

Recovery of Plastics from Household Waste by Mechanical Separation

Michael Jansen, Alexander Feil and Thomas Pretz

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1. Introduction

Plastic packaging in the waste of private households used to be incinerated until the end of 2008 in the Netherlands. In January 2009, a source separation system for plastic packaging waste (PPW) was established to reduce the amount of residual waste and secure access to secondary resources. Between 2009 and begin of 2011 three mechanical-biological treatment plants started to recover PPW from municipal solid refuse waste of some municipalities. The recovered plastic packaging is fed into different material recycling processes depending on the polymer type. Therefore, two different waste management systems are available for PPW in the Netherlands: the source separation system (NL: bronscheiding) and the recovery system (NL: nascheiding). It is necessary to describe each system's cost efficiency and waste reduction potential to reach the rising recycling targets; in 2012, 42 % of the PPW are to be recycled. Due to the rapid development of the recycling business there is a lack of data which could be used to achieve the above mentioned goal.

This paper describes parts of the results of a feasibility study initiated by the Dutch Federation of Food Industries (FNLI) as well as the Central Office of the grocers (CBL) and executed by the Department of Processing and Recycling (I.A.R.) of the RWTH Aachen, Food and Biobased Research of the Wageningen UR and others. For the first time, the limits and possibilities of sorting concentrates of rigid plastic pieces which were recovered from Dutch municipal solid refuse waste (MSRW) are discussed. Therefore, an important step in the discussion is made by delivering an objective database.

2. Treatment of the municipal solid refuse waste

Material conditioning in the mechanical-biological treatment (MBT) plants is a minimal effort approach (see Figure 1).

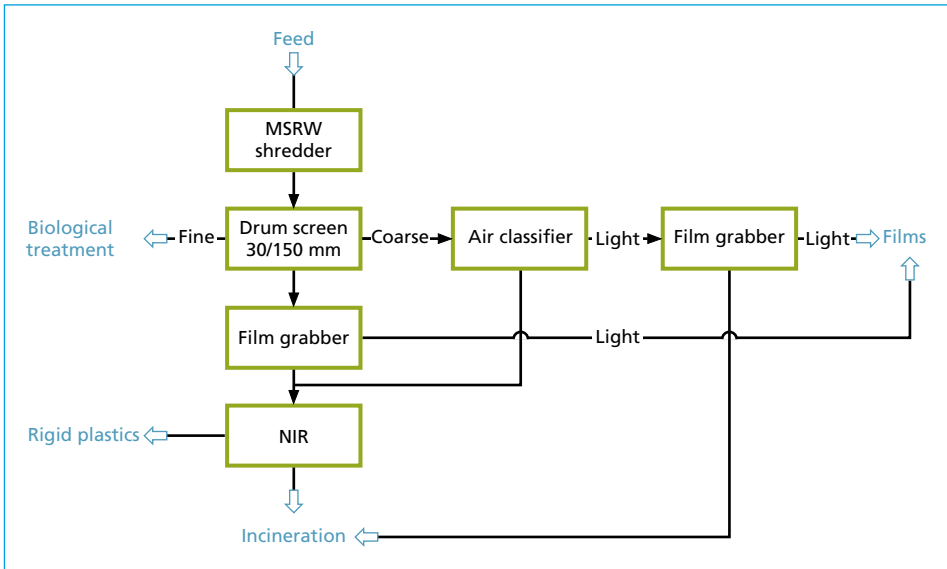


Figure 1: Process of one MBT plant in the Netherlands

The wet MSRW is screened before the plastics are extracted. The waste is split into fractions of a particle size finer than 30 mm, coarser than 150 mm and a fraction coarser than 30 mm and finer than 150 mm. The coarse material is air-classified in two stages with the second stage being a film grabber, an air classifier featuring a drum mounted with spikes to support the separation of films (see Figure 2). The 30 – 150 mm-material is also air-classified using a film grabber. The light fraction from these classification steps is a concentrate of LDPE and PP-films including residue.

