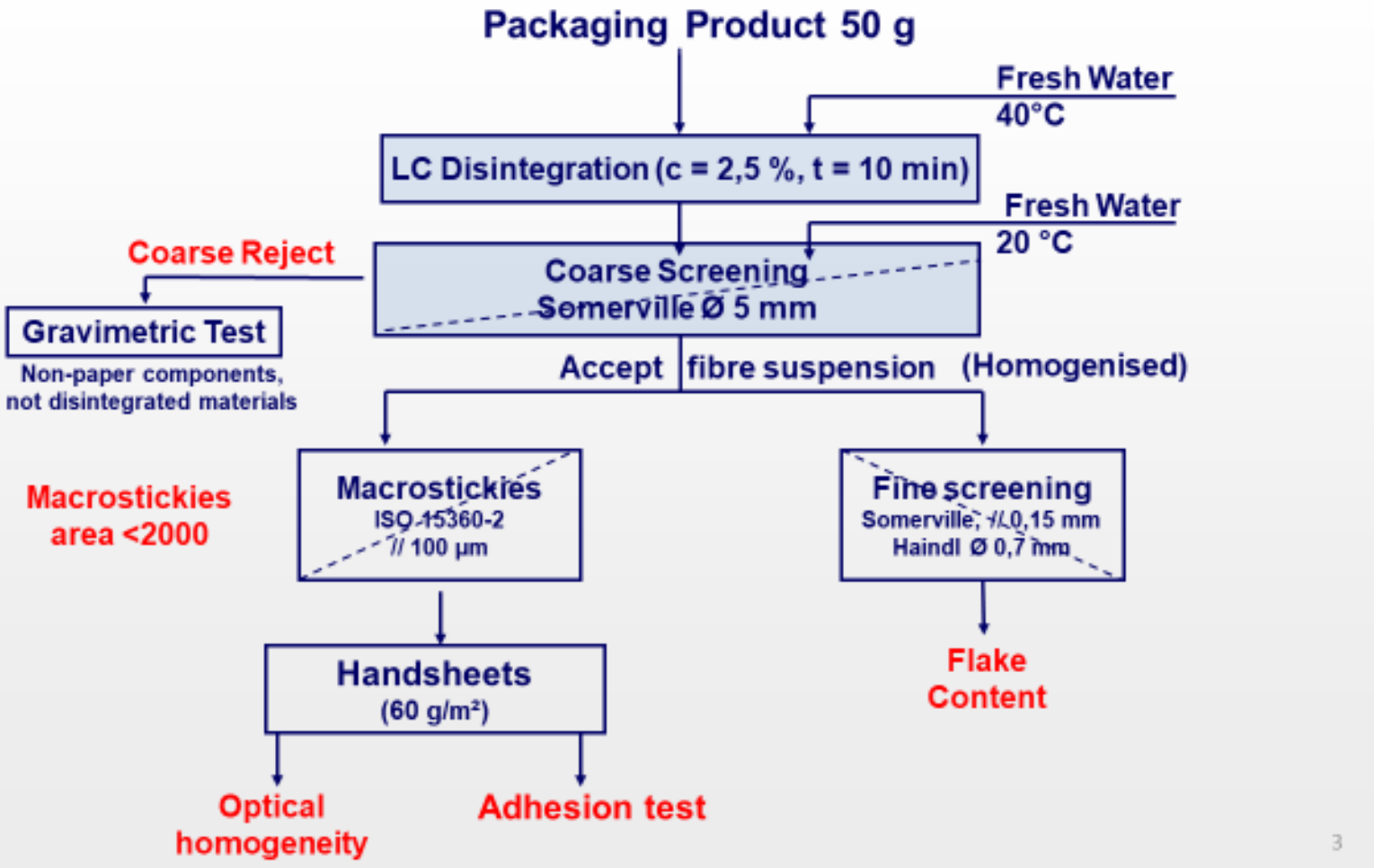
At present time, beginning 2020, there are few standards or test methods publicly available:

- Standard UNI 11743 (2019). Italian official standard method. Assessment scheme available at national level by Aticelca (link)

- Method PTS RH 021/97 (Version 2012). German test method developed by PTS research center. Assessment scheme available at national level.

