General Notice

Technical assessment of the potential for the incorporation of mono-PET trays in the existing clear PET bottles recycling stream

1/ CONTEXT

Eco-Emballage has conducted a large-scale trial since 2010 with its partners on the extension of the sorting guidelines for household plastic packaging. The findings for collection, sorting and recycling will form the basis for an initiative to improve recycling of household plastic packaging waste.

As trays represent significant tonnage of PET that will be captured under the extended sorting guidelines, it appeared necessary to examine the impacts of PET trays on the sorting and recycling of existing PET materials under current conditions.

The majority of PET trays on the French market are mono-PET, but some of them are produced from an admixture of several resins or have a cap made from different materials.

Using current automated materials recovery technologies, it is possible to identify and separate multi-material trays from bottles, **but trays made from a single material cannot be automatically separated from these flows. Hence the tests were conducted on these mono-material trays.**

Preliminary studies showed that the properties of the PET used in trays are not exactly the same as the PET used in bottles (shape, functionality, thickness, viscosity index, etc.), a finding that could have **consequences for recycling** (viscosity index of the recycled material, temperature resistance, etc.). COTREP decided to **carry out a more detailed study of the recycling behaviour of mono-resin clear PET trays in the current clear PET bottles recycling stream, if they were incorporated in the same stream**.

Recyclability tests were conducted on the trays according to a protocol developed for this context and approved by the recycling operators. The technical characteristics of the recycled material were evaluated with a view to **reprocessing as bottles,** the most demanding application in terms of quality requirements.

For COTREP, the results, which relate only to mono-PET trays, will constitute **a standard for future tests on different types of clear PET-based trays**. These tests will be conducted to assess the impact on the existing recycling stream of other materials or additives that may be combined with clear PET.

2/ PRINCIPLE AND ANALYSIS CRITERIA

The study was conducted by a laboratory specialising in recyclability studies. It consisted of assessing the influence of mono-PET trays on the recyclability of bottles in the clear PET recycling stream.

The first stage was to carry out tests in the lab on the potential for reprocessing the trays as sheets, according to an existing test protocol recognised by industry stakeholders for recycling PET bottles and adjusted for the purposes of testing the trays. The findings were positive and the test was then extended to cover the potential for reprocessing as bottles.

100% PET trays were ground into flakes and mixed with 100% recycled PET flakes produced from a standard clear PET recycling stream (bottles). A series of physical criteria were measured throughout the preparation process and compared to a standard sample made up exclusively of recycled PET flakes output from a standard clear PET stream.

Having validated the study parameters, both the control and test samples were processed into sheets and bottles and their technical characteristics evaluated.

The study procedure was as follows:

2. **Preparation of the test blend from flakes produced from mono-PET trays;** physico-chemical analysis of the sample obtained (colour, density, viscosity index, etc.)
3. **Extrusion followed by granulation of the material mixture** and calculation of the viscosity index of the granules;
4. **Feasibility assessment of the sheets and bottles and determination of the technical characteristics** of the products (optical and mechanical properties, intrinsic viscosity, dimensions, etc.).

<u>NB:</u>
The study does not lead us to project the aptitude of the rPET granules obtained for food contact applications, due to a technical limitation of the study: the temperature was slightly lower relative to usual industrial practices (see test protocols).

3/ Test protocols and main results

3/1 Sample type and constitution

The selected trays were made from 100% PET and were used primarily in blister packs or in packaging for fruit and vegetables, ready-meals and pastries. Only trays uncontaminated by food residue and without secondary packaging elements, such as labels, glue or caps, were tested for this study.
The protocol involved a number of preparation and processing steps, which were carried out on the test sample trays and on a standard sample made from standard clear PET recycled flakes.
The diagram below shows the procedure and the measurement points.

