Recyclability Report

Expanded PET and Expanded PS and their effect on the recycled plastic supply chain

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The Scottish Plastics Recycling Centre of Excellence

The Scottish Plastics Recycling Centre of Excellence (SPRCOE) has been formed by Impact Solutions in collaboration with ZeroWasteScotland as part of a European development project to invest in smart, sustainable and inclusive futures.

The aim of the SPRCOE is to enable the circular economy by improving the technical knowledge of recyclers and allowing them to align their businesses to the needs of the end markets. The SPRCOE will provide technical support, advice and help establish quality control measures throughout the supply chain, as well as working with manufacturers to ensure recyclability in design and with end users to ensure recycled material is used for the correct applications.

For more information on our services, aims and goals, please visit www.scottishplasticrecycling.org

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Summary

The Scottish Plastic Recycling Centre of Excellence (SPRCOE) were approached by our client to provide their opinion on the recyclability of;

a) Coloured Expanded PET Packaging tray
b) White Expanded PET cup

Our client have confirmed that both products are detectable under NIR in MRF conditions. This report will focus on their recyclability across the wider supply chain and the risk of the expanded PET contaminating other feed stocks.

1) What is expanded PET

Expanded PET is a foamed form of PET, and is comparable in look to the more common expanded PS (EPS). EPS has a common application in packaging due to its low weight.

However EPS can cause a number of issues in recycling supply chains if mixed into other feedstocks, as is commonly the case. These issues include;

a) Cost of transportation due to low bulk density
b) Contamination of other materials due to low density (especially Polyolefin materials)
c) Compatibility when mixed with other plastics (especially Polyolefin materials)

2) Likelihood of contamination of other feedstocks

While it has been established that both products are identifiable by NIR techniques, it is important to understand how these technologies work.

NIR technology is highly effective at removing a contaminate from a mixed waste plastic stream. However the technology is not able to sort to 100% purity, especially on a heavily mixed stream with many different plastics.

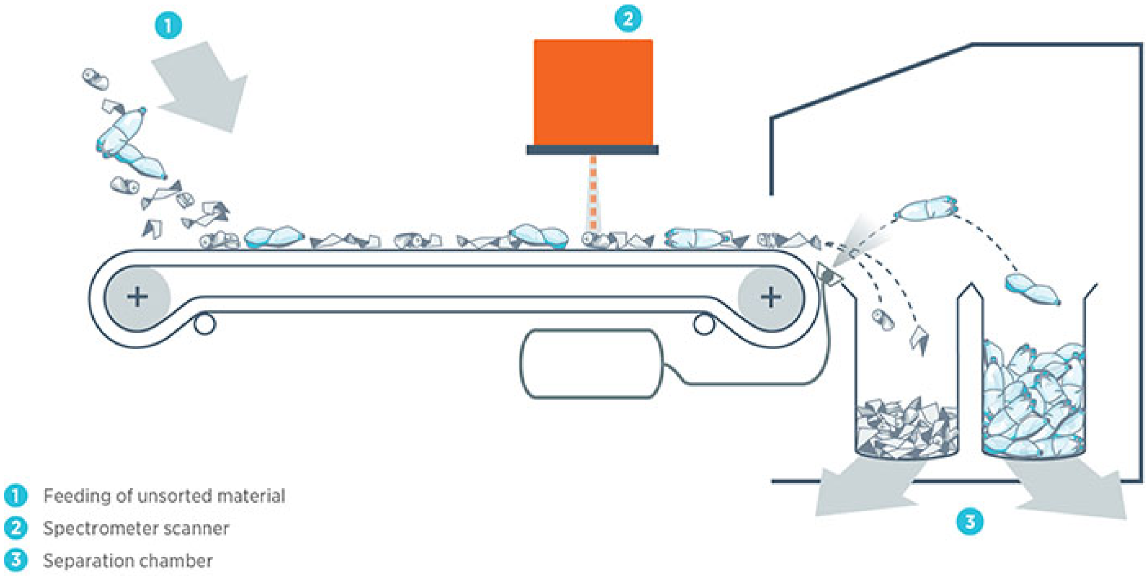

Figure 1 NIR sorter. In this example the blue bottles are being 'picked' and the grey material is going to the 'unseen' bin. Image copyright TOMRA.

The NIR will 'pick' for a material (explained above in figure 1). The purity of this material will depend on a number of factors, such as how fast the feed belt is run. As the purity on the 'picked' side increases, the purity on the 'unseen' material decreases.

In the example below (figure 2), the NIR line is set to 'pick' for PET and PS, with all other plastics going to an 'unseen' steam. The PET and PS will need to be picked to a high quality in order that those picked streams are saleable. PET is usually required at a purity of well above 99% (with contamination measured in parts per million). In order to achieve this purity, the NIR will allow a higher % of PET and PS through into the unseen bin, mixed in with the other polymers.