- EcoPaperLoop Method 1 (2014). European test method developed along EcoPaperLoop project. Draft Assessment scheme (not published).

HOW TO MEASURE RECYCLING PARAMETERS AND RECYCLABILITY?



Standard UNI 11743. Test Procedure.

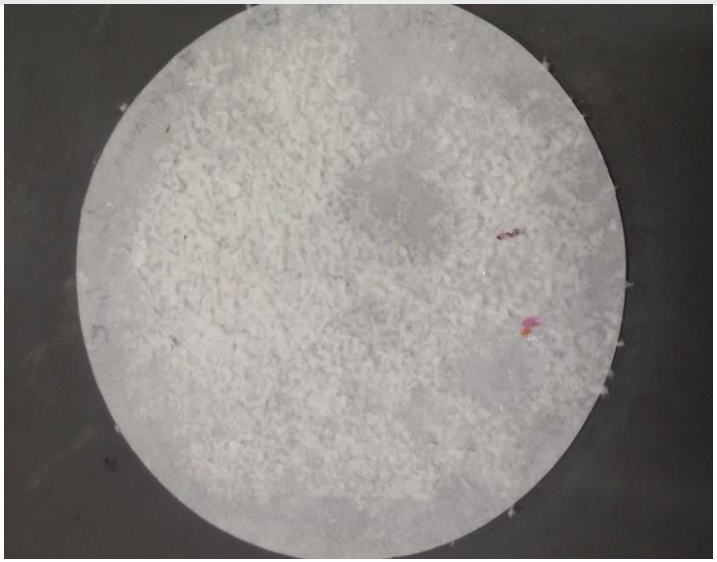
EXAMPLES OF COARSE REJECTS

Kraft paper sacks, kraft paper + PE extruded

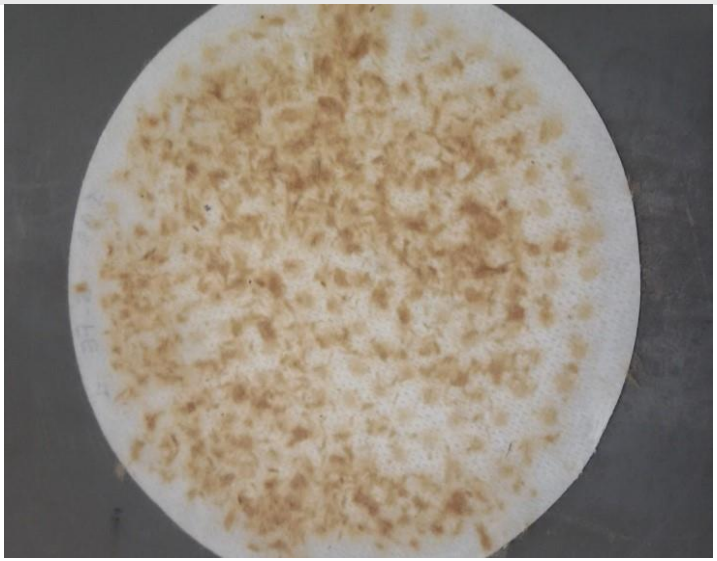
Solid boxboard for frozen food: *Paper + PE extruded*

