RecyClass

Science behind Recyclability

Sorting of plastic packaging

4 December 2023

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RecyClass

Sorting at RecyClass

RecyClass Science behind Recyclability, 4 December 2023

RecyClass

WHAT MAKES A PLASTIC PACKAGING **RECYCLABLE** ?

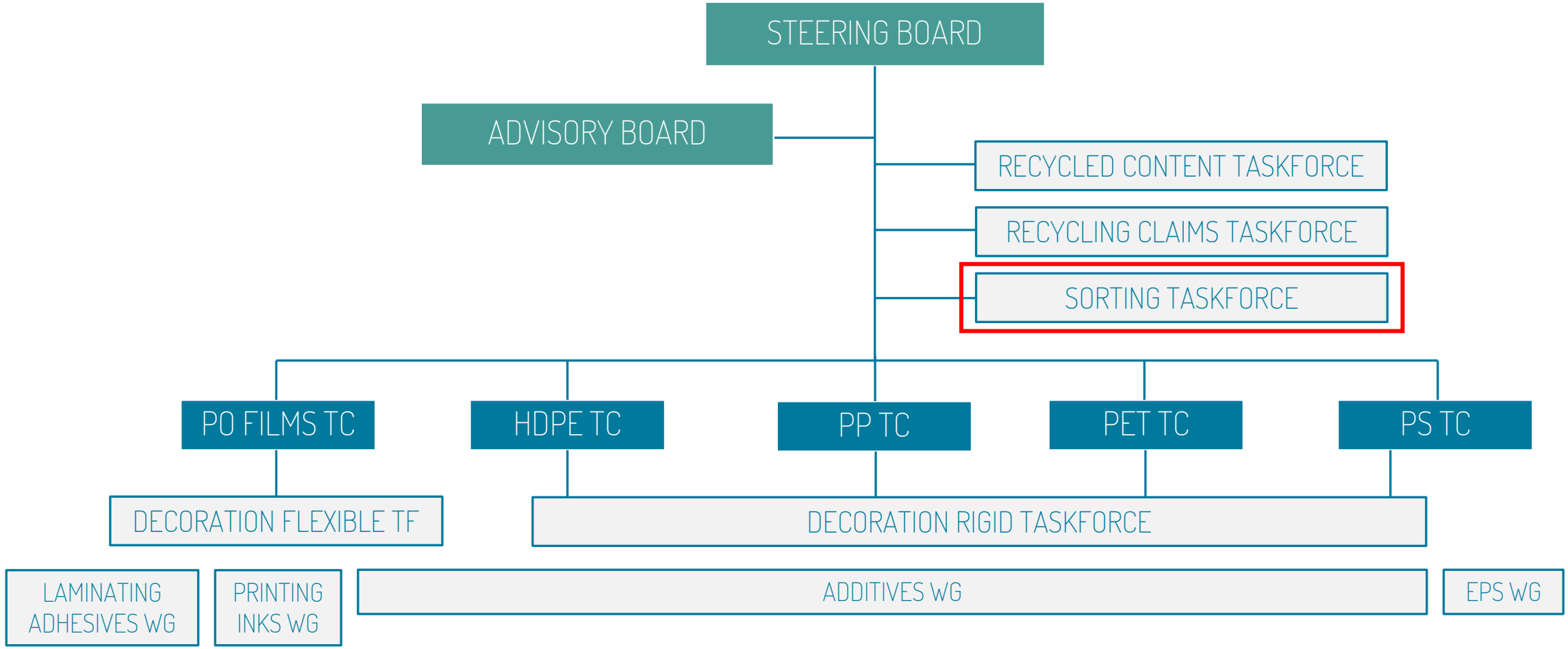
The packaging must be **made with plastic that is collected** for recycling, has market value and/or is supported by a legislatively mandated program.

The packaging must be **sorted & aggregated into defined streams** for recycling processes.

The packaging **can be processed & reclaimed/recycled** with commercial recycling processes.

The recycled plastic becomes a raw material that **is used in the production of new products.**

