

PET-Bottle-to-Bottle-Recycling – Key Success Factors 6 Years Experience in Switzerland

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Abstract

Recycling of PET is worldwide strongly growing. Besides the traditional markets for post consumer bottles like fibres and sheet, more and more PET goes back into a bottle-to-bottle-recycling. In terms of value added it is economically interesting to close the loop and go back in to the bottle. But, in terms of complexity and risk-management, there are a few points which need to be considered in order to realize a successful closed-loop-recycling of PET-bottles.

The following statements are mainly based on a 6 years experience in Switzerland. PET-Recycling Switzerland (PRS) managed to establish a system where today about half of the collected PET goes into a bottle-to-bottle-recycling. First of all, we have a look at the whole value chain of an empty PET-bottle. Each single process in the value chain can certainly vary strongly and needs to be adapted depending on the specific situation in each country/region.

Recovery deals with collection, compacting, transportation and sorting; Recycling is about grinding, washing, swimming–sinking, bottle-to-bottle-technology and end control; Re-integration involves packaging, transportation and re-use; Managing processes include quality-control, system-conformity and communication. A bottle-to-bottle-recycling demands the whole value-chain to be managed in order to coordinate the interfaces of each single process such as collection and sorting.

The paper shows critical success factors for each process in a Bottle-To-Bottle-system (B2B). We speak about the planning of establishing such a system. We discuss risks and an overview of the system PET-Recycling Switzerland (PRS) including a number of key points and figures. A Pre-Treatment-Plant is described with the example of newest sorting-factories in Switzerland. New developments in bottle-to-bottle-technology are also discussed.

Keywords: Closed loop, Bottle-to-Bottle recycling, Success story Switzerland – PRS, Whole value chain, Process quality and specification, Recycling technology

1 Introduction

1.1 Trends PET market

The worldwide strong PET market (and recycling) growth is important and demands new application for recycled bottles. Bottle-to-Bottle-recycling (B2B) is an essential answer to this trend. There are other important developments, e.g. smaller bottles (convenience, on-the-go-consumption) which mean more barrier technology due to the higher surface/content ratio. New markets such as beer and juices are other movements and are also a challenge for mechanical recycling. The discussion of global warming and CO₂-emission will lead to higher recycling targets for plastics which makes sense because closing the loop and therefore keeping the material (PET) into the value chain is a good example of avoiding greenhouse gas emissions and keeping a valuable material into a closed loop.

1.2 PET recycling system in Switzerland – Association PRS

The association PET-Recycling Schweiz (PRS) is a private non-profit organisation. It manages the whole value chain for PET recycling in Switzerland, starting at bottle design (process system conformity), collection, sorting, recycling till the re-integration of recycled PET into the bottle market. The bottle filler / retail company pay an anticipated recycling contribution. Therefore the system is a good example of a successful polluter-pays-principle. Furthermore, about 75% of PET beverage bottles are recycled, most of it in Switzerland.

Ten years ago PRS decided to establish a closed loop recycling in Switzerland and managed to establish a system where today about half of the collected PET goes into a bottle-to-bottle-recycling.

1.3 Value chain PET recycling

A Bottle-To-Bottle-recycling system demands the whole value-chain to be managed. Each single process and the interfaces of it should produce a smooth flow in order to minimize waste and optimize the final product (R-PET) which has to be comparable to virgin material.



Figure 1: Example of a PET recycling value chain

2 Critical success factors – what makes B2B recycling successfully?

2.1 Process system conformity – bottle design

Mechanical recycling and a Bottle-to-Bottle recycling in particular have certain requirements for the design of a PET bottle. In Switzerland the process to check new bottle design is called system conformity. System conformity means that a PET bottle goes – without additional costs – through the whole value chain (collection, sorting and recycling) and ends up as a new PET product.


PET		Checklist for design and system conformity PET bottles PRS			state:	10.07.07
<i>Instructions: Please fill in the yellow fields. Comments at the end of the paper. Thank you.</i>						
Product		Company				
Brand:		Name:				
Description:		Street:				
Content:		Postcode / Place				
Size of bottle (cl):		Contact:				
Weight of bottle (gr.)		Phone / E-Mail:				
Sales / year (no. bottles):		Launching date:				
Sales / year (weight kg):		Test-no. (by PRS):				
Content: Beverages such as soft-drinks, juices, ice-tea, water, syrup, beer and beverages with a protein concentration of max. 1g per 100 ml.		Bottle-to-Bottle	Fibre & Film	NO Recycling!	Example	
Bottle	Body	Materiel	Mono-layer PET-A			
		Colour	Transparent (clear) Light blue transparent Green transparent Brown transparent			
		others:				
	Plasma coatings	Actis Plasmax DLC				
	others:					

Figure 2: Part of a checklist to test bottle design for recycling (PRS)

The checklist covers all relevant points having an influence on quality criteria like closures, labels, barriers, materials such as Alu, PVC, chemical additives, etc.