Solid board: paper laminated with metalized PET film

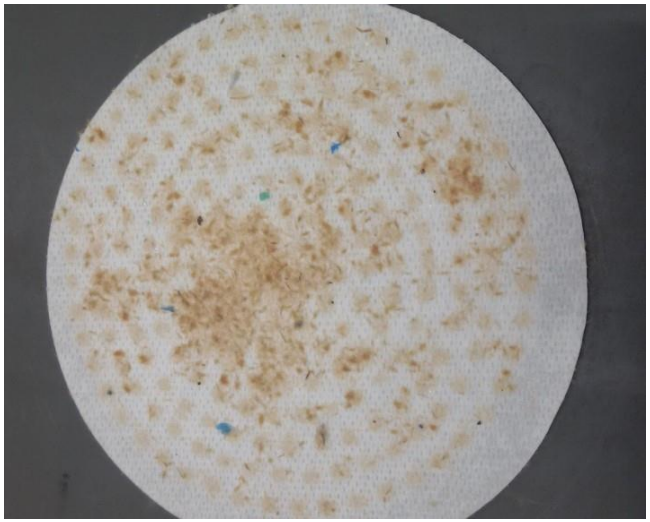
EXAMPLES OF FLAKES (FINE REJECT),



BOXBOARD FOR FROZEN FOOD

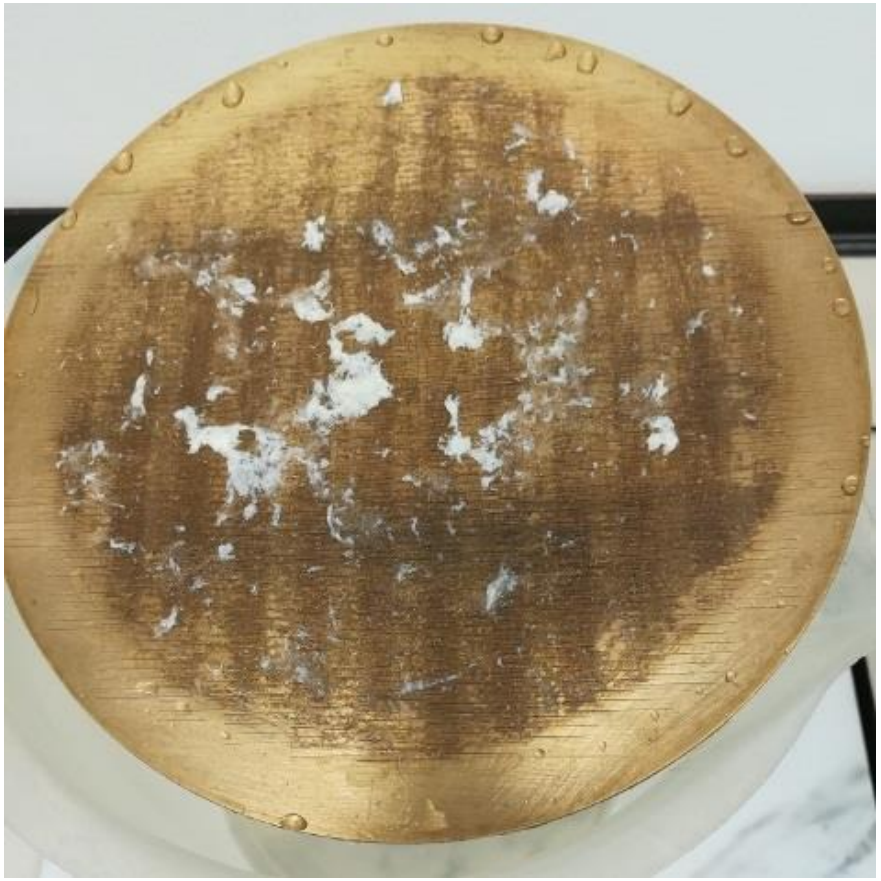


KRAFT PAPER, SHOPPER



CORRUGATED BOX

EXAMPLES OF ADEHESIVES (MACROSTICKIES)



Solid board + plastic film, laminated with dispersion glue

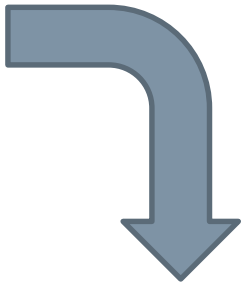
ITALY: ATICELCA EVALUATION

Parameter	Recyclable with paper				Non recyclable with paper
	Level A+	Level A	Level B	Level C	
Coarse rejects (%)	< 1.5	1.5-10	10-20	20-40	> 40
Macrostickies area < 2.000µm (mm2/kg)	<2.500	2.500-10.000	10.000-20.000	20.000-50.000	> 50.000
Flakes (%)	< 5	5-15	15-40	>40	-
Adhesion	absent	absent	absent	absent	Present
Optical in-homogenities	Level 1	Level 2	Level 3	Level 3	-

ORGANIC RECYCLING OF PAPER BASED PRODUCTS: IN WHICH CASES?

- **Packaging in contact with moist and grease foodstuff** *(not easy to clean). Some example below:*
  - soft cheese, fresh cuts ham/meat/fish
  - ready to eat greasy food (lasagne etc.)