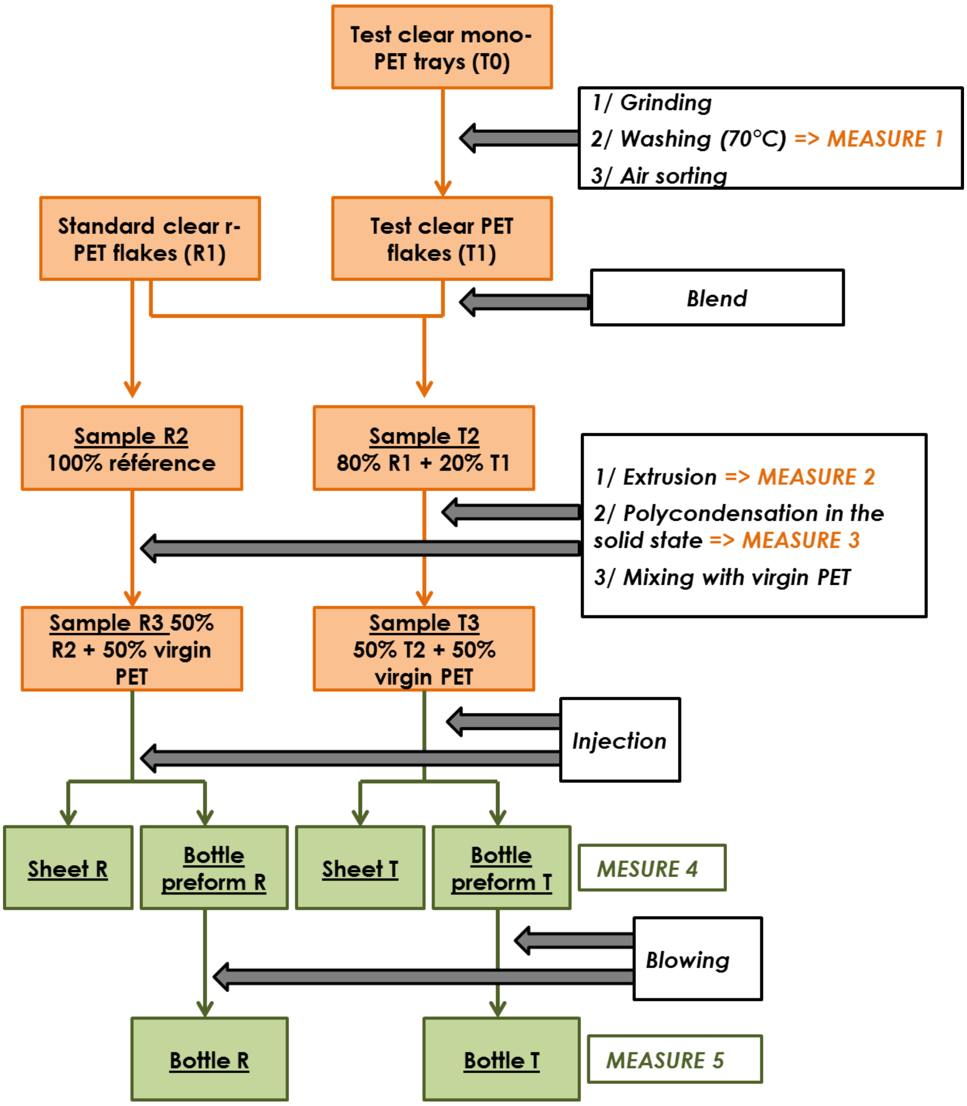

Figure 1- Test protocol and physical variable measurement points

The test protocol was as follows[1]:

1/ First, the batch of mono-PET trays (T_0) was ground into flakes washed at a temperature of 70°C. The temperature parameter was the only change relative to the established protocols in the industry (usual temperature: 85°C). The reason for the slight reduction in the washing temperature was to avoid weakening the flakes, to limit losses and to ensure the right proportion of flakes in the sample. The flakes were then dried and put through an aeraulic sorting process to eliminate the possibility of any lighter fractions remaining;

2/ The flakes sample T_1 thus formed was blended in a 20/80 ratio with a pure "standard" sample composed solely of standard clear PET recycled flakes (R_1)[2];

3/ The resulting batch T_2 was extruded, crystallised, and underwent solid phase polycondensation. Then the granules were blended in identical proportion (50-50) with virgin PET granules;

4/ The material obtained T_3 was injection moulded into sheets or bottle preforms. Bottles were then produced from these preforms in a final blow moulding process.

