

Challenges of Mixed Plastics Recovery from MSW Sources in the United Kingdom

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1. Abstract

Part of the integrated waste management approach in the United Kingdom is a mechanical pre-treatment of MSW prior to either EfW (Energy from Waste) or AD (Anaerobic Digestion). As a consequence of the pre-treatment some *unwanted* material is being separated from the primary target material and in most cases this material contains some valuable sub grades. One of these sub grades is mixed plastic. The amount and quality of recoverable mixed plastics within MSW depends firstly on the collection and transfer and storage scheme prior to the mechanical pre-treatment and secondly on the consumer and education from the Local Authority who is ultimately responsible for the local or regional waste management strategy and education. The fact that today still an estimated 300,000 t/a of valuable plastic bottles are either being landfilled or incinerated should be enough emphasis to investigate the potential for mixed plastics from MSW sources.

This is backed up by government policy and targets and there is a clear drive in the UK to increase recycling and recovery targets.

There is however today not only insufficient national processing capacity for the tray components of any mixed plastics, but also due to adhesive dirt and organic contamination on both, plastic bottles and trays, the majority of the recovered mixed plastic from MSW is at present exported and not directly reused within the UK.

The recovery of mixed plastics from MSW is technically not a challenge and there are numerous examples in the UK where a mixed plastic grade is achieved. However none of the bottle plastic re-processors is keen to process these plastics when they have as choice mixed plastics sourced from source segregated comingled recycle.

2. Legislative Background

In order to understand the drivers for recovery and recycling of mixed plastics from municipal household waste (MSW) it is essential to briefly review the present environmental legislative background in the United Kingdom.

The Waste (England and Wales) Regulations 2011 came in to force in April 2011 and amongst other important changes it remains focused on the waste hierarchy putting the emphasis on *an establishment or undertaking which imports, produces, collects, transports, recovers or disposes of waste, or which as a dealer or broker has control of waste must, on the transfer of waste, take all such measures available to it as are reasonable in the circumstances to apply the following waste hierarchy as a priority order –*

- *prevention;*
- *preparing for re-use;*
- *recycling;*
- *other recovery (for example energy recovery);*

*disposal.*¹

It is however possible to divert from these priorities in order to achieve the best overall environmental outcome where this is justified by life-cycle thinking. When this is proposed the following considerations must be taken into account:

- the general environmental protection principles of precaution and sustainability;
- technical feasibility and economic viability;
- protection of resources;
- the overall environmental, human health, economic and social impacts.²

The Packaging and Packaging Waste Directive (94/62/EC) has been around since December 1994 and it requires everyone who produces packaging that:

- packaging is to be minimised
- packaging to be designed for recovery and re-use.
- recovery targets to be met by the UK for waste packaging.
- heavy metals in packaging to be restricted

The responsibility for packaging in the UK is split between the two government departments BIS which leads on EU Directive single market and UK Packaging (Essential Requirements) Regulations. These are enforced by Trading Standards: **Trading Standards** and DEFRA which leads on broader UK waste and packaging policy and the UK Producer Responsibility Obligations (Packaging Waste) Regulations.

The Landfill Directive and Waste Strategy 2000 Recycling Targets

The Landfill Regulations 2002 states targets for reducing the amount of waste sent to landfill sites in the UK. The targets are:

Year	Landfill Regulations	Waste Recovery Strategy	National Recycling Targets*
2005		40 % of waste	25 %
2010	75 % of 1995	45 % of waste	30 %
2013	50 % of 1995		
2015	35 % of 1995	67 % waste	33 %

Table 1:

Targets for reducing the amount of waste sent to landfill sites in the UK

* recycled or composted household waste

¹ The Waste (England and Wales) Regulations 2011, clause 12 (1)

² The Waste (England and Wales) Regulations 2011, clause 12 (3)

The government has issued a *Waste Performance and Efficiency Grant* of £260 million to aid local authorities in waste reduction, increased recycling and diversion from landfills.