RecyClass | STRUCTURE & NETWORK



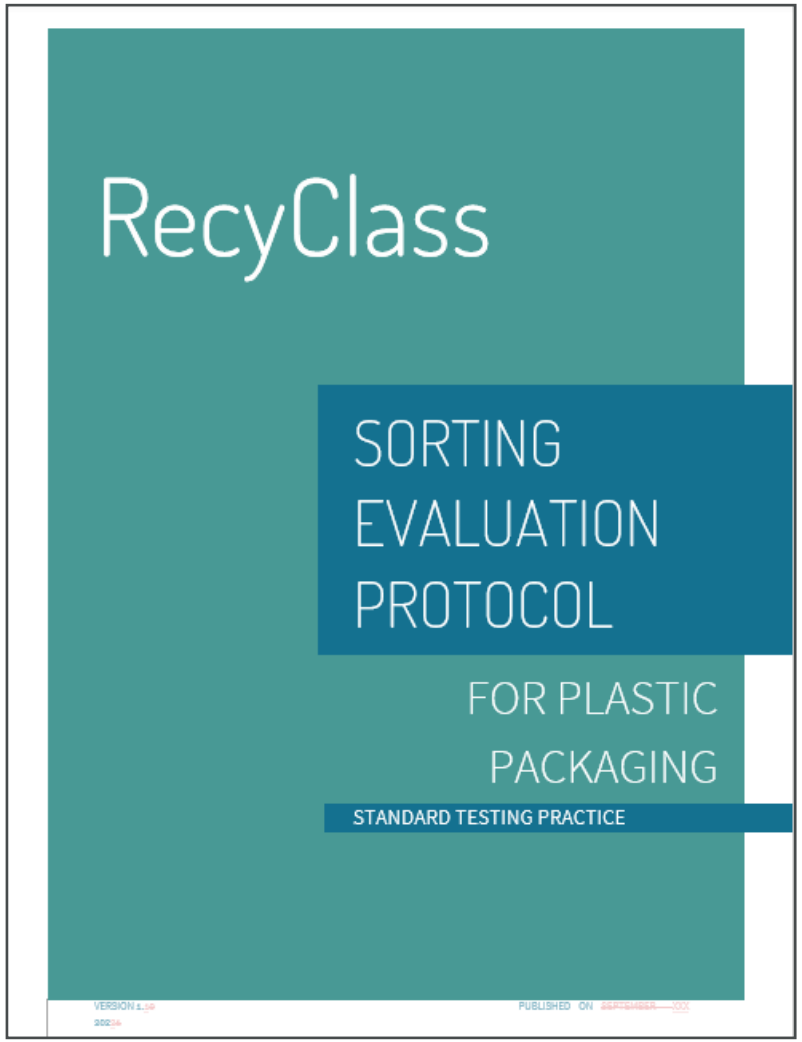
OTHER ORGANISATIONS PART OF RECYCLASS

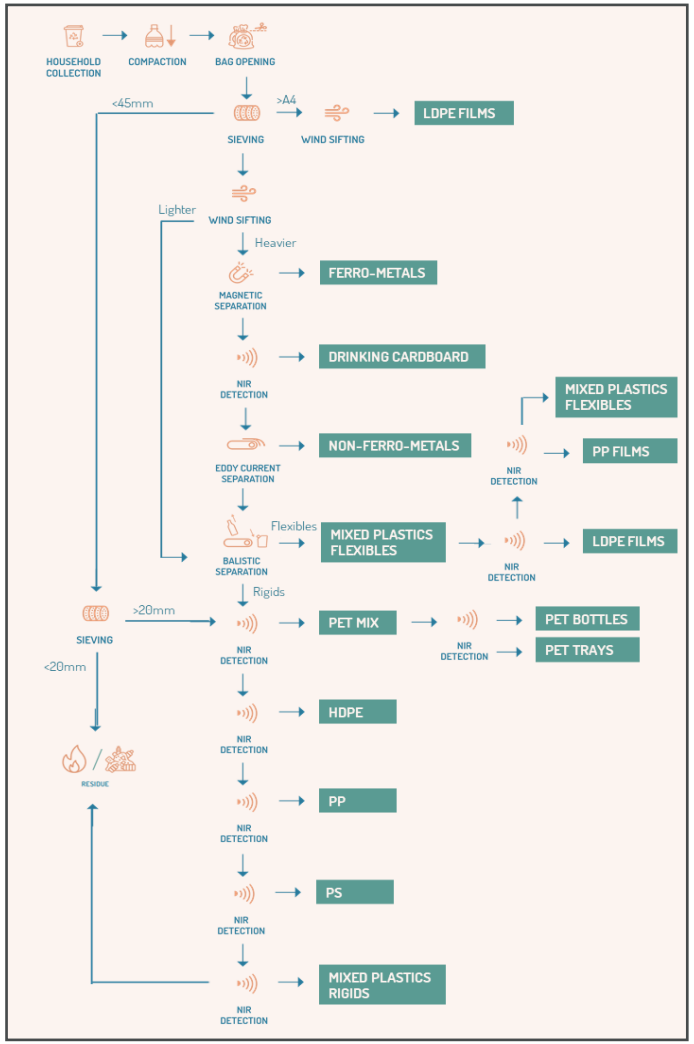
CERTIFICATION BODIES | TESTING FACILITIES | SUPPORTERS

RecyClass | VALUE CHAIN COLLABORATION

RecyClass | RECYCLASS SORTING PROTOCOL

- Released in October 2021
- Covering all the steps of a sorting line
- Widely used by RecyClass TCs when assessing packaging recyclability to release Recyclability Approvals
- Widely used by RecyClass recognized Certification Bodies when auditing packaging for Recyclability Certification
- Currently under revision. Version 2.0 expected to be released by January 2024.