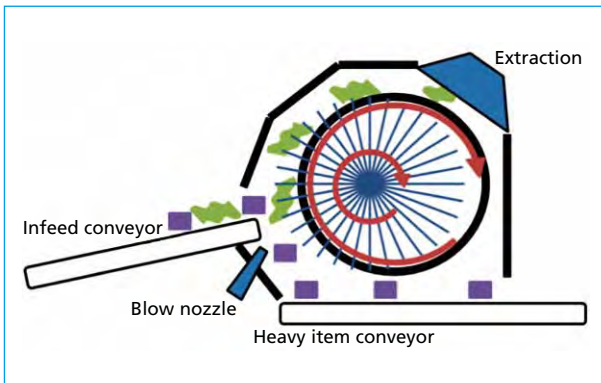


Figure 2:

Working principle of the film grabber

The rigid plastics fraction is recovered from the heavy material of the classification steps using near infrared (NIR) sorters. In contrast to plastic concentrates from source separation systems here there are two concentrates which can be kept apart during further processing and which are fed to different processes: The film fraction can directly be fed to a cleaning and recycling process and therefore won't be described here in greater detail. The rigid

plastic concentrate has to be sorted into polymer fractions (PET, HDPE and PP) and is brought to a sorting plant in Germany. This decision was made because in the Netherlands there is hardly any free capacity in existing sorting plants and there is a scarcity of sorting plants, as well.

By changing the classifiers of the NIR-sorters the quality of the rigid plastics can be influenced directly. If the sorting of LDPE is suppressed, the rigid plastics fraction contains only small amounts of film material. If the sorting of LDPE is not suppressed, the rigid plastic concentrate might show high concentrations of film material which is disadvantageous to the subsequent sorting process.

