Implementation of a Recovery System with Optimized Interfaces
– The Total Plastic Concept –

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1. Mixed dry recyclables in Germany

The German system for recovery of mixed dry recyclables has been established in the early 90s. It was installed to increase the recycling rates additional to the already existing system: the separate collection of paper and glass.

Within the system components so called light weight packaging (LVP or PMD) – like ferrous and non-ferrous metals, drink cartons, composites, plastic packaging (dense plastics and film) – are collected.

Due to the legal situation the system is financed according to the cost by cause principle.

A licence-fee is payed for each packaging unit by the packaging industry or retailer.

Companies that operate this system like *Der Grüne Punkt* are responsible for collection and recycling of post consumer packaging waste originating from households or similar facilities – in the sense of source of waste.

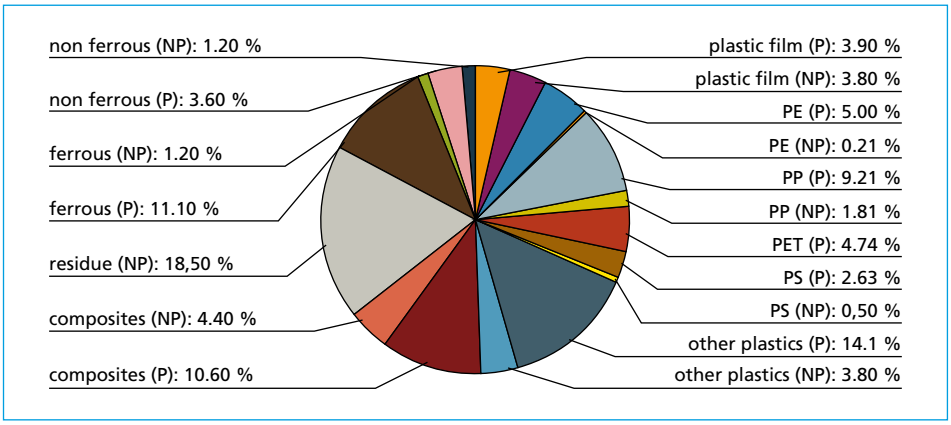


Figure 1: Composition of German PMD material

Waste collection is mainly done by curbsite collection as a source segregated system for these mixed dry recyclables. But there are also some regions where there are just bring sites installed.

The total annual amount of material collected within the described system is some 2.2 Mio. tons.

The pie chart shows the composition of German PMD material (Figure 1).

2. Sorting processes

The comingled collection of several different materials or composites make it necessary to treat the PMD-material by sorting before giving it to specific material recycling paths.

The technical process of sorting separates defined material fractions wherefore suitable quality requirements in form of data sheets have been established and modified over the years.

Though the definitions are mainly based on item descriptions instead kinds of base material; the further recycling process for the products of these sorting plants follow the recycling path of the base material.

An example is listed below:

- ferrous metals – steel production
- non-ferrous metals – production of aluminium
- drink cartons, composites – paper industry
- plastics – plastic industry as PCR (Post Consumer Resin) regranulate

The technical process of sorting can be described as follows:

The collected material is delivered with CV´s to the tipping – hall of the plant.

Many of the collection schemes are operated as bag collection. Even in case of bin collection systems the consumers use bags to store the packaging waste.

The first machine in the process line is according to this a combination of bag opener and dosing unit. Dosing is quite important for the process to realize a constant volume flow downstream the process.

Especially NIR-sorting units but also screening devices are very sensitive to volumatic overload.

Subsequent two screening steps separate the material stream into a coarse, a midsize and a fine fraction.

The fines < 20 mm leave the process as residue. In a next step the lights (plastic film, paper) are removed by means of a wind sifter in the midsize and coarse material.

Coarse lights (> 220 mm) pass through a sorting cabin to pick out paper and other contraries manually before being stored and pressed into bales as plastic film.

By this example the already mentioned correlation between items and base material for recycling can be explained.

Plastic film of a certain grain size (larger DIN A4) is mainly made of LDPE and can be recycled to a defined plastic regranulate with constant quality.

The midsize heavies are fed to a magnetic separation step where cans and other ferrous metals are separated. Non-ferrous metals are separated by eddy current; this material has to pass a pyrolysis plant before the aluminium can be reused. Sensor based automatic sorting devices are installed for the following sorting tasks:

Separation of

- drink cartons
- paper
- plastic items comingled

or

- PE-plastics (dense plastic)
- PET-plastics (also coloursorted in clear, blue, green)
- PP-plastics (dense plastic)
- PS-plastics (dense plastic)

To reach the requested product quality an automatic (NIR) or manual sorting is installed as a second step for the product streams mentioned above.

To store and ship the material the different fractions are pressed to bales.