RecyClass | SORTING TESTS

Sorting is a key step in evaluating recyclability. Some features of the packaging may lead to problems in the sorting, hence this must be tested before to apply the Recyclability Evaluation Protocol.

Flexibles

- Size: < A4 format or between 20 x 20 and 50 x 50 mm (compacted)
- Large labels
- Multi-layer structures (excluding PE or PP with EVOH)
- Metallisation (excluding on the inside/in the middle layer)
- Non NIR detectable colours (also when dark colours used for internal layers)
- Printing covering larger than 50% of the surface and/or use of dark colours
- Different types of plastic used on front and back sides
- Different types of plastic (rigids and flexibles) used in the package

Rigids

- Size: < 5 cm (compacted)
- Large labels (>50% covering for <500 ml and >70% covering for >500 ml)
- Full body sleeves
- Perforated full body sleeves
- Multi-layer structures (excluding PE or PP with EVOH)
- Metallisation (excluding on the inside/in the middle layer)
- Non NIR detectable colours (also when dark colours used for internal layers)
- Printing covering larger than 50% of the surface and/or use of dark colours
- Different types of plastic used on front and back sides
- Different types of plastic (rigids and flexibles) used in the package
- Round shape, very rigid and hard to compact

If some of these features are present, test must be done at one of the RecyClass Recognized Testing Facilities according to the Sorting Evaluation Protocol for Plastic Packaging

NTCP national test centre circular plastics

CIRCPACK by VEOLIA

RecyClass

How does sorting work?

Freek van Rhijn
Technical Director of NTCP

RecyClass Science behind Recyclability, 4 December 2023

04 December 2023
RecyClass

Freek van Rhijn, Technical Director

NTCP – R&D for recycling at industrial relevant scale

nationaal testcentrum
circulaire plastics

Who?

NTCP is a testing & research organisation for circular plastics

NTCP is not-for-profit

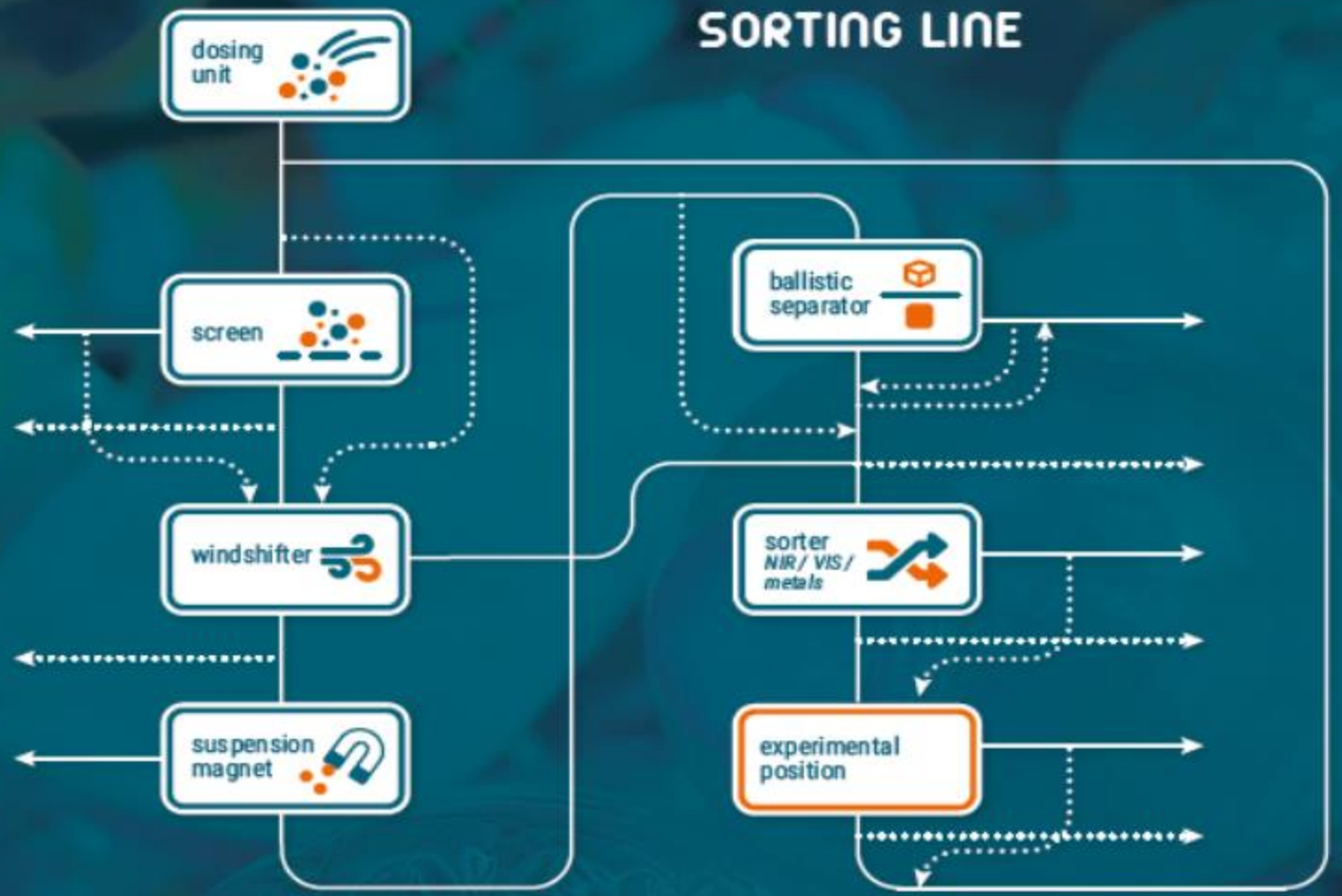
NTCP is independent – open to all players in the recycling chain