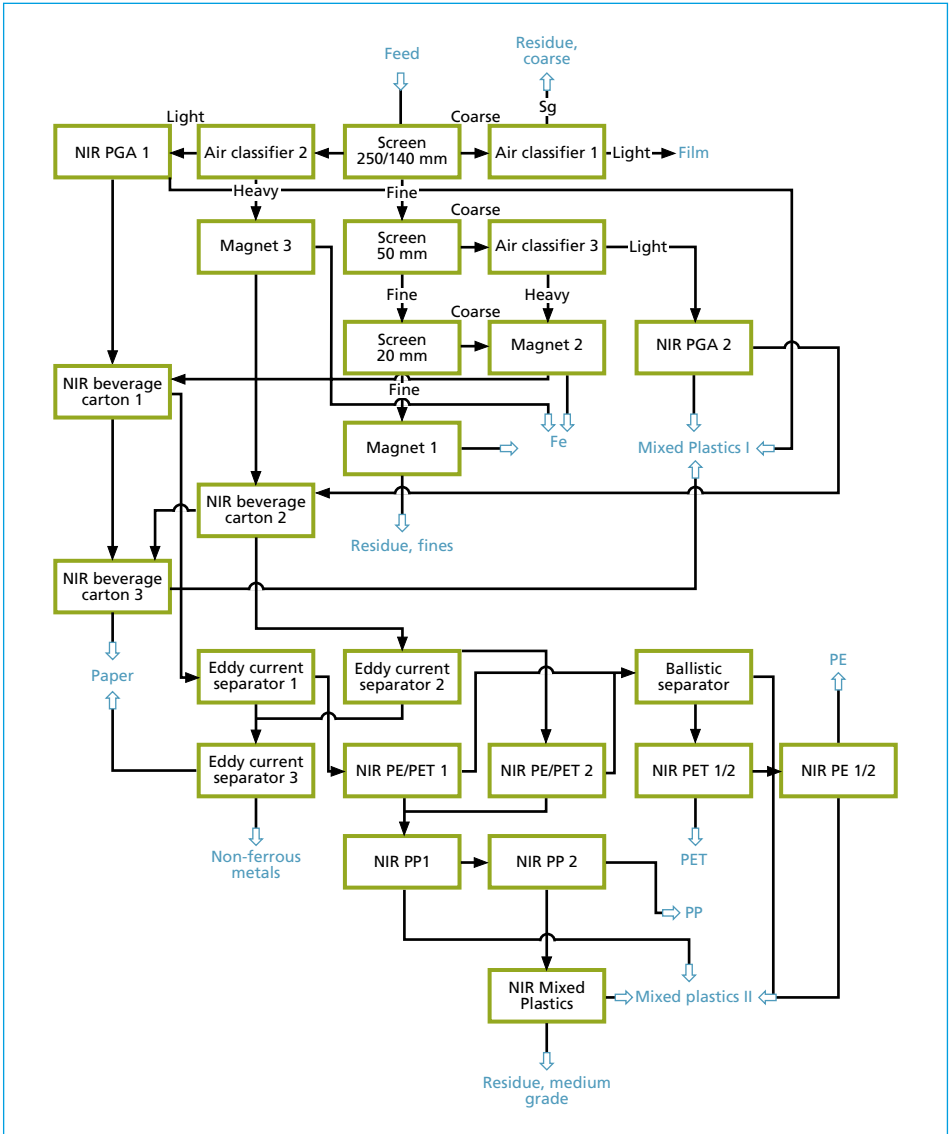


Figure 3: Flow sheet of the sorting facility in Germany

Other approaches, e.g. in Trier, Germany, also featured drying steps, coarser screen grid sizes and a split between body shaped and flat materials. The approach used in the Netherlands allows for a very high recovery of plastics as almost all plastics reach a separation stage. Only the fine fraction is not used. A more complicated approach using e.g. a separation of flat and body shaped materials might have the advance that unwanted materials like fabrics made of synthetic fibres don't reach the NIR stage.

3. Treatment of the plastic concentrate

A main aspect of the research conducted was to describe the sorting of a PPW concentrate recovered from MSRW.

Currently, the plastic concentrates from the Netherlands are brought to various sorting plants in Germany which are usually used for sorting the light weight packaging mix from the German source separation system. An example of one plant is given here (see Figure 3).

Before sorting, the process is optimised to suit the different input material. PET, HDPE and PP are to be recovered as individual fractions. This is achieved using the existing NIR-sorters. As there are very little beverage cartons and metal packaging in the rigid plastic concentrate little effort has to be made to recover those fractions. The NIR-sorters used usually for sorting beverage cartons can be adjusted to sort a polymer type instead. The eddy current separators and magnets however remain largely unused as there are few metals in the feed as well as some wires from the baling process.

The data for the results presented here were collected during several trials with 50 to 100 tonnes of input material each. The composition of the products was measured by sampling each product stream.

4. Result of the trial

An average composition of the feed material for the sorting process is shown in Figure 4. Roughly two thirds of the feed material is composed of rigid plastics. MSRW contains various pieces which are no packaging. These pieces are also composed of the polymers PET, PP and HDPE which are commonly used for packaging. Some of those pieces are system compatible, e.g. plastic furniture and some are considered to be residue, e.g. cloths made of synthetic fibres. The NIR-sorters in the MSRW treatment plant can only distinguish between

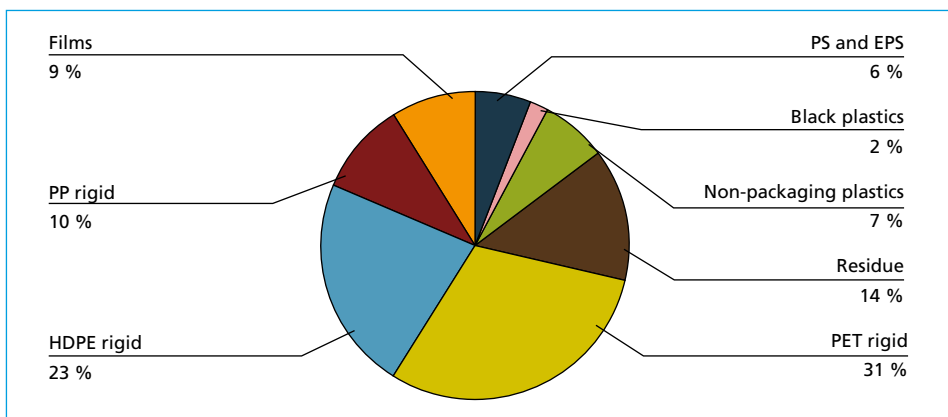


Figure 4: Average composition of the input material for the sorting process in Germany

