PETCORE ANNUAL CONFERENCE 2024

Session 4: Design guidelines
WG: opaque and functional bottles

Alessandra Funcia – Head of Sales & Marketing - Sukano

8 February 2024

Task Force: Webinar on sorting

Pellenc; Antoine Bourely

- Objective: educative and forward looking
  - What can we do more if we could better sort our PET packaging waste
- Save the date: **March 19th – 9am to 12:30am – CET**
- Headline: How to improve circularity in PET, via sorting technologies

Part 1: Panel discussion EPR in Europe

- Streams strategy
- Opportunities/needs for high quality streams
- CITEO/COREPLA/Indorama

Part 2: Technical novelties update

- From spectroscopy, to object recognition (with AI), to markers
- Tomra/Pellenc/Sesotec

Part 3: Future sorting technologies

- Capabilities, limitations and TRL (technology readiness to launch)
- Digimarc/Filigrade/NextLoop/ Perfectsort Consortium

TF: Opaque colored PET bottles end of life options

REPI; Karsten Fritsch

Objective: Identify and define criteria for most suitable EoL recommendation for opaque colored and functional/additivated PET bottles to be recycled

Quantification of the EU market

- **Colored opaque PET bottles**
  - Non white opaque, non light blue, non light green
- **Estimated > 100ktons** based on inputs and calculations from TF members 2022 data

Initial considerations for colored PET stream

- **Only use food grade colorants/ingredients** for any applications
  - Allows use of colored PET in food and non-food (main target: non-food)
  - Qualify correct labelling as recyclable application
- **Use of colorants as "markers"** to separate non-food PET packaging
- **Flakes and granulates preferred outlet:**
  - Non-food PET packaging
  - Ensures circularity within packaging ; not exclusively closed-loop
- Functional bottles to be sorted together with colored PET bottles

TF: Continued review of DfR guidelines and support EPBP

Sukano; Alessandra Funcia

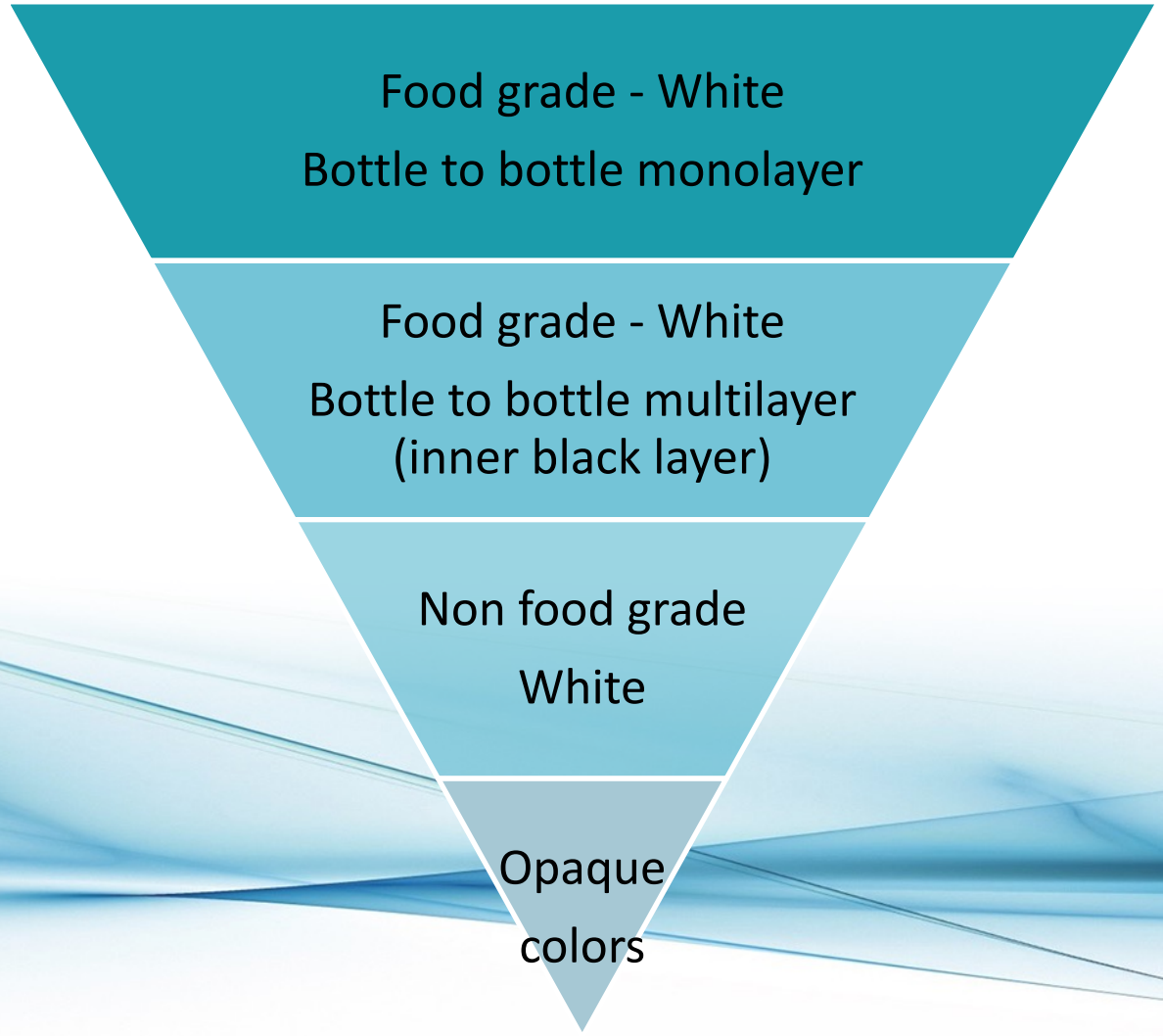
Objective: Continued review of the Opaque white PET bottles DfR guidelines by EPBP .
Technical reviewed answers to the additional information requested by EPBP TC