How?

- Semi-industrial facilities, designed for R&D purpose
- State of the art technology
- Modular and fully adjustable
- Controlled environment

Sorting line

Washing line



The NTCP pilotplant:

Modular design

- Each sorting step can be executed and sampled individually
- Each sorting step in the line can be by-passed

Experimental position for new equipment/technologies

Pilot scale washing line will be realised late 2020

Process steps

1: Sample preparation
- Standardized protocol to determine product left over
- Standard Contamination and Compression protocol

2: Packaging assesment by optical sorter
Sorting evaluation over complete sorting process as individual sorting steps.

3: Determine split factor (efficiency) per sorting step
The package will be mixed into PMD and fed into the line and then looped imitating an industrial plant

Simulation consumer use, collection, transport & sorting friction

Consumer use & collection

New packaging

Pollute with 10% own product

Compress mixed with PMD

Separate

Transport

Contaminate SKU pieces with fines in mixer

Compress mixed with PMD

Separate

only when not doing a sorting trial

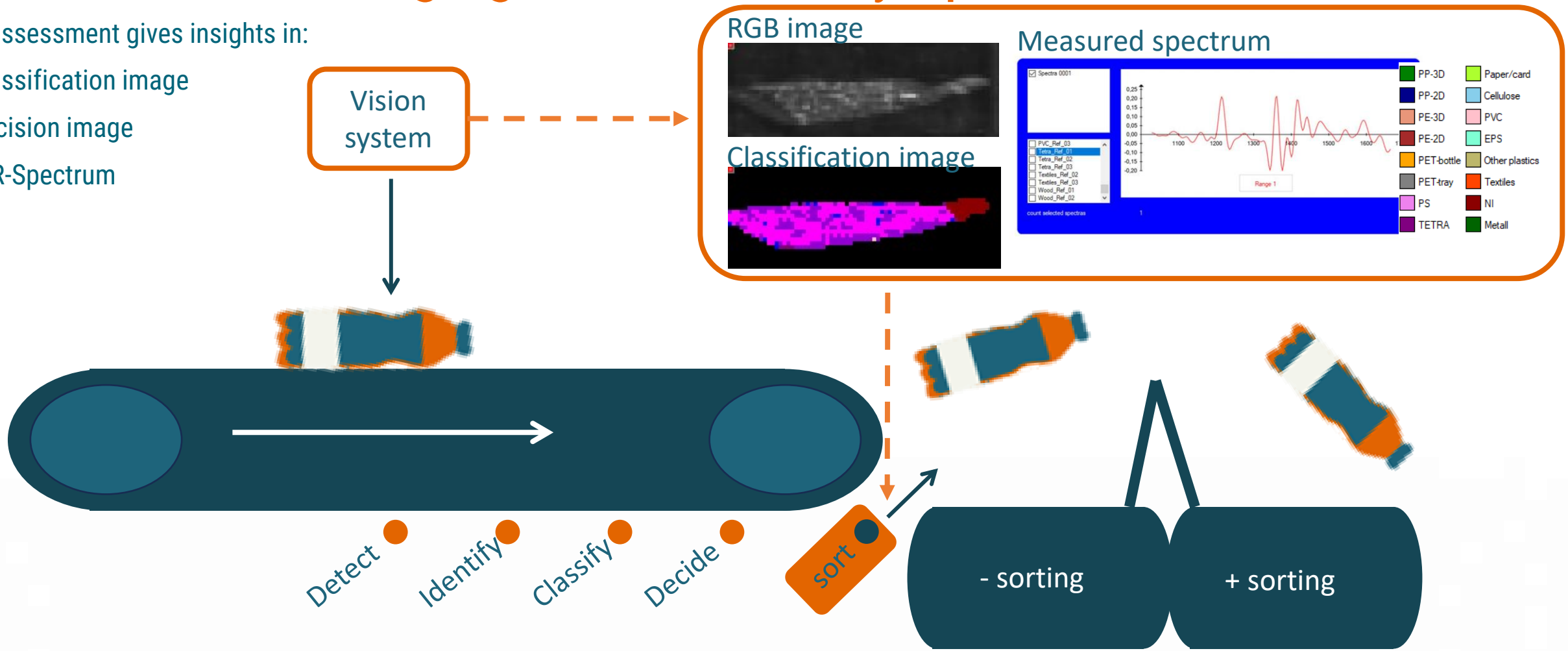
Sorting friction

Run SKU pieces on sorting line (15 min)

Packaging assessment by optical sorter

This assessment gives insights in:

- Classification image
- Decision image
- NIR-Spectrum



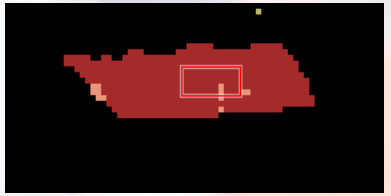
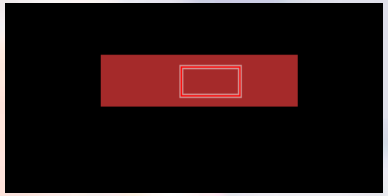
Sortability trial – split factor per sorting step

	Process	Streams		Efficiency	Items
	Vibrating screen	+	< 40 mm	0 %	0
		-	> 40 mm	100 %	50
	Windshifter	+	Lights	0 %	0
		-	Heavy	100 %	50