It is evident that the level of automation of the sorting process corresponds with CAPEX and OPEX of sorting.

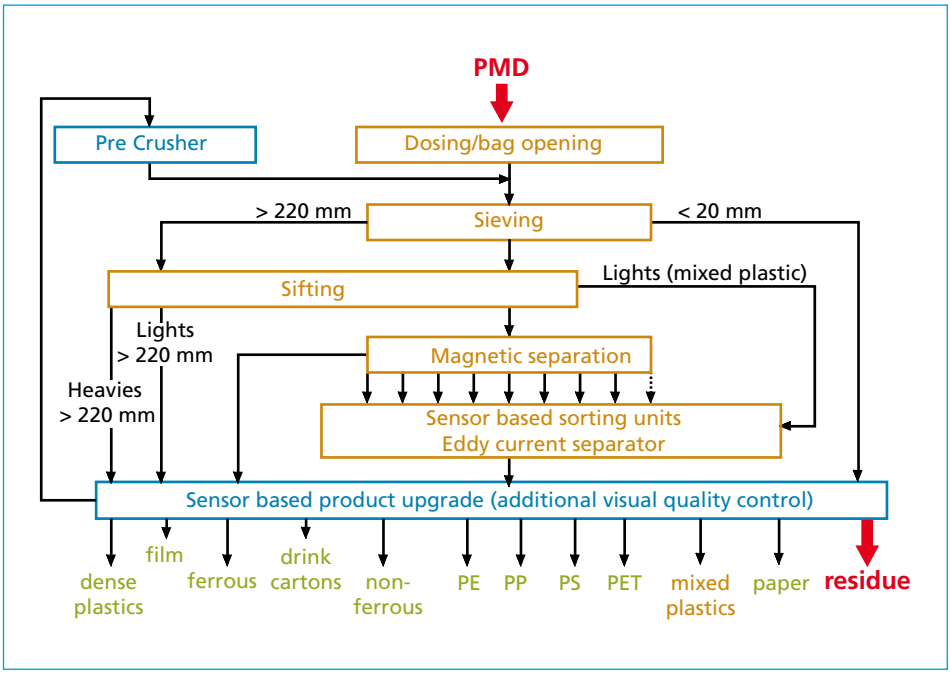


Figure 2: Process flowsheet of the sorting process

3. Sorting cost situation, economy of scales

Looking at the requested sorting equipment and – due to the low bulk density of the material – quite low throughput rates, it becomes evident, that specific operational costs are relatively high.

The question arises to find a break-even point for additional sorting steps, to sort out different plastic types.

As a minimum it is possible just to sort out plastic film, mixed plastic bottles and a mixed plastic stream. High diversification of plastic - sorting on the other hand allows to produce:

- plastic film
- dense PE
- dense PP
- dense PET 3x coloursorted
- dense PS
- mixed plastics