Landfill Tax is a tax on the disposal of waste. It aims to encourage waste producers to produce less waste, recover more value from waste, for example through recycling or composting and to use more environmentally friendly methods of waste disposal. At present the landfill tax for inert wastes is 2.50 £/t and 64 £/t for all other waste.

A **Material Recycling Facility Code of Practise** is being discussed with the aim for Defra to consult on the code in August 2012 with a view to laying legislation before Parliament by 2013 and bringing laws into force in April 2014. The concept behind the Code of Practice is that it will require the measurement of the quality input and output material which will give MRF clients - local authorities, businesses and reprocessors – confidence in quality and contamination levels of MRF material. The Code includes a quality management system and independent verification, where a third party audits the system and checks evidence.³

The challenges discussed further down in the article are linked to the above selected legislation and political motivators and they will be referenced accordingly.

3. Material Definition

As this article discusses recycling of mixed plastics from municipal household waste (MSW) it seems appropriate to explain and define its source. With the aim to recover a valuable mixed plastic fraction from MSW it is important to understand how this fraction is presented within the MSW mix and therefore the following sources of MSW are briefly explained with the intent to show that waste treatment facilities who aim to produce a mixed plastic may have to cope with a mix of MSW sources which can affect the quantity, composition and quality of mixed plastics. The content of mixed plastics present in MSW will always be a function of how well people have been educated by the local authorities, whether there is a separate recycle collection available and to an extent the social economic background of the collection area.

Household Waste collected directly via RCV's and delivered to processing facility can either contain refuse bag waste or wheelie bin waste. In both cases there will be a majority of black bags which require mechanical opening prior to being processed, but in the latter case there will be an element of heavier and larger items as they can be contained by the more solid structure of a wheelie bin. In summary though this waste is easy to treat and will contain, subject to the above mentioned collection function a good content of mixed plastics.

Household Waste Recycling Centres (HWRC) or Civic Amenity Sites (CA Sites) are collecting a vast amount of household wastes and subject to the regional waste recycling protocol the number of source segregated materials differs. As a consequence the *residue* element of these sites differs in composition particularly as it generally contains bulky items, such as mattresses, sofas, bulky plastic containers, garden benches etc. Bottle plastic is generally source segregated on these sites. As a consequence this residue waste, which is as per EWC classed as household waste, contains not a lot of useful mixed plastics.

Transfer Stations which receive waste from a number of various outputs can have a detrimental effect to the quality of MSW which is delivered to the processing facilities. As transfer

³ MRW Revealed: MRF code of practise 11th May 2012 James Illman

stations generally receive waste from different contracts or single customers it is likely that these feeds are blended and mixed up to a quality which either suits the transfer station operator or satisfies contractual requirements of the TS output material, which will then become the MRF input material. As a consequence TS can have a negative impact on MSW waste composition, unless the TS operator keeps MSW from RCV collections separate from HWRC collections and C&I wastes.

4. Markets for recovered MSW plastics

In the UK there are generally three main markets for mixed plastics. These are UK and European based Plastic Processing Plants or Export to the Far East, such as China and India.

For UK and European based plastic processing plants the condition of the targeted plastic is of importance, particularly when the polymer requires a high grade of purity and when it has to undergo a washing and sterilisation process in order to be used as new packaging product for the food industry. Whereas this market is in theory available to UK sources mixed plastics from MSW the discussion further down in this paper comes to the conclusion that there are a number of challenges which at present prevent these materials from entering.

The main destination of mixed plastic sourced from MSW at present remains the export to the Far East, where due to market conditions the further treatment of these plastics is still economical.

5. Process Flow

The extraction and enrichment of mixed plastics from MSW is generally a combination of screening and ballistic separation followed by NIR optical detection. The process can be broken down into two stages. In the primary stage the MSW undergoes a combination of screening and mechanical agitation in order to increase recovery and purity levels for the stage 2 treatment. This is demonstrated in Figure 1.