	Suspension magnet	+	Ferro metals	0 %	0
		-	Other	100 %	50
	Ballistic separator	+	2D	4 %	2
		-	3D	96 %	50
PET-tray/bottle	Optical sorter	+	PET-tray/bottle	0 %	0
		-	Other	100 %	50
PP-3D	Optical sorter	+	PP-3D	81 %	44
		-	Other	19 %	10
Paper/Cardboard	Optical sorter	+	Paper/Cardboard	0 %	0
		-	Other	100 %	50
PO-2D	Optical sorter	+	PE-2D, PP-2D	18 %	9
		-	Other	82 %	42
MIX	Optical sorter	+	Mixed plastics	100 %	40
		-	Other	0 %	0

An example
Sample preparation

An example
Packaging assessment by optical sorter

Pouch of multi material

RGB	Identification	Decision
		 PE-2D

Materialverteilung

PP-3D	0 px	0.0 %	Paper/card	0 px	0.0 %
PP-2D	0 px	0.0 %	Cellulose	0 px	0.0 %
PE-3D	12 px	2.6 %	PVC	0 px	0.0 %
PE-2D	445 px	97.2 %	EPS	0 px	0.0 %
PET-bottle	0 px	0.0 %	Other plastics	1 px	0.2 %
PET-tray	0 px	0.0 %	Textiles	0 px	0.0 %
PS	0 px	0.0 %	NI	0 px	0.0 %
TETRA	0 px	0.0 %	Metall	0 px	0.0 %

SKU is identified and classified as PE-2D.

An example
Split factors per sorting step

Process	Streams		Eff.
Vibrating screen	+	< 40 mm	0 %
	-	>40 mm	100 %
Wind-shifter	+	Lights	52 %
	-	Heavy	48 %
Suspension magnet	+	Ferro metals	0 %
	-	Other	100 %
Ballistic separator	+	2D	36 %
	-	3D	64 %
Induction bar	+	Non-ferro metals	0 %
	-	Other	100 %
Optical sorter Beverage carton	+	Beverage carton	0 %
	-	Other	100 %
Optical sorter PET	+	PET	4 %
	-	Other	96 %

Process	Streams		Eff.
Optical sorter PE-3D	+	PE-3D	2 %
	-	Other	98 %
Optical sorter PP-3D	+	PP-3D	2 %
	-	Other	98 %
Optical sorter PS	+	PS	0 %
	-	Other	100 %
Optical sorter Paper	+	Paper	0 %
	-	Other	100 %
Optical sorter PO-2D	+	PO-2D	91 %
	-	Other	9 %
Optical sorter MIX	+	Mixed plastics	96 %
	-	Other	4 %
Optical sorter PVC	+	PVC	0 %
	-	Other	100 %