2.2 Pre-Treatment process

Besides the actual recycling process, the Pre-Treatment process is also crucial for the target product quality. In this phase, most of the Non-PET such as glass bottles, paper labels, polyolefin closures, etc. has to be sorted out. Often, the sorting of the whole bottles is done in a separate plant. The washing, grinding, etc processes are then often in line with the recycling process.

Pre-Treatment processes: :
<i>Input control (check, if with in specification)</i>
<i>Sorting Non-PET (metal, other plastics, packaging)</i>
<i>Sorting colour (e.g. transparent, blue, green)</i>
<i>Pre-washing whole bottles (removing labels)</i>
<i>Grinding flakes (e.g. down to <10 mm)</i>
<i>Air separation (e.g. removing nylon barrier)</i>
<i>Washing (removing glue)</i>
<i>Swim / Sink (removing polyolefin's)</i>
<i>Drying (e.g. <0.7%humidity)</i>
Bottle-to-Bottle recycling process

Figure 3: Example of a possible Pre-Treatment process

2.3 B2B recycling technology

First of all, a B2B recycling technology has to prove its effectiveness by doing a challenge test (migration test with exaggerated levels of surrogates). Most of the available B2B technologies on the market have a No Objection Letter by FDA (US Food and Drug Administration). Besides this prove of effectiveness there are other criteria for a successful process, such as:

- Input (purity needed, see Pre-Treatment, colours, etc.),
- Energy, waste (energy source and consumption, yield, by-products, etc.),
- Process (dimensioning, chemicals needed, throughput, colour change, residence and down time, etc.),
- Output quality (colour, possible degradation, intrinsic viscosity level, flakes or pellets, etc.).

The right recycling technology has to be chosen, adapted to the existing or planned value chain (PET market, collection quality, sorting capacity, etc.). Most of B2B recycling technologies are mechanical recycling, producing pellets or flakes. So far, no chemical recycling technology is realized in Europe.

2.4 Quality control – whole value chain

Not only the actual B2B recycling technology determines the requested output quality, but also the other processes in the value chain such as collecting and sorting. These processes are very important to guarantee a recycled PET which is accepted by the market and also by the authority (e.g. direct food contact regulation).

Therefore a quality management system is needed. It should cover and involve all processes and organizations within in the value chain. Key data is needed to steer the quality of the PET. A few examples:

Quality indicators	Details	Process involved
Non PET bottles	System boundary: which bottles to be collected. Labelling and communication.	Communication Collection System conformity
Dust	Dust produced by the machinery (e.g. parts smaller 1mm < 0.3%).	Recycling
Impurities	Silicon valves disturb the recycling process and are very difficult to remove and should therefore not be used.	System conformity
New market	Markets like juices with a higher demand for barriers (e.g. nylon or plasma coating, e.g. nylon < 500 ppm).	System conformity Recycling
Misused bottles	Recycling process has to be proved to remove chemically misused bottles (e.g. 0.03%) by doing a challenging test.	Recycling

Figure 4: Examples of quality indicators and involved processes

3 Conclusion

Bottle-to-Bottle recycling is a great opportunity for the whole PET industry. In Europe, it is the fastest growing technology market for recycled PET.

It raises the importance and awareness of bottle design to every player in the value chain (producer-pays-principle). Direct food contact with recycled PET requires proved technology, mastered processes and a quality management system to guaranty a stable and desired product specification.

Steering the whole value chain is an important critical success factor for a sustainable B2B recycling system. The right adjustment and coordination of each single process like grinding, washing, etc. is another important factor in order to close the loop successfully.

References

Wehrli Richard, Tischer Roland, Geisselhardt Patrik, Bewertung Bottle-to-Bottle-Recycling-Verfahren für PET-Flaschen, study for Verein PRS, PET-Recycling Schweiz, May.2006

Process system conformity of Verein PRS, PET-Recycling Schweiz, Naglerwiesenstrasse 4, CH-8049 Zürich, www.prs.ch

Lecture "PET bottles and Sustainability" Geisselhardt Patrik for PRS at conference Barrier PET Bottles 2007, May 2007 in Brussels

Specification of BAG (Federal Office of Public Health in Switzerland) for the use of recycled PET in direct food contact

International Life Science Institute, Brussels, ILSI Europe Report Series, Recycling of Plastics for Food Contact Use, 2000

European Commission, Franz Roland, Bayer Forest, Welle Frank, Guidance and Criteria for Safe Recycling of Post Consumer Polyethylene Terephthalate (PET) into New Food Packaging Applications, February 2003