the polymer type and not what purpose the article served during its life time. A piece of cloth made from synthetic fibre is therefore recognised as PET as well as a PET-bottle. This results in a relatively large residue fraction in the feed material.

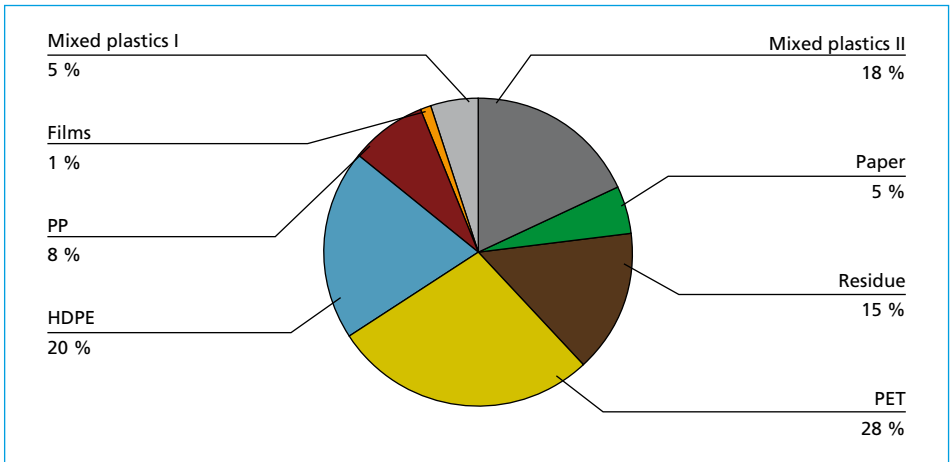


Figure 5: Mass balance of the sorting process in Germany

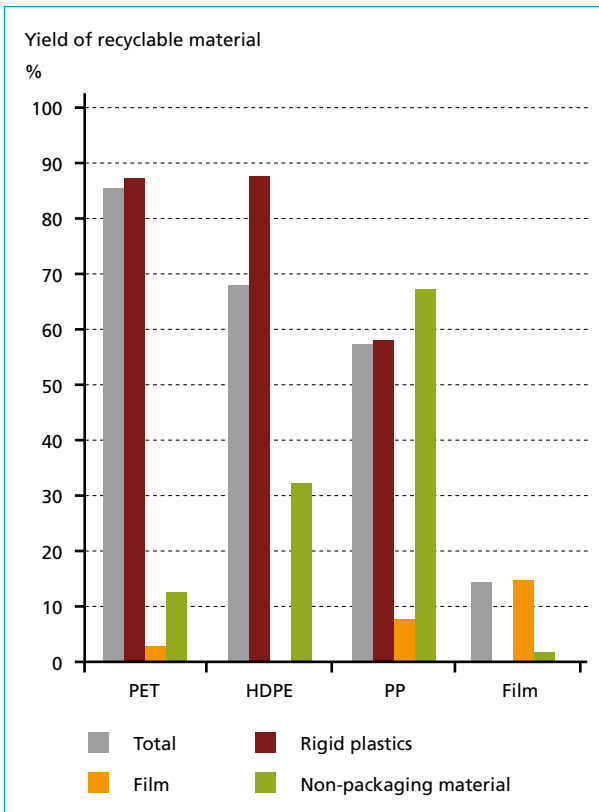


Figure 6:

Yield of recyclable material of the sorting process in Germany

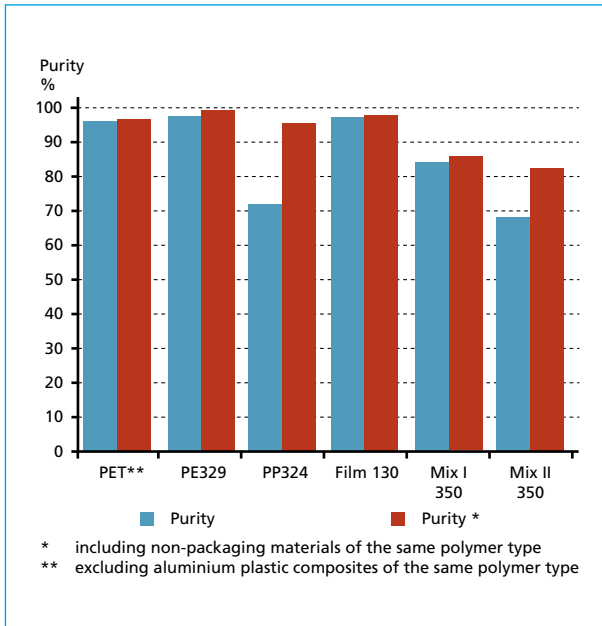


Figure 7:

Purity of the products of the sorting process in Germany

The results of the process are shown in Figures 5 to 7. It becomes clear that approximately 60 % of the mass of the input is recovered into the products (excluding paper and mixed plastics). The yield of the PET and HDPE fractions is above 85 %, the yield of the PP fraction only above 55 %. The purity of the HDPE, PET and PP fractions is each above 95 % if non-packaging articles are included.

The sorting of the material can therefore be rated as successful. The yield and the purity of the valuable fractions are both high. The sorting of the PP fraction can be improved to yield more PP contained in the input material. Most likely the difference in efficiency of sorting PP and PET/HDPE is due to the plant not being designed for a mixture of plastics but for light weight packaging materials from the source separation system in Germany. During the adjustment of the plant some cut-offs had to be made to match it to the different input material which leads to a loss of efficiency during the sorting of PP.

5. Conclusion

For the first time it has been shown that the sorting of rigid plastics recovered from MSRW is generally possible.

The efficiency of the sorting stage is high. The comparison between the yield of PP and the yield of PET/HDPE show, that the process needs some further optimisation. It is possible to recover more of the contained PP if a process is used which fits the input material. A high yield of recyclable materials is in general possible for the sorting of plastics recovered from MSRW.

The recovery of mass into the products and the comparison between the feed material and the mass balance of the process show, that the enrichment process within the mechanical-biological treatment plant needs some further optimisation. The amount of residue and

undesired plastics like PS and EPS in the feed material should be reduced as it stays untouched during the sorting process or ends up in the mixed plastic fractions and has to be disposed of at high costs. This can be achieved with an adjustment of the software of the NIR-sorters.

Besides the process technological matters other points of interest have to be considered with regards to the discussion in the Netherlands on the cost and efficiency of the source separation and recovery system:

If the performance of a source separation system is compared to one of a recovery system the process of the MBT plant has to be balanced and considered in a calculation of a mass per capita of PPW recovered.

Further research is needed to clarify if – and if yes, to what extent –MSRW as a source of plastics has an impact on the actual recycling stage. These plastics are typically much dirtier than those from a source separation system. The DSD specifications which are commonly used to describe the quality of the sorting products leave no room for this peculiarity. The above presented qualities are not based on the actual mass of plastic contained in a product but on pieces of the same polymer type including dirt and moisture. Pieces of a different polymer type are counted as impurities. This may lead to significantly lower recoveries during the recycling stage.

Current research activities of the I.A.R. address the above mentioned problems. The results will be scientifically based statements on the cost efficiency and waste reduction potential of recovery systems for PPW recovered from MSRW being a base of the discussion on future waste management options in the Netherlands.

6. References

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