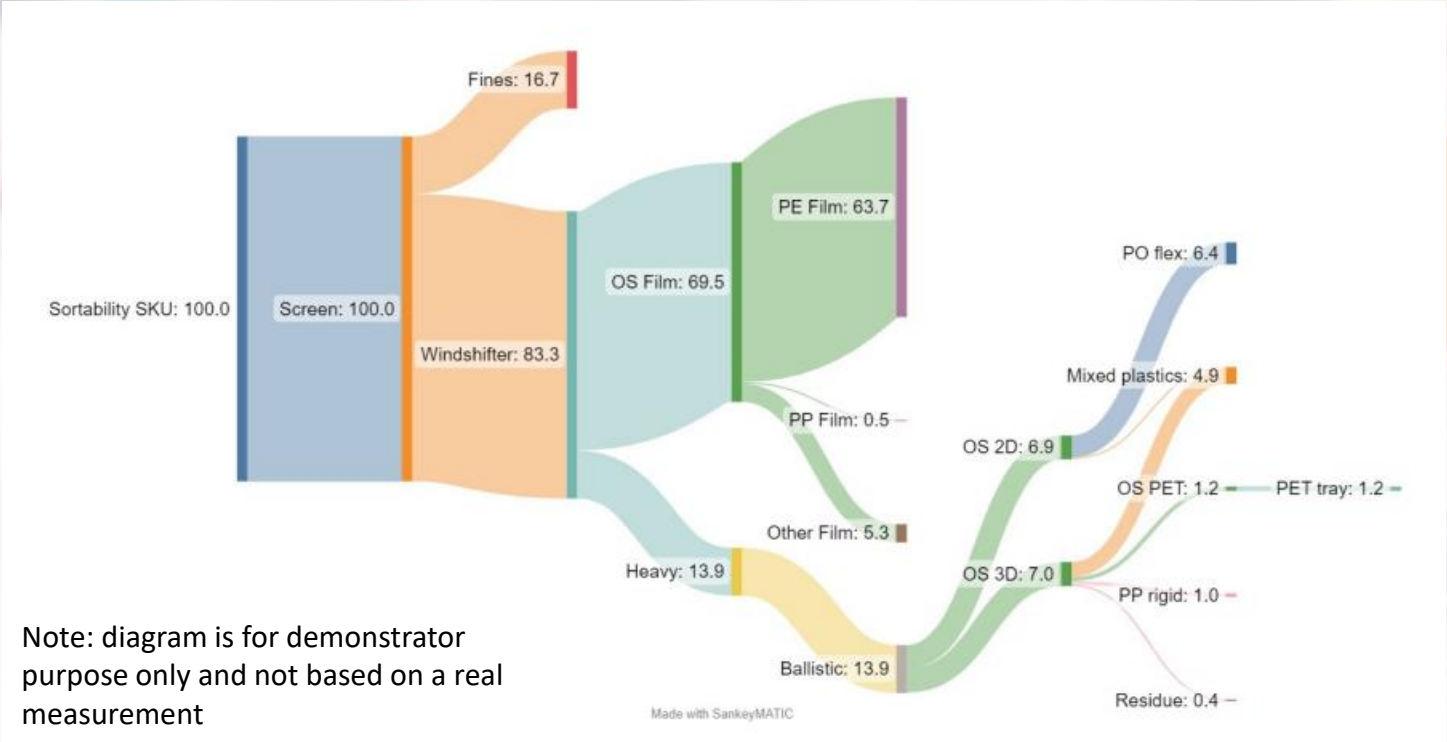
Comments

- Pouch behaviour: rigid and heavy. As a result poor sorting efficiency for lights and 2D sorting
- High sorting efficiency for mixed polyolefins

Link split factors to industrial sorting facility

Use splitfactors to RecyClass Sorting Protocol process

Use of Split factors to create Sankey Diagram



Note: diagram is for demonstrator purpose only and not based on a real measurement

Let’s cooperate to accelerate the transition towards a circular plastics economy

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Thank you for your attention!

RecyClass

RecyClass
Sorting Evaluation Protocol

Case Study

RecyClass Science behind Recyclability, 4 December 2023

RecyClass | PROPOSAL: BACKGROUND, GOAL & SCOPE

Background : Design for Recycling Guidelines recommendations on labels and sleeves

Current recommendations

- Size of non-PE detectable surfaces on containers > 500 ml: < 70 % Coverage
- Size of non-PE detectable surfaces on containers < 500 ml: < 50 % Coverage

Goal: Generate know-how to support the design of labels and sleeves

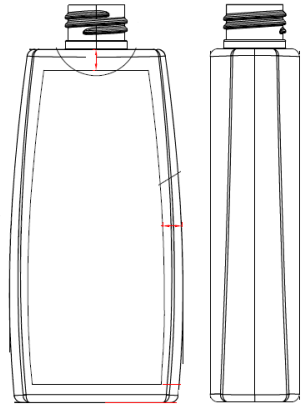
Scope : Study non-NIR detectable surfaces of decorative technologies especially 3 main aspects:

Evaluate the impact of **mass coloration** for non-PE labels & sleeves' NIR detectability

Evaluate the influence of **heavily & dark printing** on NIR detectability

Evaluate the NIR detectability of various non-PE **labels & sleeves' thicknesses**

RecyClass | MATRIX OF SAMPLES



Flat HDPE Bottles (200 ml)

Material	Bottle	Coverage	Thickness		Cavitation		Opacity (TiO2 content)	Number of samples
			Thin	Thick	Y	N		
PP labels	Flat HDPE	≈ 70 %	40 µm	60 µm	60 µm	60 µm		4
PET-g sleeve	Flat HDPE	full	30 µm	50 µm			50 µm	3
PO sleeve	Flat HDPE	full		50 µm				1

Thickness study:

Impact of thickness:

- ✓ Clear PET-G sleeve 30 µm (real case, *light printing*)
- ✓ Clear PET-G sleeve 50 µm (real case, *light printing*)
- ✓ Clear PO sleeve 50 µm (real case, *light printing*)

Impact of adhesive:

- ✓ Clear PP label 40 µm (real case, *light printing*)
- ✓ Clear PP label 60 µm (real case, *light printing*)

Mass colouration:

Impact of mineral fillers:

- ✓ *PET-G* sleeve non-cavitated with TiO2

Impact of cavitation:

- ✓ *PP label* cavitated with low TiO2 content
- ✓ *PP label* non-cavitated with low TiO2 content

Printing:

To be defined after the first trials.

ISDIN LOVE YOUR SKIN · AVERY DENNISON · All4Labels GLOBAL PACKAGING GROUP · CCL

RecyClass | SAMPLES

Impact of thickness and adhesive:
- ✓ Clear PP label 40 µm (real case, *light printing*)
- ✓ Clear PP label 60 µm (real case, *light printing*)

Impact of cavitation:
- ✓ *PP label* cavitated with low TiO2 content
- ✓ *PP label* non-cavitated with low TiO2 content

Mass colouration:

Impact of mineral fillers:
- ✓ *PET-G* sleeve non-cavitated with TiO2

RecyClass | SAMPLES

Thickness study:

Impact of thickness:

- ✓ Clear PET-G sleeve 30 µm (real case, *light printing*)
- ✓ Clear PET-G sleeve 50 µm (real case, *light printing*)
- ✓ Clear PO sleeve 50 µm (real case, *light printing*)

RecyClass | STATIC TEST – RESULTS

No.	Labelling Description	Picture
1	PP60 CAVIT TOP White PP label white, cavitated with TiO2, 60 µm	
2	PP40 TOP CLEAR PP label clear, 40 µm	
3	PP60 TOP CLEAR PP label clear, 60 µm	
4	AE403 PP TOP White PP label white non-cavitated with TiO2, 60 µm	
5	A4L-FBS White PET-G sleeve 50 µm	
6	PET 30µ Clear PET-G sleeve 30 µm	
7	ECOFLOAT 50µ Clear PO sleeve, 50 µm	
8	PET 50µ Clear PET-G sleeve, 50 um	

No.	Labelling Description	NIR			
		PP (rigid)	PE (rigid)	Mixed plastics	PET
1	PP60 CAVIT TOP White	Undetected ▯	Detected ✔	Detected ✔	N/A
2	PP40 TOP CLEAR	Undetected ▯	Detected ✔	Detected ✔	N/A
3	PP60 TOP CLEAR	Undetected ▯	Detected ✔	Detected ✔	N/A
4	AE403 PP TOP White	Undetected ▯	Detected ✔	Detected ✔	N/A
5	A4L-FBS	N/A	Detected ✔	Detected ✔	Undetected ▯
6	PET 30µ	N/A	Detected ✔	Detected ✔	Undetected ▯
7	ECOFLOAT 50µ	Undetected ▯	Detected ✔	Detected ✔	Undetected ▯
8	PET 50µ	N/A	Detected ✔	Detected ✔	Undetected ▯

RecyClass | DYNAMIC TEST 1 – RESULTS

No.	Labelling Description	Picture
1	PP60 CAVIT TOP White PP label white, cavitated with TiO2, 60 µm	
2	PP40 TOP CLEAR PP label clear, 40 µm	
3	PP60 TOP CLEAR PP label clear, 60 µm	
4	AE403 PP TOP White PP label white non-cavitated with TiO2, 60 µm	
5	A4L-FBS White PET-G sleeve 50 µm	
6	PET 30µ Clear PET-G sleeve 30 µm	
7	ECOFLOAT 50µ Clear PO sleeve, 50 µm	
8	PET 50µ Clear PET-G sleeve, 50 um	