In Stage 2, once the material which contains the targetable mixed plastics element has been enriched, a combination of optical sortation units can be used to either recover a mixed plastics which will also contain the more valuable polymers of HDPE and PET. Alternatively, additional NIR optical sorting units can be installed which recover the above polymers, which in the UK are in general drinking, milk and detergent bottles. Purities for a one hit are in the region of 92 % but can be increased with post optical quality control stations to above 95 % – 98 %.

6. Challenges

This part of the paper is listing the challenges for the initial recovery and further processing of mixed plastics sourced from municipal solid waste (MSW) which exist at present. These challenges can be grouped into three categories. The first one contains consumer related challenges which are either driven by consumer behaviour or parties who influence consumer behaviour.

The second group addresses challenges for MSW pre-treatment MRF input material and the third group lists mixed plastics product challenges in combination with input challenges for further plastic refinement.

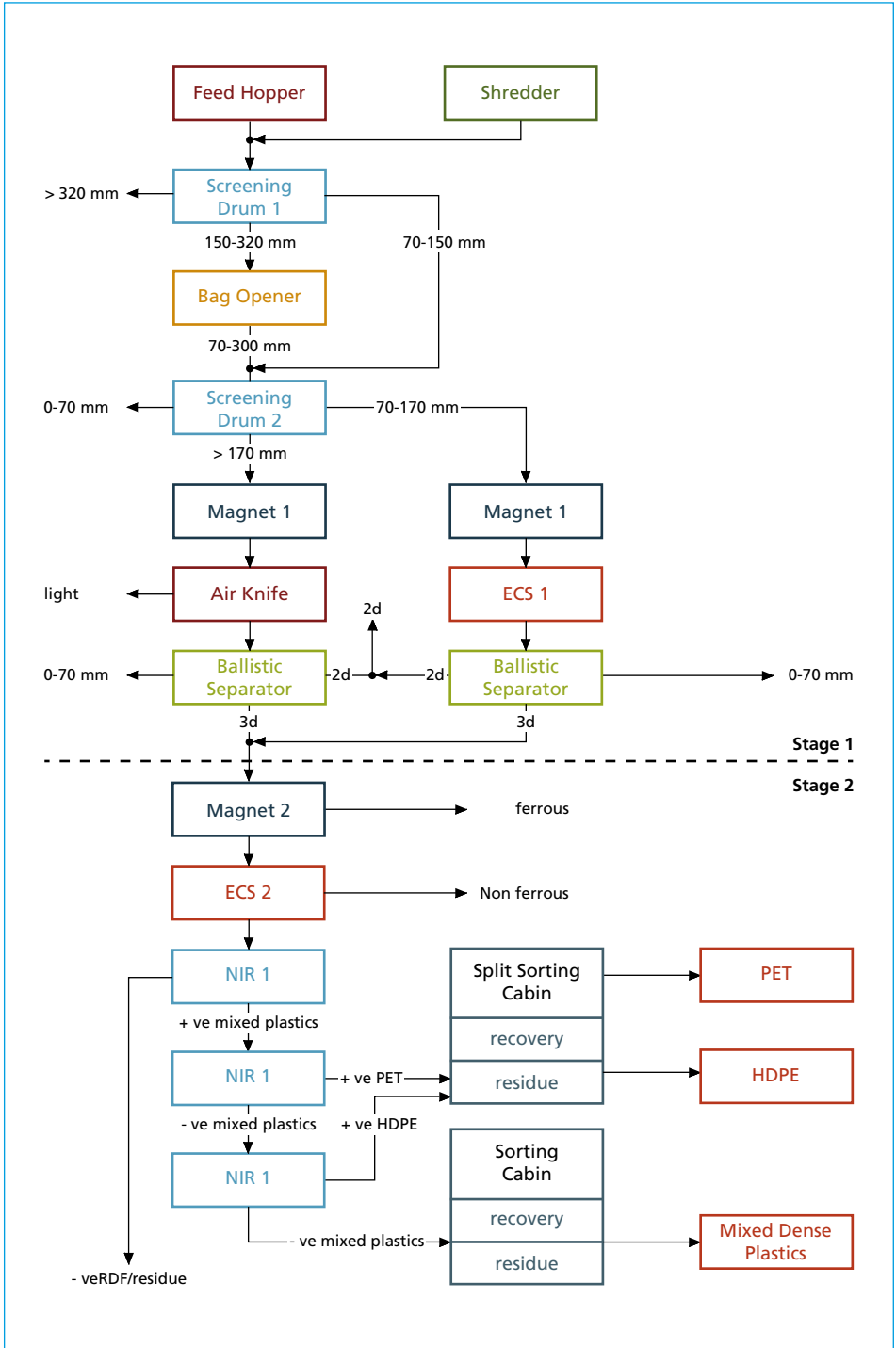


Figure 1: MSW Plastic Block Flow

As we have seen already the input material in MSW is vastly dependent on the origin of the waste as collection systems, social factors and delivery systems have an impact. A challenge for each recycling process is to get the input material right in order to design a process around it. This includes the input waste density. With a comparable light density of plastic within the MSW mix changes of density in the input material will have an impact on processing success. The targetable mixed plastic fraction within MSW contains mostly plastic bottles and food packaging trays and containers and it is important that these mostly 3dimensional items with a size of 70 mm to 300 mm are ending up on the mixed plastic recovery process line.

The origin of the MSW has also got an influence of the waste input density but more so has the existing collection strategy where MSW is sourced for the recovery process. The input of targetable valuable mixed plastic, which is bottle plastic and mixed trays, will drop if for example at transfer stations household waste is mixed with HWRC waste. Similarly the content is lower if a comingled recycling collection scheme is successfully operated within the same collection area where the MSW is sourced from.