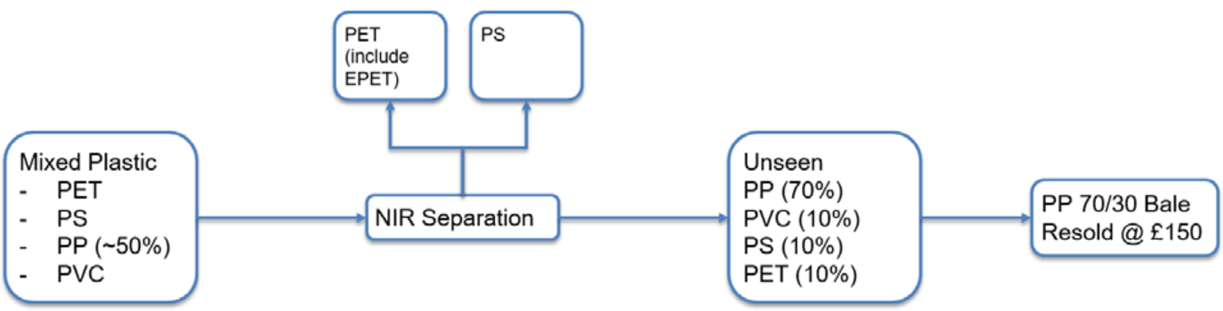

Figure 2 flow of a NIR system picking for PET and PS

Because of the purity in the picked streams, the unseen stream is comprised of a mixed plastic. Current UK figures show that the typical optical plant will pick 38% of the feed, with the remaining 62% going to an unseen bin[i].

The picked PET will likely to a ‘jazz’, which will be a mixed of different colours, and will typically sell baled for between £100 - £150/tonne.

As shown in figure 2, it is therefore highly likely that a portion of the expanded PET is likely to find its way into the unseen bin, which will form the majority of the plastic processed. We can now look at how this affects the further supply chain.

3) Effect on other separation technologies

As shown in figure 2, the unseen material is typically baled. These bales are usually described as 70/30 or 60/40 bales, with the first number indicating the likely % of PP in the bale. These bales can be sold by the MRF to a further reprocessor for circa £150/tonne. A picture of such a bale, being produced from a London MRF is shown in figure 3.

Figure 3 70/30 bale produced by London MRF from unseen on a NIR line. This material is sold for £150/tonne to a London reprocessor.

As explained in figure 2, this bale will be PP (Polypropylene) rich, with approximately 30% other plastic contamination. In the event of expanded PET being in the feed, then there will be a small % of this present in the bale which has not been picked up by the NIR.

The reprocessor will typically process this material using either;

A) Hand sorting
B) Density separation

Hand sorting is labour intensive and prone to human error. As such it is usually only used in foreign markets (India, China etc) where the cost of labour is cheap enough to support the value gained.

Density separation is therefore more common in the EU. Density separation relies on the fact that different plastics have different densities as shown in figure 4.

