ANALYSIS OF FACTORS INFLUENCING THE CIRCULARITY OF PLASTIC PACKAGING WASTE RECYCLING

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Abstract: On average, global plastics production grows by around 9% each year. Just for the period 2018-2021, global annual plastic production increased from 365.5 million tonnes to 390.7 million tonnes, or around 7%. According to the Eurostat data, up to 30 million tonnes of plastic waste is generated in Europe every year. Looking at the use of plastics by industry, it can be seen, that the packaging (around 40%) and the building sector (around 20%) are the biggest end-use markets for plastics. In 2020, the EU generated around 15.5 million tonnes of plastic packaging waste [1].

The lifespan of different plastic products may varied between a few years in agriculture, electronic sectors etc., and to only months in packaging. This leads to considerable waste generation.

The EU has set ambitious targets for recycling packaging waste, aiming to recycle 65% of all packaging waste by 2025 and 70% by 2030. Meanwhile, the recyclability of plastic packaging is expected to reach at least 50% by 2025 and at least 55% by 2030 [2]. The only solution to achieve these objectives – is to develop a circular economy to replace the current, linear, economy. In a circular economy, products and materials are being re-used, refurbished, or recycled according to the waste hierarchy, instead of being incinerated or disposed.

Most common used polymers for package are thermoplastics, which covers almost 85 % of overall plastic market demand (such as polyethylene terephthalate (PET), high density polyethylene (HDPE), low density polyethylene (LDPE), polyvinyl chloride (PVC), polypropylene (PP), and polystyrene (PS)), while the thermosets account for 15 % overall plastic market (duroplast, polyurethane (PU), polyester resin) [3].

Recycling of plastic products made from different polymers is different, due to the different physicochemical properties of plastics.

In order to determine the polymeric distribution of plastic packaging waste, real field studies were carried out in 2023 at waste management facilities in Kaunas, Daugavpils and Tallinn (Lithuania, Latvia, Estonia). The research included morphological investigations of the composition of plastic packaging waste.Morphological analysis was performed according to the 'Standard Test Method for Determination of the Composition of unprocessed Municipal Solid Waste' (ASTM D 5231 – 92 (Reapproved 2003)). During morphological analysis the following plastic sub-fractions have been identified: HDPE (jars); LDPE (films); PP (jars, rigid packaging); PP (films); PP film with Al layer; PET (bottles, rigid packaging); PS (foam); PS (jars, rigid packaging); PVC; polyamide – PA; other plastic – OTHER; combined packages (tetrapack); combined packages (blisters).

Investigations have shown, that most common polymers in separately collected plastic waste in Kaunas case were PP ~ 20% and LDPE ~ 29% (Fig. 1). The content of polymer plastics was roughly similar in other cities (Tallinn, Daugavpils).

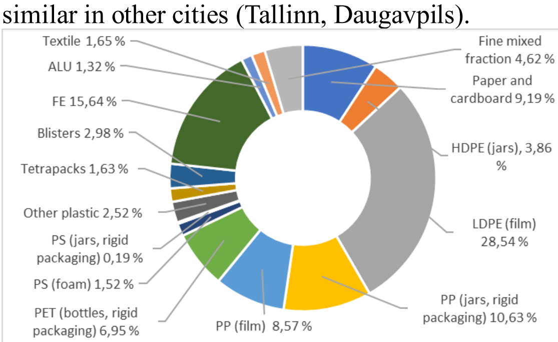

Fig. 1 Morphological composition (%) of separately collected plastic waste in the city of Kaunas, 2023

Efficient and correct sorting of waste can turn mixed plastic waste into high-value resources, which otherwise would be only suitable for combustion. It directly contributes to better availability of waste input for recycling as well as better quality. Sorting can be done on both product/object level (macro-sorting) and on shredded plastic flakes (micro-sorting). While macro-sorting is often done manually or with the help of object recognition, micro-sorting needs automated classification [4].

The main results of the study, which will be presented detailed in the paper, are as follows:

The morphological distribution of the composition of plastic packaging waste was identified;

Some technological solutions were proposed to improve the efficiency of sorting and recycling processes for plastic packaging waste (e.g. Separation of plastic packaging waste by polymer type by optimising NIR technology);

Assessing the environmental impacts of different recycling methods (e.g. Mechanical Recycling, Chemical Recycling) for plastic packaging waste using life cycle assessment (LCA).

References:

1. Plastics Europe. Report. Plastics – the facts 2022. Access via the internet: https://plasticseurope.org/knowledge-hub/plastics-the-facts-2022/
2. European Commission. Packaging waste. Access via the internet: https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste_en
3. Mickevičiūtė, Šleiniūtė, A., Pitak, I., Mumladze, T., Sholokhova, A., & Denafas, G. (2021). Morphological content and recyclability of separate collected packages: a case study for Kaunas, Lithuania. Vìsnik Nacìonal′nogo Tehnìčnogo Unìversitetu Ukraïni <<Kiïvs′kij Polìtehnìčnij ìnstitut ìmenì Ìgorâ Sìkors′kogo>>. Serìâ <<Hìmìčna ìnženerìâ, Ekologìâ Ta Resursozberežennâ>>, 4, 57–62. https://doi.org/10.20535/2617-9741.4.2021.248944
4. Mangold, H., & Vacano, B. (2022). The Frontier of Plastics Recycling: Rethinking Waste as a Resource for High-Value Applications. Macromolecular Chemistry and Physics, 223(13), n/a–n/a. https://doi.org/10.1002/macp.202100488