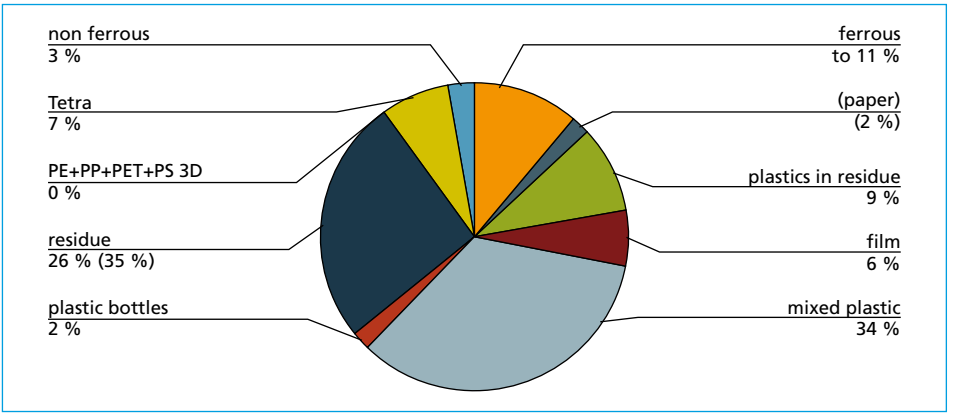


Figure 3: Product balance of basic sorting process

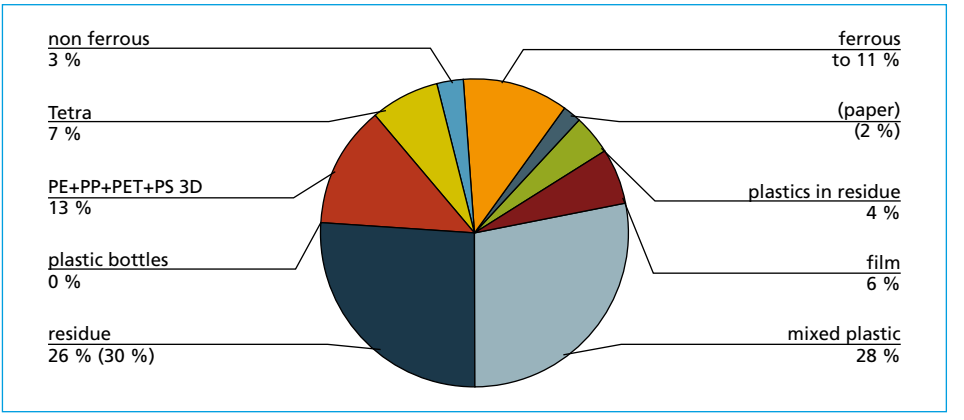


Figure 4: Product balance of high diversification sorting process

The two resulting product distributions are shown in the two pie charts below.

As we can see from the charts the high diversification process has advantages in recycling rates in the existing system.

Looking at the mass distribution of the sorting products, we can see, that there are several product fractions with a percentage between 2 and 7 %.

A model calculation of operational costs for additional product fractions shows the following results.

The model has been set up considering the capital costs for the requested devices some conveying system and a product control.

The base process is considered as existing.

Sorting costs

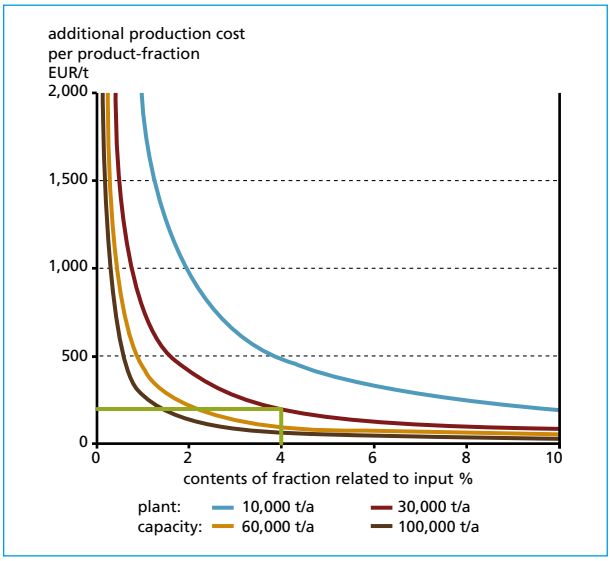


Figure 5:

Additional production cost per plastic type

Looking at the graphs it becomes obvious that costs increase with decreasing percentages.

The other thing shown is the economy of scales – meaning a higher throughput rate lowers the operational costs.

Besides the cost aspect the yield of these processes have to be taken in account.

A higher number of separation- or cleaning-steps downstream will bring down the efficiency of the process.

In addition to this the following recycling processes also leak products during the sequence of separation.

4. Recycling process with optimized interfaces e. g. The Total Plastics Concept

When looking at the process of the sorting plants we can see, that much of the expensive technical equipment is used to produce plastic product fractions.

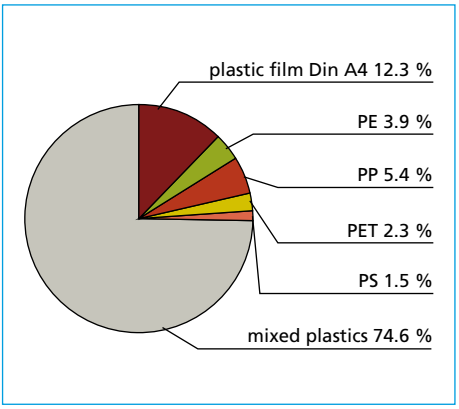


Figure 6: Composition of plastics within PMD

Recycling paths for dense polyolefin products are well established. But when producing these fractions a significant percentage of plastics remain as mixed plastics.

The mixed plastic fraction can be described as a mixture of 2D and 3D plastic-material with components made of an wide range of plastic types, blends and compound material. In the described situation this is the remaining 2D and 3D plastic fraction after partial separation of PE, PP, PS and PET components.

For the mixed plastic fraction there are also existing recycling paths but due to the composition a mayor part is used as energy from waste.

The idea of the Total-Plastic-Concept was to increase the recovery rates in the recycling – chain and to minimise the complexity of the process in the sorting plants.

The main reason to make this possible was that the interface between the two processes could be simplified.

As a PCR the Total-Plastic-Process uses a mixture of PE and PP-material (PO for polyolefin).

A percentage of mixed plastics – lights from midsize shifter – and the dense PE and PP plastics are baled as one product. The remaining material from these sorting steps is used together with the residue as an energy from waste product.

This enables also smaller – in capacity – sorting plants to operate cost – effective.