Questions

1. Define a min and max % of inorganic opacifier to ensure full sortability and processability of RPETo in multiple loops
2. Definition of “opaque” from a recycling point of view
3. Closed (multiple) loops for white opaque RPETo stream: define conditions to manage and prevent “accumulation” of inorganic opacifier and maintain blowability

- Results and conclusions must encompass the entire value chain players performance

From closed loop to circular applications



RPETo outlet hierarchy

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Test set up by Resilux

- **Mono & Multi** layer preforms (26.5gr)
- **5-10-15% inorganic opacifier**; black middle layer constant
- 4 **masterbatches** grades
- **1Lt PET** bottle, +/- **230µm** wall thickness
- **Lab machine**, heat coefficient 80-120%, speed 1400bot/h, stretch rod 1m/s, preblow P1 5 bar

Test results

- All **preforms and bottles** could be produced at **all inorganic opacifier concentration** levels without problems
- Different **energy requirements** according to masterbatch grade, % of ino opacifier and technology (mono/multi), as expected
- **Light transmission** considered for UHT in this trial: <0.1% at 540-550nm, **achieved** with opacifier levels of 10% (mono) and <5% (multilayer including inner black layer)
- Max. inorganic opacifier level needed for **light protection in sensitive applications** is below max. inorganic opacifier level tested

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Penncolor; Nicolas Rivollet

Modelling multiple loops as a function of MB LDR%, amount of inorganic opacifier and RPETo

ACCUMULATION OF OPACIFIER IN WHITE OPAQUE PET BOTTLES, USING rPET FROM CLOSED LOOP DEDICATED STREAM

MASTERBATCH			0	1	2	3	4	5
Let down ratio of masterbatch	% of part weight	A	10%	**10.00%**	**10.00%**	**10.00%**	**10.00%**	**10.00%**
Opacifier in the masterbatch	% of masterbatch weight	B	60%	60%	60%	60%	60%	60%
Opacifier in part, from the masterbatch	% of part weight	C=AxB	**6.00%**	**6.00%**	**6.00%**	**6.00%**	**6.00%**	**6.00%**
PET MATERIAL								
PET material (Virgin and rPET)	% of part weight	D=1-A	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
rPET content	% of PET material	E	20%	20%	20%	20%	20%	20%
Opacifier in rPET	% of rPET material	F	0.00%	**6.00%**	**7.08%**	**7.27%**	**7.31%**	**7.32%**
Opacifier in PET material (virgin + rPET)	% of PET material	G=ExF	0%	1.20%	1.42%	1.45%	1.46%	1.46%
Opacifier in part, from the PET material	% of part weight	H=DxG	**0.00%**	**1.08%**	**1.27%**	**1.31%**	**1.32%**	**1.32%**
BOTTLE								
Total opacifier	% of part weight	I=C+H	**6.00%**	**7.08%**	**7.27%**	**7.31%**	**7.32%**	**7.32%**

Assuming rPET in loop 1 comes from white opaque bottles produced in loop 0

Assuming rPET in loop 2 comes from white opaque bottles produced in loop 1

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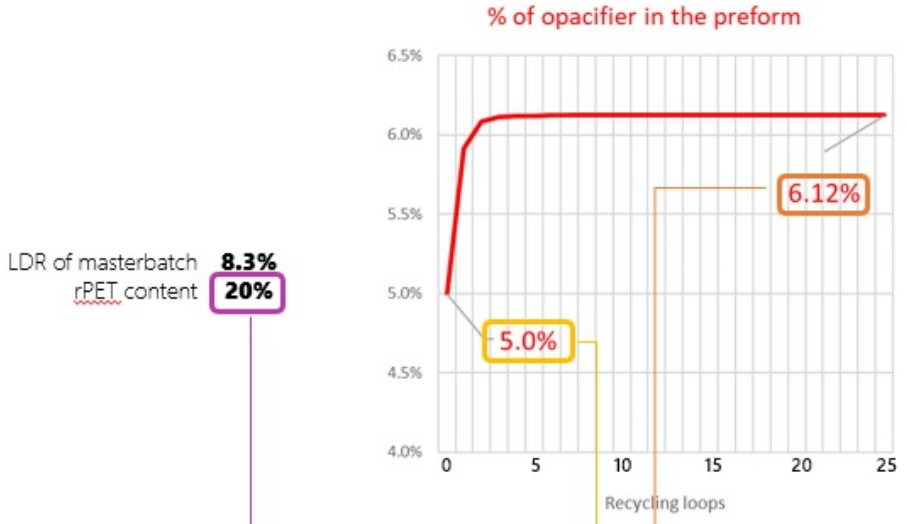
The model shows, in all scenarios the accumulation reaches a plateau within n recycling loops.