No.	Labelling Description	NIR			
		PP (rigid)	PE (rigid)	Mixed plastics	PET
1	PP60 CAVIT TOP White	☹	☺	😕	N/A
2	PP40 TOP CLEAR	☹	☺	☺	N/A
3	PP60 TOP CLEAR	☹	☺	☺	N/A
4	AE403 PP TOP White	☹	☺	☺	N/A
5	A4L-FBS	☹	☺	☺	☹
6	PET 30µ	N/A	☺	☺	☹
7	ECOFLOAT 50µ	☹	☺	😕	☹
8	PET 50µ	N/A	☺	😕	☹

The following provides an overview of the scoring system for Dynamic test 1 ejection rate results:

☺ = 70 – 100% (Good) ☺ = 50 – 69% (Fair) 😕 = 30 - 49% (Poor) ☹ = 0 – 29% (Insufficient)

RecyClass | DYNAMIC TEST 2 (FULL OPERATIONAL SORTING TEST)- RESULTS

No.	Labelling Description	Picture
1	PP60 CAVIT TOP White PP label white, cavitated with TiO2, 60 µm	
2	PP40 TOP CLEAR PP label clear, 40 µm	
3	PP60 TOP CLEAR PP label clear, 60 µm	
4	AE403 PP TOP White PP label white non-cavitated with TiO2, 60 µm	
5	A4L-FBS White PET-G sleeve 50 µm	
6	PET 30µ Clear PET-G sleeve 30 µm	
7	ECOFLOAT 50µ Clear PO sleeve, 50 µm	
8	PET 50µ Clear PET-G sleeve, 50 um	

No.	Labelling Description	Waste Stream		
		PE (rigid)	Mixed plastics	Residue
1	PP60 CAVIT TOP White	82%	11%	7%
2	PP40 TOP CLEAR	85%	7%	8%
3	PP60 TOP CLEAR	91%	6%	3%
4	AE403 PP TOP White	86%	11%	3%
5	A4L-FBS	78%	21%	1%
6	PET 30µ	94%	3%	3%
7	ECOFLOAT 50µ	89%	8%	3%
8	PET 50µ	77%	12%	11%

RecyClass | LABELS AND SLEEVES – RESULTS

Main conclusions

- All tested labels and PET-G 30µm & Ecofloat full body sleeved bottles achieved a sorting efficiency > 80% (without contaminating another mono-stream).
- The white and printed 50 µm PET-G sleeve (A4L-FBS / 78%) and clear and printed PET-G 50 µm (77%) reached an efficiency between 70-80% (without contaminating another mono-stream). *This will correspond with 1 class deduction according to RecyClass methodology*.
- The 30 µm (thinner) PET-G full body sleeve scored better than 50 µm (thicker) version.
- Labelling did not influence the packaging in a way that it was sorted into its material-based stream (i.e., Bottles with a PP based label were not sorted into the PP waste stream and the same for the PET based sleeve labelling regarding PET waste stream).

RecyClass | LABELS AND SLEEVES – RESULTS

Current recommendations

- Size of non-PE detectable surfaces on containers > 500 ml: < 70 % Coverage
- Size of non-PE detectable surfaces on containers < 500 ml: < 50 % Coverage

New recommendations (to be linked to a technical review)

- Technical review to be published on RecyClass website with the findings.
- Sorting tests shall follow the current recommendations but, if falling outside of the recommended thresholds, companies can check the results of the test campaign to better understand which is the best solution.
- With more information in the future, Guidelines could be updated.

Next steps
- Technical review to be published on RecyClass website.

RecyClass

KEY TAKEAWAYS

- Sorting tests are key to ensure that plastic packaging is well sorted in the *right stream*, without contaminating another mono stream.
- RecyClass has a *standardized testing procedure and recognised testing facilities* available to perform the tests. Sorting test is mandatory for specific packaging design criteria.
- Several parameters can hamper the sorting of plastic packaging. A *correct design* of the packaging is needed to avoid further problems.
- *Avoid using full-body sleeves and labels with high coverage* made from a foreign material different from that of the underlying container.
- If full-body sleeves or labels with high coverage cannot be avoided, the *findings of RecyClass test campaign* can be used as guidance and a sorting test should be performed the packaging is sorted.
- The results of a sorting test should show *more than 80 % efficiency* of the packaging sorted in its own stream, and *less than 10 % of contamination in another mono stream* to avoid penalizations according to RecyClass methodology.

RecyClass

Questions & Answers

Use the Q&A box in the top-right corner of your screen

RecyClass

Thank you for participating!

Sign up for the next sessions!

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