In Table 1 three different models of sorting and interfaces are listed.

- basic sorting process
- high diversification of plastic sorting
- total plastics concept with optimized interface

Gains and losses of different processes

The percentage in the columns show the recovery rates related to 100 % PMD and second 100 % plastics.

The orange marked lines show the energy from waste part of the recovery chain.

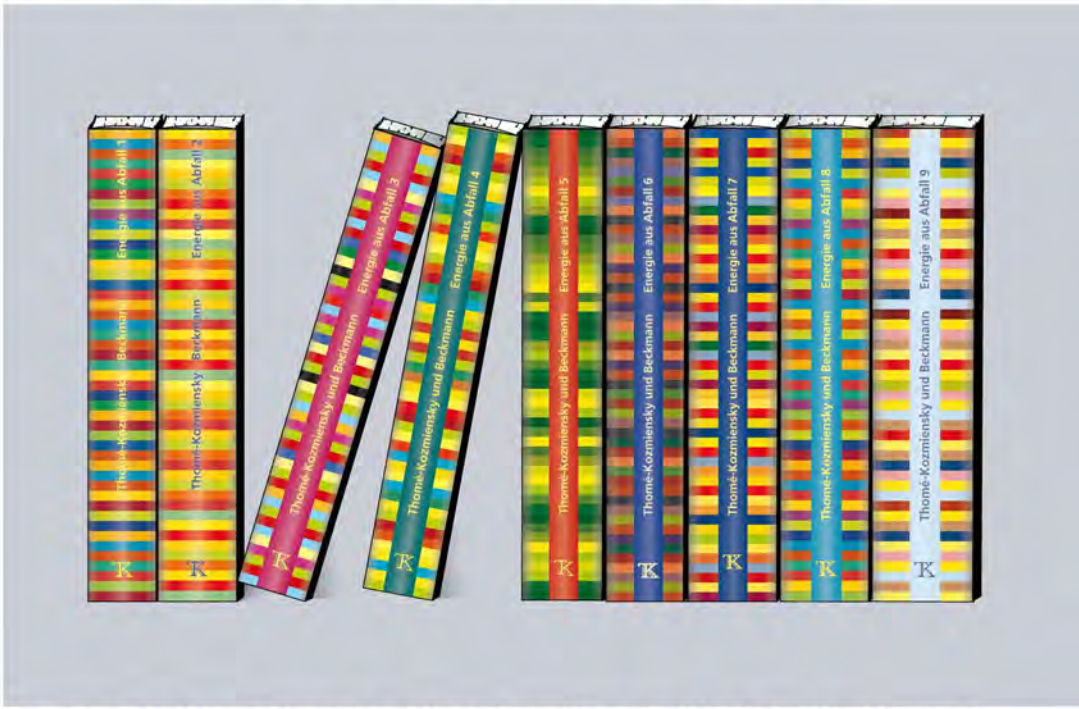
A sum related to 100 % plastics is given at the bottom of the table *sorting process* showing the percentage of material which is used as close loop recycling. These figures give an impression on how the recovery rates – specific for plastics – can be improved.

Taking the yield of the recycling process downstream in account the total recovery rate of the sorting process can be raised significant from some 11 % to over 40 %.

Table 1: Different models of sorting and interfaces

	unit	basic sorting process		high diversification of plastics		e.g. Total plastics concept without (with) PS, PET			
		percentage		percentage		percentage			
sorting process:		related to PMD	related to plastics	related to PMD	related to plastics	related to PMD		related to plastics	
film	%	6	12	6	12	6		12	
mixed plastic	%	34	67	28	55				
plastic bottle	%	2	4						
plastics in residue	%	9	17	4	8				
PE/PP/PET – 3D	%			13	25	(4)		(8)	
MPO	%					28		55	
EFP	%					17	(13)	33	(25)
sum	%	51	100	51	100	51		100	
quota for plastic recovery	%	**total**	**83**	**total**	**92**	**total**		**100**	
close loop recycling (non thermal)	%		**16**		**37**			**67**	**(75)**
recycling process: specific recovery rate	kg/t		**112**		**270**			**425 (480)**	

Energie aus Abfall



Herausgeber: Karl J. Thomé-Kozmiensky und Michael Beckmann • Verlag: TK Verlag Karl Thomé-Kozmiensky

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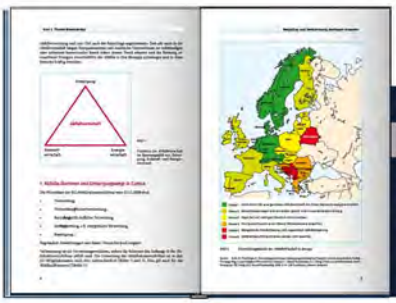

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