



Co-Funded by the European Union's Horizon 2020 research and innovation programme

DELIVERABLE
N°3.2

Proj. Ref.: SOL-REC² 101003532

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INNOVATIVE DIGITAL WATERMARKS AND GREEN SOLVENTS FOR THE RECOVERY AND RECYCLING OF MULTI-LAYER MATERIALS

Funding scheme: European Union's Horizon 2020 Research and Innovation programme

Call identifier: H2020-SC5-2020-2

Theme: CE-SC5-24-2020: Improving the sorting, separation and recycling of composite and multi-layer materials

Grant Agreement: 101003532

Project start date: June 1st, 2021

Duration: 36 months

DELIVERABLE N°3.2

Methodology for decontamination

Due date of deliverable: Januray 31 st 2022	Actual submission date: Januray 31 st 2022	Lead Beneficiary: MIK
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1 Abstract

In this work package we provide an overview of potential plastic waste sources and identify their potential contaminations. We highlight risks coming from the contaminations and suggest solutions for separation and cleaning of the plastic waste. Furthermore, we define suitable sources of material for further investigation in the project. We collected different samples in two different countries.

2 Plastic waste sources

Plastic waste can be categorized based on their source in the two broad categories: 1) post-industrial waste from production of packaging materials and/or waste from packing the products at manufactures, and 2) post-consumer waste.

Post industrial

The post-industrial waste stream is, compared to the post-consumer waste stream, better defined, less polluted and in many cases with plastic types not mixed. Thus, in many cases polymer grades can be sorted. Recycling practices associated with this waste stream are referred to as primary.

For pharma blisters the production waste typically consists of trims of the packaging or whole blisters. In case the packaging is brought in contact with a pharmaceutical product (drug), it is considered hazardous waste and must be incinerated. If no contact has been made with drugs or other chemicals, the packaging can be processed and recycled as normal packaging waste at least in Hungary.



In case of multi-layer packaging materials production waste from converting plants typically represents ca 6-10% of production volume and comes in two forms a) trims and b) wrongly printed material, e.g., from production start.

In vast majority of cases different packaging structures are mixed together because typical converting plant has several production lines each producing different packaging but there is only one central waste collection system.



Post consumer

The waste stream here is highly contaminated, including many different types of plastic materials and different grades of the same plastic type. Other contaminants may include adsorbed chemicals during product utilization. The material's chemical and physical ageing is an addition element that influences material properties, reclaimed value and associated risks.

Pharma packaging from this waste stream is collected separately and treated as hazardous waste. Further treatment normally leads to incineration.



3 Common practice to deal with plastic waste.

Why do waste plastic need to be separated.

From the use and or the chemical point of view plastic materials are very different. They cannot be mixed during the plastic recycling since the characteristics would vary and the end result would cause problem during the further usage.

Sorting manually

Most commonly used and reliable method to separate different plastics from each other. During the process the separation is based on the form of the plastic (ex. bottle, film, etc.) The heavily polluted plastic waste also can be separated for further treatment.

Automatic sorting

These method are based on the different (chemical) characteristics of plastic.

- Near-Infrared Sorting
- X-Ray Fluorescence
- Laser-Aided Identification
- Different marker systems

Here we can mention the sorting according density what is related to washing.

These automatic sorting methods are quicker than manual but have the main problem of being sensitive to pollution. (Ex. contaminated agricultural foil cannot be IR separated)

4 Why do waste plastic need to be washed and dried

As we all know, general waste plastics will be polluted to varying degrees. Even single-use packaging plastics will be stained with various oil, sand, dust, and other impurities. When recycling these waste plastics, all kinds of impurities attached to the plastic surface must be cleaned.

If these waste plastics are not cleaned and dried, they are directly processed with plastic recycling equipment, which will not only damage the plastic processing machine but also affect the quality of the plastic particles made.

Manual cleaning

Some plastic products can only be cleaned manually before recycling, while some plastic products can be mechanically cleaned and dried. Manual cleaning is mainly suitable for waste plastics with low pollution and small processing volume.

Mechanical cleaning

Shredded waste material enters the washing line as contaminated plastic flakes and is first conveyed through a friction washer for cold water cleansing of light contaminants such as liquids and paper. After the first wash, the next step is drying the material stream and separating further contaminants, for example, dust and sand. This is done in a mechanical dryer. For highly contaminated material, e.g. to remove adhesives from labels, and to meet food grade standards, another washing stage may be required. In a continuous plastic hot washer, the flakes are soaked in a mixture of hot water washing solution, followed by a friction washer where the material is rinsed. In a sink-float tank the plastic flakes separation from the lighter plastics (ex. PET from such as PE/PP from bottle caps) will take place. Lastly, the mechanical dryer will dewater the plastic flakes while the polyolefins are dried by a thermal dryer.

