REVIEW OF POST-CONSUMER PLASTIC PREPARATION IN AUSTRIA AND NEW APPROACHES FOR FEEDSTOCK RECYCLING

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Abstract

For reasons of security in supply and high plant availabilities in feedstock recycling, substantiated knowledge about post-consumer plastics streams, their management and particular mechanical preparation processes is essential. Therefore, a flow chart has been developed based on data from literature, statistics and plant visits to illustrate the structure of the existing preparation processes, their interlocking and the underlying material streams in Austria. This provides the basis to figure out new concepts to supply adequate feedstock for material recycling like polyolefins and polystyrene (POS) rich fractions. Therefore, tests of two sorting devices, the near- infrared sorting unit (NIR- unit) and the sorting centrifuge have been conducted. The investigated plastic-rich materials are mixed plastics (MP) and refused derived fuel of high calorific value (RDF-HC). The tests show that the sorting centrifuge produces POS fractions of high purity (100 %) and recovery (100 %), but it is an apparatus of high complexity. A succesfull application for sorting of post-comsumer plastics is in doubt. The NIR- unit creates lower purities (90 %) and recovery rates (80 %) but is a proven technology in plastic sorting.

Keywords: *post- consumer plastic streams, plastic sorting, feedstock recycling, near-infrared sorting, sorting centrifuge*

1. Introduction

Today the highest volumes of raw materials in man-made production are plastics. Low weight, low cost, multifunctional applicability and analogous material properties compared to others ensure their leading position. The steadily increasing consumption of plastics results in high material streams leading to an enormous challenge for sustainable management of the post-consumer material. Mechanical recycling only partly covers the need of material recovery. The majority of these valuable hydrocarbons ends up in landfills or as heating fuels, in other words is converted directly to almost non-recoverable CO_2 and H_2O. In contrast feedstock recycling comes across this problem and increases the sustainability of plastic utilization by recovering the hydrocarbon molecules.
To guarantee material supply of feedstock recycling plants and to secure high plant availabilities a substantiated knowledge about post-consumer plastics streams, their management and particular mechanical preparation processes is crucial.

2. Materials and Methods

Phase I
The current situation of plastic containing waste streams of different plastic contents in Austria has been investigated. Austria was chosen as an example because of sufficient data availability. The result of this basic study is a flow chart, relating the found waste streams with the established preparation technologies and recycling, recovery and disposal systems. The scheme combines information and data from literature [1], [2] and statistics [3]. Moreover, visits of waste treatment plants and meetings with plant operators complete the used sources. The objective is to illustrate the structure of the existing preparation processes and their interlocking.
Based on the current situation, starting points for new concepts to absorb appropriate plastic fractions like polyolefins and polystyrene (POS) are figured out. Referring to the different compositions of the material streams and the given technical embedding diverse separation and sorting equipment undergo further tests.

Phase II
Tests include dry processing as well as wet processing. Today, latter is very unusual for preparing post-consumer plastics, because most of the material is incinerated. Furthermore, the tests are conducted on pilot scale plants mostly at laboratories of the corresponding equipment suppliers or universities.
In particular the focus is on two plastic-rich waste streams:

- Residues of packaging waste sorting plants named mixed plastics (MP) which go to preparation plants for producing refused derived fuels (RDF)
- Refused derived fuels of high calorific value (RDF-HC) for co-combustion at the primary burner in cement kilns

The plastic content of both of these fractions is more than 50 % per mass. A rough specification is shown in Table 1, in which all the shares are referring to mass.
The sorting tests aim to gain information about the sorting efficiency expressed in the form of material

purities and recoveries and to calculate mass balances. POS are separated from the rest.

Table 1: Rough specification of MP and RDF- HC

	MP	RDF- HC
Particle size [mm]	30 - 250	< 30
Bulk density [kg/m³]	50 - 100	200 - 250
Water content [%]	10 - 20	15 - 25
POS content [%]	> 60	> 50
Impurities [%]	< 40	< 50
Calorific value [%]	> 25	> 20
Halogens [%]	< 3	< 1

Based on literature research and the experiences from phase I following apparatuses have been investigated:

- near- infrared sorting unit (NIR- unit) respective dry processing
- sorting centrifuge respective wet processing

Depending on the material stream's properties especially the particle size the NIR- units and the sorting centrifuge are intended to be applied at different positions along the preparation chain. Consequently the MP of larger particle size is processed on the NIR-unit and the smaller particles in the RDF-HC are tested on the sorting centrifuge.

3. Results and Discussion

Phase I

Austria's total post- consumer plastic of about 500 000 t/a in 2009 splits into five main waste streams. They are summarized in Table 2 in percent by mass and order of their plastic content.

Table 2: Plastic-rich waste streams in Austria

	Plastic content [%]
Production waste	100
Packaging waste	70
Domestic commercial waste	25
Shredder waste	25
Municipal waste	10

Either directly or after different preparation steps more than 70 % per mass of post- consumer plastics are used for heat and/or energy recovery in mono or co-combustion plants. Slightly more than 20 % are mechanically recycled. The remaining amounts are system losses or get landfilled. The predominating sorting technology for the majority of post- consumer plastic streams is the near-infrared sorting unit, apart from simple sorting technologies like ballistic separators, air classifiers and manual sorting for quality control. Further commonly used equipment for crushing are impact mills and for material stream splitting are drum sieves.

Phase II

The test results of the NIR- unit and the sorting centrifuge in pilot- scale are summarized in Table 3. The first line in Table 3 shows the share of the POS fraction and the rest referring to the input mass stream respectively.

Table 3: Results of the sorting tests

	NIR- unit [%]	Sorting centrifuge [%]
Share POS	45	51
Share rest	55	49
Sum	**100**	**100**
Purity of POS	90	100
Recovery of POS	80	100

Purity and recovery are defined in equation (1) and (2).

$c_{i,j} = m_{i,j} / m_{j,tot}$ (1)

$c_{i,j}$ purity [kg/kg]
$m_{i,j}$ mass of material i in the stream j [kg]
$m_{j,tot}$ total mass of the stream j [kg]

$r_{i,j} = m_{i,j} / m_{j,input}$ (2)

$r_{i,j}$ recovery [kg/kg]
$m_{i,j}$ mass of material i in the stream j [kg]
$m_{j,input}$ mass of the material i in the input [kg]

The test results show clearly that the separation of POS conducted by the sorting centrifuge is of high efficiency. But on the other hand the sorting centrifuge is a very complex apparatus with many influencing parameters, which caused a couple of problems during the test procedure. Originally the sorting centrifuge was not build for processing this type of impure materials like RDF-HC. As consequence there is a doubt that stable and trouble free operation for sorting RDF- HC in commercial plants could be guaranteed. The NIR- unit produces POS of lower purity and recovery but apart from that it is a proven sorting technology for all kind of plastic-rich waste streams. Choosing smart interconnection of several NIR-units will help to increase POS recovery.

4. Conclusions

Based on the current main post- consumer plastic streams, the frequently used preparation technologies and recycling, recovery and disposal systems, the current structure of post- consumer plastic management in Austria is illustrated. Consequently, the potential of producing POS enriched plastic fraction could be estimated. Tests of diverse sorting equipment show promising results to create new concepts for efficient post- consumer plastic preparation of high material recovery.

References

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