Grain size dependent Distribution of Plastic Types in coarse-shredded Mixed Commercial Waste

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Keywords: grain size distribution, plastic type distribution, plastic content, dimensionality of plastic types.
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Abstract: This article deals with the enrichment of different plastic types with different dimensionalities (2D and 3D) in different grain size ranges in coarse-shredded mixed commercial waste. The aim of the investigations is the identification of relevant particle size ranges in which specific plastic types with a dimensionality 2D or 3D can be enriched. On the basis of these results, statements can be made about a targeted enrichment and application by sieve for certain plastic particles for the examined waste. The enriched plastic fractions could subsequently be used for mechanical or chemical recycling.

Introduction

Mixed commercial waste (MCW) is non-municipal industrial waste that is not collected separately. The composition of MCW varies and is highly industry-specific. Currently, little is known about their exact composition, and the amount is uncertain in Austria. MCW is used to produce solid recovered fuel (SRF) due to its calorific value and low moisture content. According to the EU's new recycling regulations, by 2030 at least 60% of all municipal waste has to be recycled (2035: 65%). At present, there are no efforts in the EU or in Austria to introduce recycling rates for MCW. Nevertheless, in the future it will be necessary to process waste streams more deeply in order to recover more valuable materials and to efficiently remove contaminants. Detailed waste analyses form the basis for decision-making for future handling and utilization options. One of the questions that arises is whether or not relevant types of plastics exist in specific particle size ranges and can be concentrated by shredding and sieving.

Material & Method

For the investigations, MCW (about 14 tons) from the Graz area was used. The shredding was done with a mobile industrial shredder. It was operated at maximum shaft rotation speed and minimum gap width. Sampling took place from the falling stream, assuming a d95 of 400 mm for the calculation of the total sample mass. The sample material was then sieved by means of a drum screen and optionally reduced in mass to produce nine particle size fractions: <5 mm, 5-10 mm, 10-20 mm, 20-40 mm, 40-60 mm, 60-80 mm 80-100 mm, 100-200 mm and 200-400 mm. For the grain size fractions >20 mm, the composition (eight fractions and sort residue) was determined by manual sorting analysis. The plastic fraction was sorted into two-dimensional (2D) and three-dimensional (3D) objects. Both object fractions of all grain size fractions >20 mm were sorted into 11 plastic fractions and unidentified fraction using sensor-based sorting by means of NIR sens or and FTIR spectrometer. In both technologies, each material particle is fed to the sensor, the material-specific spectrum recorded and compared with database spectra, whereby the assignment is made to a type of plastic.

Results & Conclusions

Manual sorting analysis of MCW showed that the plastic 3D fraction (14%) is larger than the 2D fraction (9%). The fine fraction (<20 mm) was 33% and was not analysed due to the extremely time-consuming procedure and expense. The investigations on the grain size-dependent distribution of the plastic 2D and 3D fraction in mixed commercial waste show that the 2D content increases steadily with increasing grain size. The largest share was found to be 46% in 200-400 mm. By contrast, the proportion of 3D decreases with increasing grain size from 29% (20-40 mm) to 12% (200-400 mm).

The particle size distributions within the sorting fractions are very different for the plastic 3D fraction. With >10%, the plastics PP, PET, LDPE and PS (including EPS) were identified as relevant while the PVC content was 7%. A large proportion of non-identifiable objects (20%) could not be further sorted. The reason was that plastic parts filled with soot are not detectable in the NIR range. The consideration of the particle size distribution over the sorting fractions additionally gives the information in which particle size classes the examined plastics are the most frequent or least available. This information is relevant for the enrichment and further discharge. For example, PP with 32% and LDPE with 31% were mainly detected in the grain class 40-60 mm. PET was found mainly in the particle size classes 60-80 mm (30%) and 80-100 mm (28%). Since PVC is generally considered as an impurity,

in this case, a discharge from the 200-400 mm grain class would be possible because the largest content (52%) was found there.
It is to be expected that with increasing legal pressure, mixed commercial waste will be used as a source of value for certain types of plastics in order to achieve recycling targets. To make this possible, the basic knowledge about the composition of such waste has to be generated, continuously extended and updated.

Acknowledgements
Partial funding for this work was provided by:
The Center of Competence for Recycling and Recovery of Waste 4.0 (acronym ReWaste4.0) (contract number 860 884) under the scope of the COMET – Competence Centers for Excellent Technologies – financially supported by BMVIT, BMDW, and the federal states of Styria, managed by the FFG.