3/2 Analysis of the results: technical feasibility and measurement of physical variables

The results are given in the table below (see Table 1).[3] An analysis of the results shows no significant difference in physico-chemical characteristics (mechanical properties, increasing viscosity, thermal constants and optical parameters) between the test and control samples at a 20% concentration of flakes from mono-PET trays for both types of products tested, i.e. sheets and bottles.

Moreover, the potential for processing was found to be good for all the bottles and sheets produced, under exactly the same preparation and production conditions as those commonly used (apart from the washing temperature which was reduced in order to limit material losses).

TECHNICAL CONCLUSIONS

The study results were analysed to assess the potential for incorporating clear mono-PET trays in the current clear PET bottles recycling stream.

In the quantities tested, namely 20% concentration (the maximum relative to the proportion of such trays in the overall packaging tonnage on the market), the products obtained (sheets and bottles) had the expected mechanical properties and the colour was in line with the control.

As a result, mono-PET trays are recyclable in the clear PET bottles recycling stream, for the target applications and under existing industrial recycling conditions. Nonetheless, in view of the fact that PET trays are more fragile and behave differently according to the recycling line, it is important to point out that we are not in a position to judge the impacts on reprocessing efficiency from the results of the tests conducted as part of this study.

[1] A similar protocol was followed for the standard sample in order to draw a comparison between all the physical variables measured for the test sample at the various preparation and processing stages.

[2] This value was defined based on a 245 k ton stock of clear PET bottles and 65 k tons of clear PET trays. On the basis of fully incorporating the trays in the bottles stream, the rate of incorporation in this stream is assessed as 65/(245+65) = 21%. Due to the possible presence of coloured and opaque trays amongst the clear trays, and a capture rate that is potentially lower than the rate for bottles, this value has been rounded down to 20%.

[3] Only the data concerning the last stages of the process (polycondensation products, sheets, preforms and bottles) were recorded.

Stages	Solid phase polycondensation		Injection			
Physical variables / Samples	Control	Test granules	Control	Sheets	Control	Preforms
Viscosity index (measured on granules)	t = 2h: VI = 0.749 t = 6h: VI = 0.802 t = 8h: VI = 0.825	t = 2h: VI = 0.728 t = 6h: VI = 0.776 t = 8h: VI = 0.809	-	-	Not recorded	<u>In accordance with the control</u> IV = ±0.02 vs. standard
Thermal constants (°C)	Tg = 80.65 [(1)] Tg = 137.29 [(2)] Tm = 244.35 [(3)]	Tg = 80.72 [(1)] Tg = 135.89 [(2)] Tm = 244.20 [(3)]	-	-	-	-
Acetaldehyde concentration (ppm)	0.23	0.38	-	-	3.61	3.57
Optical properties – Colouration ($L^*a^*b^*$)	Slight aqua marine colouration L* = 66.84 a* = -2.19 b* = 3.40	<u>No discolouration observed relative to the control</u> L* = 66.43 a* = -2.20 b* = 3.00	• Slight aqua marine colouration • Slight discolouration relative to the granules L* = 85.59 a* = -2.20 b* = 12.44	Small amount of discolouration observed but identical to that of the control ⇨ <u>In accordance with the control</u> L* = 85.63 a* = -2.28 b* = 12.00	-	-
Optical properties – Opacity	-	-	8.67	9.07	-	-
Technical feasibility	-	-	-	Good potential for processing *(on 300 sheets produced)*	-	Good potential for processing

Blow moulding		
Physical variables / Sample	Bottles	
Dimensions	Comparable to the control	
Distribution of matter (bottle thickness at various levels)	Similar to the control	
Thermal stability	>90% of the control value ⇨ No significant difference with the control	
Mechanical properties (drop, stretch, and burst resistance, fill, retention of CO_2, etc.)	No significant difference with the control (< 10%)	
Optical properties (colouration and opacity)	<u>Strictly identical to the control</u>	
	Control	Test
	L* = 94.30 a* = -0.27 b* = 1.75	L* = 94.29 a* = -0.28 b* = 1.75
Technical feasibility	Good potential for processing *(on 150 bottles produced)*	

(1) Tg: Vitreous transition temperature (2) Tc: Crystallisation temperature (3) Tm: Melting temperature