- **In closed community loops**
  - school or company catering
  - large shopping centres
  - airports/flights
  - public events/fairs



- **LIKELY the presence of residual food**
- **EASIER to guarantee:**
  - **USE of certified products**
  - **PROPER COLLECTION (agreement with composting plants)**

WHAT ARE THE MOST CRITICAL ASPECTS TO GUARANTEE COMPOSTABILITY?

1- Limits of the presence in the packaging for HEAVY METALS and FLUORINE.

2- BIODEGRADABLE COMPONENTS. The packaging raw materials SHALL be biodegradable: pure cellulose and/or biodegradable bioplastics.

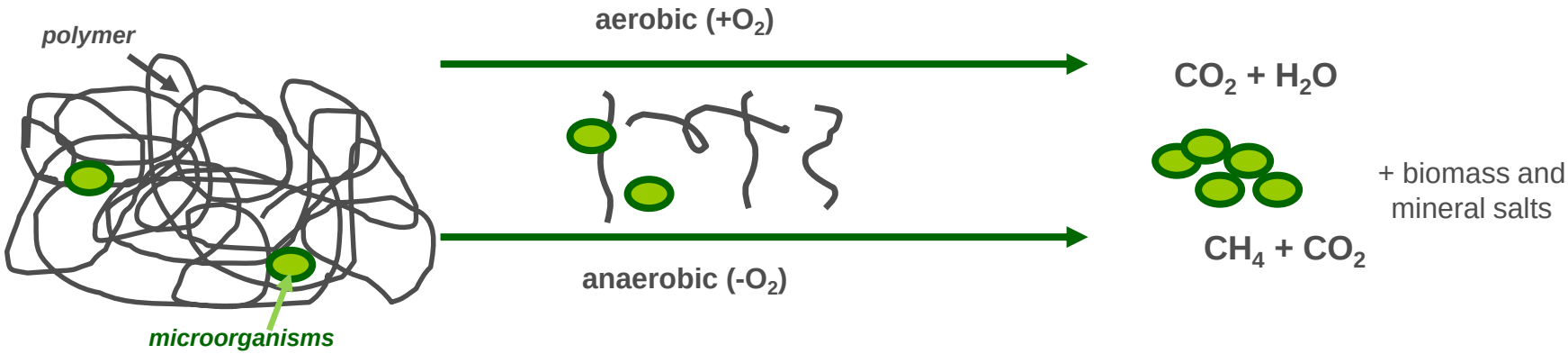
3- NON BIODEGRADABLE constituents/additives are allowed at limited concentrations <1% for each constituents. For a maximum of 5% in total for the sum of different constituents.

4- Complete DISINTEGRATION of the packaging during composting process.

5- Absence of ECOTOXIC effects of the compost resulting from composting process on seeds germination and plants growth.

BIODEGRADABILITY CONCEPT

The biodegradation of materials is mediated by microorganisms and their enzymes.
Chemical transformation of an organic substance (polymer) to low molecular weight molecules by the action of bacteria that can use the substance as nutrient by the following routes:



***Aerobic biodegradation in the presence of oxygen**: complete transformation of organic substances to: CO_2, H_2O, mineral salts - mineralization and new biomass - INDUSTRIAL COMPOSTING PLANTS.*

***Anaerobic biodegradation in the absence of oxygen**: complete transformation of organic substances to methane - INDUSTRIAL BIOGAS PLANTS.*

Laboratory Testing methods measure these transformations.

BIODEGRADABILITY CONCEPT

Degradation does not mean BIODEGRADATION

DEGRADATION is a material fragmentation by the action of physical and chemical agents. Degradation can be the intial step for biodegradation (for example wood) but it SHALL be followed by the bacteria utilization of fragments as nutrients.
Only fragmentation will generate environmental pollution (as for OXO-POLYMERS) .

COMPOSTABILITY CERTIFICATION: WHAT ARE THE LIMITS FOR BIODEGRADABILTY?

The complete biodegradability of the packaging components SHALL be demonstrated by laboratory tests: the limit value is equal to 90% complete transformation of the components to CO_2 and water. The 90% limit refer to the variability of the testing method and to the bacteria biomass increase during the test.

That means: 10% not biodegradable components and/or constituents are NOT PERMITTED.

COMPOSTABILITY CERTIFICATION: PERMITTED NON BIODEGRADABLE CONSTITUENTS

NON BIODEGRADABLE constituents/additives are admitted at the limited concentration: <1% for each constituents. For a maximum of 5% in total for the sum of different non biodegradable constituents.