If the plastic processing line is correctly designed for throughput and density and the material has undergone a successful previous ballistic separation, for example with the use of a Stadler Ballistic Separator, the recovery yields of mixed plastics are in the region of 70 % and by using Optical sorting equipment from Titech the product purities prior to manual quality control can be as high as 90 %. Acceptable recovery and purity levels regardless of mixed plastics or further sorted polymers such as PET or HDPE are therefore achievable. The main challenge of the recovered mixed plastic however is the adhesive contamination in form of organic and dirt, which the material picks up during collection, storage and processing. This adhesive contamination provides two problems for the next processing step, which are plastic flaking plants, such as Viridor Polymer Recycling in Skelmersdale or Ecoplastics in Hemswell, which is at present the largest bottle recycling plant worldwide. The first one is that plastic and paper labels contain increased amount of dirt and contamination which will make it more difficult for optical sortation equipment to pass the bottle into product. Whereas previously this was possible at the mechanical pretreatment of the MSW material, this process requires purities of over 99 % and even if the system is using a recovery loop, eventually to many bottle material have the potential of ending up in the reject fraction. The second problem presents itself during the washing stage of the then enriched polymers, as the organic and residue contamination of the MSW mixed plastic/PET/HDPE increases the workload for the washing process and the subsequent process water clean up. Whereas this technically does not create new challenges, it puts capacity pressure operationally onto existing systems which have not been designed accordingly.

The fact that the standard practise of baling MSW mixed plastics prior to dispatch results in spread of contamination within the bale and the fact that the baler is used for baling other MSW recycle products results in unpleasant, dirty looking mixed plastic bales. Although this is only a visual issue it does not help the marketability of these bales further.

The final challenge is the large amount of plastic food trays and non-bottle plastic contained within the MSW mixed plastic product. Although the contamination issues as described above are the same, in addition to this, there is insufficient infrastructure available in the UK to deal with mixed plastic from source segregated comingled material let alone. The aim is to reduce this deficiency over the next three to four years, as there are a number of processing plants at various planning stages.