

Mixed bottles & mono-material thermoforms test in France

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Context and purpose of the tests:

- Recycled PET coming from the bottles stream has had a rapid development in recent years and meets a huge demand. There is so a large interest in the PET trays which is an opportunity to recycle additional tonnage. Moreover, the part of the PET in the thermoforms market could increase, in substitution of other resins, especially the PVC against which the PET is considered as being more recyclable.
- As part of the extension of the sorting instructions, the proportion of PET trays will strongly increase in the curbside stream. Today, PET thermoforms represent about 15% to 20% by weight of the virgin PET output (compared to bottles), we have currently an average of 7% in the mixed bales.
- The research project, supported by Ademe, Eco-Emballages and Valorplast, is driven by Valorplast. It has the ambition to valorize more plastics and in particular the PET trays which represent a potential greater than 60kT.
- Tests conducted in 4 different plants are intended to answer the following questions:
 - ✓ What is the impact of the trays on the recycling of PET bottles?
 - ❖ Quality of the manufactured RPET
 - ❖ Impact on the yield.
 - ✓ Can we recycle a mixed flow of bottles and PET thermoforms?
 - ❖ What are the adaptations on the processes (in Material Recovery Factories and in Recycling Plants)?

Description of the test (1/2):

Preparation of bales made of PET bottles boosted with 20% of mono-material trays PET

- The PET bottles and thermoforms are coming from the French curbside system.
- Bales of PET bottles have been manually boosted with 15 to 20% of mono-material trays (with no cappings) in a sorting center:
 - ✓ Trays were collected in the French curbside system, discarded from the bottle stream, baled and stored until a sufficient amount was on stock.
 - ✓ Thermoforms bales were then broken in order mix the trays with the bottles.
 - ✓ The inflows have been sorted on optical sorting equipped with multi-material / mono-material recognition.
 - ✓ Around 235 tons had been manufactured.
- Bales are dispatched in 4 different plants, all members of the SRP:
 - ✓ France Plastique Recyclage in Limay, Plastipak in Sainte Marie la Blanche, Suez RV Plastique Atlantique in Bayonne and Wellman France Recyclage in Verdun.
 - ✓ All those units are equipped with PELLENC or TOMRA optical sorters that have the detection of the mono-material thermoforms versus the multi-material one.

Description of the test (2/2):

Usage of these boosted bales in the regeneration process

- Each plant has achieved a production campaign on its industrial tool:
 - ✓ Production test conducted in the presence of Valorplast.
 - ✓ Characterization of the bales before the start of the tests.
 - ✓ Production lines are emptied before the start of the test.
 - ✓ Production is carried out with the standard settings (output, wash temperatures, settings of the sorting machines).
 - ✓ Production lines are emptied at the end of the test and everything is weighted.
 - ✓ Global mass balance is calculated.
 - ✓ Finished product manufactured is controlled against current specifications.

- One part of the recycled raw material thus produced is sent to some customers of the regenerators in order to check the impact on their production.

Characterization of the input bales (1 / 2) (percentage of the input weight)

Input bales		FPR	Plastipak	Suez RV	WFR	Total
<u>Received amount</u>	<u>tons</u>	<u>67,24</u>	<u>82,10</u>	<u>17,68</u>	<u>69,56</u>	<u>236,58</u>
Clear/Light blue PET bottles	%	81,20%	82,02%	81,80%	80,00%	81,18%
Clear mono-material non capped PET thermoforms	%	16,60%	15,63%	15,20%	17,90%	16,54%
Sub-total good PET	%	97,80%	97,65%	97,00%	97,90%	97,72%
Multi-material PET trays	%	0,20%	0,00%	0,00%	0,30%	0,15%
PVC	%	0,00%	0,00%	0,12%	0,08%	0,03%
Other contaminants	%	2,00%	2,35%	2,88%	1,72%	2,10%
Sub-total Contaminants	%	2,20%	2,35%	3,00%	2,10%	2,28%
<u>Total</u>	<u>%</u>	<u>100,00%</u>	<u>100,00%</u>	<u>100,00%</u>	<u>100,00%</u>	<u>100,00%</u>

Characterization of the input bales (2 / 2)

Several important points are to be reported on the analysis of the composition of bales:

- Using data from the SRP's Observatory of the quality, a comparison with the quality of the clear PET bales usually received was carried out. We see overall that the quality of the bales delivered for these tests is significantly better than the one usually received:
 - ✓ Less multi-material thermoforms with capped.
 - ✓ Less PVC
 - ✓ Globally, less total contaminants in the test bales. This decrease will result in an artificial increase in the overall yield.