NON BIODEGRADABLE constituents/additives are for example PIGMENTS, INKS, GLUES, RESINS and chemicals for surface treatments/coatings that SHALL guarantee the following:

- Heavy metals and fluorine within the limits for the packaging.
- Absence of any ECOTOXIC effects on seeds germination and plants growth.

COMPOSTABILITY CERTIFICATION: WHAT ARE THE LIMITS FOR HEAVY METALS AND FLUORINE?

Element	mg/kg dry weight (of the single packaging unit)			
	EU +EFTA countries	USA	Canada	Japan
Zn	**150**	1400	463	180
Cu	**50**	750	189	60
Ni	**25**	210	45	30
Cd	**0.5**	17	5	0.5
Pb	**50**	150	125	10
Hg	**0.5**	8.5	1	0.2
Cr	**50**	-	265	50
Mo	**1**	-	5	-
Se	**0.75**	50	4	-
As	**5**	20.5	19	5
F	**100**	-	-	-
Co	**-**	-	38	-

Inorganic fillers, as well as inks, can enhance the heavy metals content. Wet resistence additives or filler such as talcum can enhance fluorine content.

COMPOSTABILITY CERTIFICATION: INKS-HEAVY METALS OUT OF THE LIMITS

Some inks, mainly cyan and green, may contain very high metals concentration (i.e. copper, molybdenum). The ink application on the packaging SHALL be designed to guarantee that for the single packaging unit heavy metals content will be within the limits.

Element	Red (mg/kg)	Cyan (mg/kg)	Violet (mg/kg)	Green (mg/kg)	LIMITS (mg/kg)
Chrome	8.7±1.5	15.7±2.4	23.1±3.3	11.8±1.9	50
Cobalt	<0.1	<0.1	<0.1	<0.1	38
Nickel	11.7±1.9	11.0±1.8	6.8±1.2	2.6±0.6	25
Copper	14.5±2.2	73689±2488	101±11	28108±1127	50
Zinc	7.2±1.3	8.7±1.5	3.3±0.7	1.8±0.4	150
Arsenic	<0.1	<0.1	0.2±0.1	0.4±0.1	5
Selenium	<0.1	0.55±0.15	1.04±0.26	1.62±0.37	0.75
Molybdenum	<0.1	50.1±6.2	1.1±0.3	14.7±2.3	1
Cadmium	<0.1	0.1	0.3±0.1	<0.1	0.5
Lead	<0.1	0.3±0.1	0.1	3.6±0.7	50
Mercury	<0.05	0.34±0.04	<0.05	<0.05	0.5
Fluorine	<10	<10	<10	<10	100

COMPOSTABILITY CERTIFICATION: PACKAGING DISINTEGRATION REQUIREMENTS

DISINTEGRATION during composting process. A composting process with organic waste in the presence of the packaging components is carried out at laboratory level for 12 weeks.

Start of the test

4 weeks

8 weeks

12 weeks

COMPOSTABILITY CERTIFICATION: PACKAGING DISINTEGRATION REQUIREMENTS

At the end of the composting process the obtained compost is sieved to 2 mm sieve to check for any packaging residues.

REQUIREMENTS for PACKAGING DISINTEGRATION: the packaging component SHALL disintegrate within 12 weeks of composting process to 90% of the initial weight.

COMPOSTABILITY CERTIFICATION: ECOTOXICITY OF THE FINAL COMPOST

The final compost obtained after disintegration test is checked for any ecotoxic effect on seeds germination and plant growth.

REQUIREMENTS for ECOTOXIC EFFECTS: the compost obtained in the presence of the packaging component SHALL guarantee:

- **90% germination of seeds**
- **90% plant growth**

Respect a reference blank compost obtained from a composting process conducted in the absence of the compost.

PACKAGING CERTIFIED FOR COMPOSTABILITY AND BIODEGRADABILITY

- Biodegradable and compostable certified packaging - **means that the packaging at the end of the life can be disposed in an industrial composting plant**

It **does not mean that can be abandoned in the environment**.

LITTERING MUST BE ALWAYS AVOIDED.

A compostable material might not be biodegradable in the environment.

THANK YOU!!

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