Here we must mention the necessity of water treatment. The washing solvent -usually water- must be treated and reused. The water treatment depends on the incoming plastic waste and its potential pollution. (Ex. agricultural foil waste washing solvent is different than a publicly collected detergent bottle fraction) Post consumer pharma packaging is not predictable from the contamination so the solvent treatment point of view. Must be considered as hazardous and treated accordingly.



5 Processing of industrial waste – Primary (mechanical) recycling

Collection

Collection takes place at the source. Materials may be polluted (as a result of the industrial process), however through proper handling contamination can be avoided. Normally they are not mixed with other materials or grades.

Processing

No intricate processing or sorting methods are required, however for larger industries and where processing and recycling takes place in a different location than the source, inventory management practices are required and the presence of a digital watermark will allow for processing automation. Separation, if needed is manually done. The size of the waste pieces are usually large enough to separate manually. There is no need of eddy current based automatic separation, The pharma blister contains Al so basically everything would be selected out by Eddy current method. Subsequently, the materials are grinded to an appropriate size for further processing. The material is then washed normally using water as a washing medium. Washing water is filtered, treated (based on the contaminants) and is reused in the process.

Purchasing

The recycled granulates are fed to an extruder and pelletized. The pellets are sold to industry. In special cases the washed flakes can be used up directly by the industry.

6 Processing of consumer waste – Secondary (mechanical) recycling

Collection

Depending of the source (household, commercial, institutional), different collection methods may apply. Collection practices will affect the required sorting methods and intensity applied. The collection of a homogenous waste stream is highly unlikely and most often the waste stream includes different plastic types and grades

Processing

The material must be sorted even manually and/or automatically

Since the waste parts are relatively large (like a plastic bottle and or plastic bag), they can be separated. (It is usually manual, due to the fact, the waste is contaminated, difficult to automatize, the potential yield is low) We have to be very careful with any optical separation here!!! IR, digital watermarks, etc. Can be cheated! Here we usually separate according the form. (foil, bottle (with closure), cardbox, etc[GT1])

Grinding

Washing, and isolation

Example: PET bottles and their closures and grinded and washed together. PET density > 1, closure (PE) density < 1 so can be separated through floating

Important: The washing fluid is treated and reused.

Purchasing

The recycled granulates are fed to an extruder and pelletized. The pellets are sold to industry or in special cases can be used up as washed flakes.

7 What we did during the project

We defined the possible incoming plastic waste sources according their availability. We did consider the legal issues what accrued and decided not to work with post consumer pharma packaging due to legal issues. Considered as hazardous and collected accordingly throughout Europe.

For the initial laboratory evaluation Plastigram collected 78 samples of different flexible packaging materials containing Alu and



21 samples of pharma blisters. For the majority of flexible packaging material the composition was given, however, it was further verified in the project.

In addition, Mikrolin collected post-industrial blister waste from one of the largest pharmaceutical companies. The blister is a multilayer composite packaging material. The composite includes Al as a layer. The pharmaceutical company did not give out information on the content of the blister. The different layers must be identified during the project.



After the samples evaluation Aimplas decided to continue with large scale tests with the pharma blister sample from Mikrolin and PE/ALU, PE/ALU/PET and paper/ALU/PET structures of flexible packaging materials.

The collected pharma blister sample was cleaned and sent out to the partners for further investigation. The dust content of the incoming sample was 5%. During the treatment we reduced the dust content and the sample is ready for further investigation.



The washing process was done on site.



The initial dust content as of 6.5% was reduced to 2%. No special detergent was used. Washing solvent was a room temperature water. The clarity of the final washed flakes depends on the speed of the washing line heavily. (How much time the plastic is in the water). We control the speed of the washing.

We agreed that Eddy current automatized sorting method does not work in case of the blister packaging due to Al layer.

8 Conclusions

Plastic packaging waste streams are complex, typically containing several contaminants, additives and multilayer materials that complicate the recycling processes. Cleaning of plastic waste through advanced pre-treatment processes is a promising route to tackle the difficulties that are encountered in mechanical and chemical recycling due to contaminants.

Conventional pre-treatment steps that are currently applied in industries, which comprise sorting and water based washing, have shown to be not 100% efficient towards removal of the broad range of heterogeneous substances that are present on a post-consumer plastic waste stream. It works perfectly for post industrial plastic waste though.

During the project we have to focus on delamination. Delamination allows the separation of the different layers present in multilayer plastic packaging. We have to distinguish between post industrial blister and post consumer other multilayer packaging material.

Nonetheless, advanced pre-treatment processes show a great potential towards upcycling and closed-loop recycling of plastics.