- The average rate of mono-material thermoforms is 16.54%.

Test results: quality and comments (1 / 2)

Decrease in the quality of the finished product

- Increase of the residual PVC up to 3,5 times the normal rate
 - ✓ The PVC is resulting, for the bottle and sheet applications, in gels or blackspots. For the fiber applications, it could result in strand breaks.
 - ✓ In at least one plant, the higher PVC resulted in a declassification of the finished product to be re-rooted in low end application markets.

- Presence of semi-crystallized flakes up to 14% measured in one factory:
 - ✓ After the hot wash and/or the drying process, the flakes coming from the trays do not have the same cooling speed than the ones coming from bottle. The flakes made out of trays tend to start crystallizing:
 - ❖ The flakes are becoming opaque, and they could then be detected and throw away by the flakes optical sorters that are set to take out the opaque flakes (coming from the milk bottles as an example)
 - ❖ These flakes are also much more brittle: in case of high shear centrifugal systems, they will be broken to become dust, resulting in the loss of dust and fines. Please note that it is pretty common to have such systems, originally designed to break the PVC flakes.

- Strong yellowing after pelletizing (5 points on the b*) in one of the plants :
 - The root cause could come from a degradation of the PET or the presence of other polymers degrading at the normal process temperature of PET.

Test results: quality and comments (2 / 2)

Taking into account the higher purity of the test bales, the yield is decreasing with a large spread (more than 7%) between plants

- A portion of the input thermoforms are lost:
 - ✓ The losses can be found at different steps of the process:
 - ❖ In the infeed screening system. Due to the preparation of the samples, this loss might be reduced in the real life, but it is difficult to estimate.
 - ❖ In the screening systems of the flakes (see next bullet point)
 - ✓ Generation of fines and dust:
 - ❖ According to the process, some high shear centrifuges driers (designed originally to break PVC) are now breaking the semi-crystallized flakes.
 - ❖ Wash water contains more fine, resulting in more sludge coming out the water treatment.
 - ✓ Increase of the reject flakes (from the flake sorters) in two of the plants
 - ❖ Presence of PVC or other polymer contaminants.
 - ❖ Presence of semi-crystallized flakes.
 - ❖ Coloration of the flakes coming from the trays due to the way the samples were made (long outside storage of the trays in order to capture enough quantity)

Downstream test:

- 12dTEX fiber in Wellman International Irish plant:
 - ✓ Taking into account the high PVC level, Wellman did blend the flakes at **10%**, when with standard production the flakes could be used at 100%.
 - ✓ No difference was seen compare to standard production of such a quality product.
 - ✓ Note: 12dTex fiber is a low value fiber that suffer the competition from Asia suppliers, production today tends more in fiber that are 2 to 6 times finer.

- Injection of preform (after extrusion and solid stating):
 - Good quality pellets were used to manufacture preforms.
 - Nothing special to say.

Conclusions :

- The tests have been performed with bales that have a higher quality than what is usually found.

- We find differences to varying degrees depending on the plants and regeneration processes used by each production units:
 - ✓ one recycler did not see any effect
 - ✓ a decrease of quality (PVC, yellowing, opacity).
 - ✓ a decrease of the yield.

- Recycling mono-material PET trays and PET bottles at 15-20% would cause the following :
 - ✓ Sorting equipment will imperatively need to be upgraded all along the recycling chain, from Material Recovery Factories to the Recycling plants in order to separate mono-material thermoforms from others.
 - ✓ Heavy investments to upgrade the lines of regenerators (strengthening of the optical sorting as mentioned above, screening systems modification, changes of the centrifuges, modification of extrusion equipment) to ensure the same level of quality and to avoid the material losses seen during the test.
 - ✓ Adjust the prices of mixed bottle/tray bales to compensate the yield loss in the final pricing of the rPET.

Such a new sorting scheme (adding trays in the curbside) will also have a lot of impact in a 65M inhabitants country that we need now to study and quantify:

- Investments to modernize/create the sorting center scheme (moving from 200 to a target of 130).
- Impact on the overall cost of the all value chain from collecting to recycling.
- Social impact in the country areas that are not heavily populated.

The positive impact is that we will have more PET to recycle:

- Just the fact of collecting trays increased the number of collected bottles by 13%.
- We are getting closer to the new European targets for circular economy

Testing will have to continue to also include new recycling ways (chemical recycling is an example)

A compromise that is suitable for all involved parties will have to be found.