THE CONTENT OF OPACIFIER AT PLATEAU IS A FUNCTION OF INITIAL CONTENT OF OPACIFIER & RECYCLED CONTENT



LDR of masterbatch **8.3%**
rPET content **20%**

White opaque rPET content	2.5%	5.0%	6.5%	7.5%	10.0%	12.5%	15.0%	Initial content of opacifier
10%	2.76%	5.50%	7.14%	8.22%	10.91%	13.57%	16.22%	
20%	3.09%	6.12%	7.91%	9.09%	12.00%	14.85%	17.65%	
30%	3.51%	6.90%	8.87%	10.17%	13.33%	16.39%	19.35%	Content of opacifier at plateau
40%	4.05%	7.89%	10.10%	11.54%	15.00%	18.29%	21.43%	
50%	4.80%	9.23%	11.73%	13.33%	17.14%	20.69%	24.00%	

All cases with 60% opacifier in masterbatch

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Modelling multiple loops as a function of MB LDR%, amount of inorganic opacifier and RPETo

Limited By Availability Of rPET

Limited By The Technical Need & The Economics

		2.5%	5.0%	6.5%	7.5%	10.0%	12.5%	15.0%	Initial content of opacifier
White opaque rPET content	10%	2.76%	5.50%	7.14%	8.22%	10.91%	13.57%	16.22%	Content of opacifier at plateau
	20%	3.09%	6.12%	7.91%	9.09%	12.00%	14.85%	17.65%	
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	40%	4.05%	7.89%	10.10%	11.54%	15.00%	18.29%	21.43%	
	50%	4.80%	9.23%	11.73%	13.33%	17.14%	20.69%	24.00%	

> 15%

⚠ WARNING: This not a statistical model. This pure arithmetical model does not represent the expected fluidity of the market and assumes that the whole market behaves as "one average market": for example, it does not account does not account for the fact that the rPET may contain a mix of materials with a different "loop" history ; it does not account for consumption growth, where incremental production may be produced with recycled content and opacifier content different from the average.

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The opacifier accumulation in rPETo allows for a reduction in MB white needed for light barrier

BY ADJUSTING THE LDR TO A LOWER LEVEL THAT ACCOUNTS FOR THE OPACIFIER ALREADY IN THE rPET, THE TOTAL CONTENT OF OPACIFIER CAN BE KEPT AT THE NOMINAL LEVEL

LDR ADJUSTED

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CONCLUSIONS FROM TF5

01 Sensitive applications demand max of 10%, 230µm wall thickness, monolayer. Inorganic opacifier level does not need to exceed 10% in weight.

02 RPETo manufacturers to report on opacifier level. Ash test and/or XRF measurements

03 RPETo amount and inorganic opacifier needs, are defined by brand owner. Convertors ensure tolerance (keep constant and controlled)

04 The more opaque the white PET bottle, the better the sorting occurs. Min 1% inorganic opacifier.

05 EU targets of 25% and 30% RPETo recommended, max. of 50% RPETo granules also feasible with adapted white MB LDR%

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CONCLUSIONS FROM TF5

06 Modelling in closed and circular applications confirms that multiple loops are feasible. Could, however, be limited by the max 10% of inorganic opacifier

07 Masterbatches dosage is advised to be adjusted and can be reduced to achieve initial light barrier specification, based in RPETo amount in use.

08 Raw material cost reduction opportunity by using RPETo in replacement of RPET clear and reduced dosage of masterbatch

09 All top loads were good (+/- 15 kgf). No significant difference, neither between the different % of inorganic opacifier, nor the various masterbatches.

10 Innovations to the white opaque PET bottles stream shall have its recyclability assessed

Next Steps 2024

Any other proposal – please approach PETCORE or O&F team

- Webinar on sorting – March 19th, 2024
- TF4:
  - Exchange within TF4 members about alternative outlets for coloured and functional PET bottles
  - Define criteria and consequent hierarchy for circularity of coloured and functional PET bottles
- TF5
  - Drop test measurements in the different inorganic opacifier levels
  - Evaluate recycling process of highly loaded white opaque PET bottles:
    - Agglomeration/filters replacement
    - IV fluctuation and impact
    - Wear and maintenance
  - Present the results of the TF5 to the EPBP TC – date TBD

Thank you

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