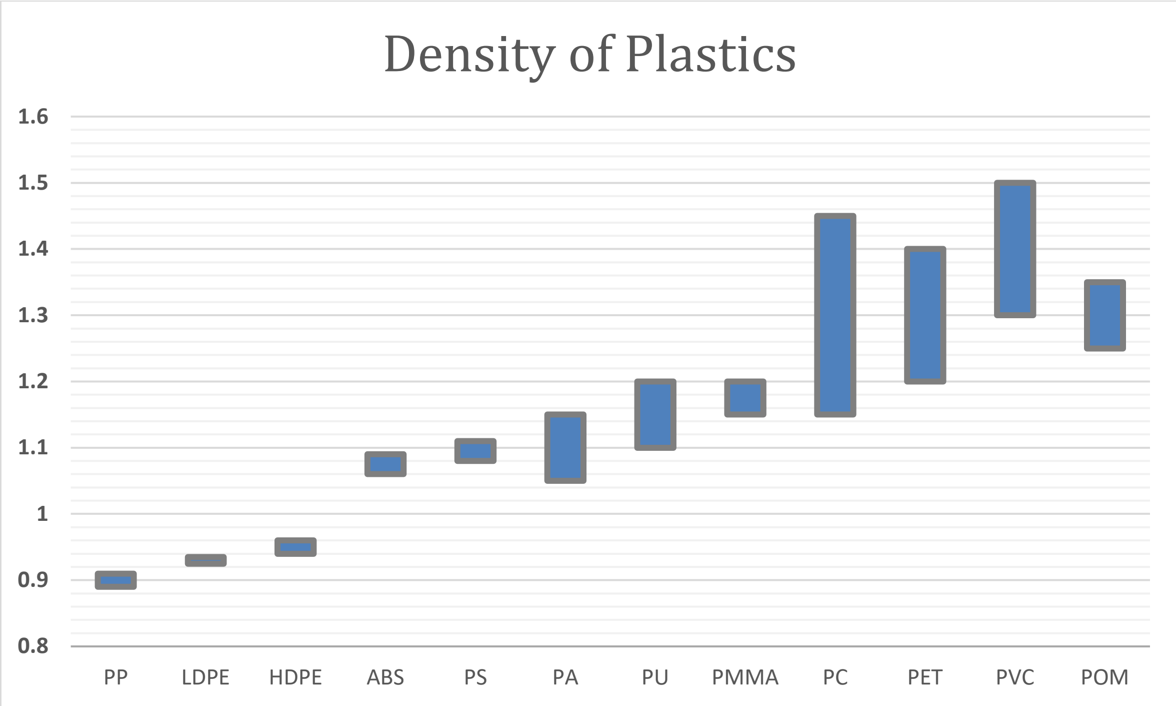

Figure 4 Densities of different plastics

Density is commonly used to separate Polyolefins (PP, LDPE and HDPE) from other plastics. This is because they have a lower density than water. In figure 4, you can see that PP and PE are below 1g/cm3 in density. This means that when placed in a bath of water (1g/cm3) they will float, while the plastics which are heavier/denser than 1g/cm3 will sink. This is shown in figure 5.

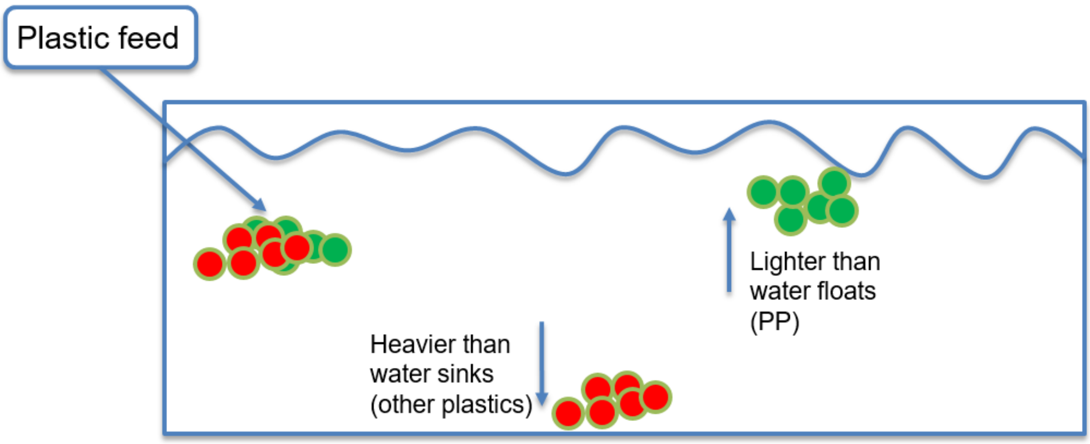

Figure 5 basic schematic of how a sink/float density separation process works

There is a number of different types of density separation, ranging from the basic sink/float tank as described in figure 5, through to more advanced systems such as centrifuges (Flottweg) and baffled oscillation (BOSS)

The effect of an expanded PET being in this mixed plastic feed is shown in figure 6.

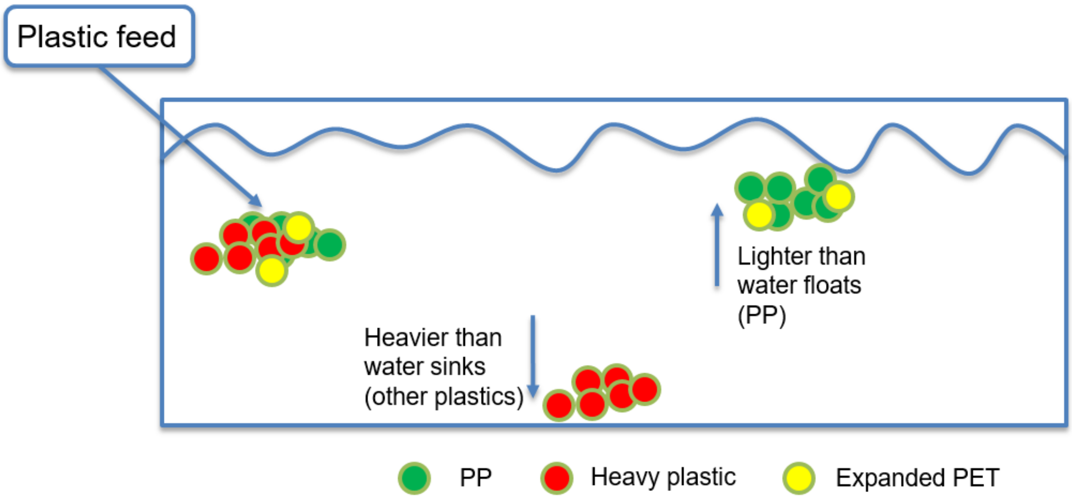

Figure 6 Sink/float process with mixed plastic contaminated with expanded PET

The expanded PET is coloured yellow. Due to the very low density (0.35g/cm3) the plastic will float in the density separation, causing a contamination of the PP material.

Because of the material properties such as melt temperatures, PP is not compatible with PET, which will cause problems during the extrusion process, and as such devalues the PP stream.

4) Cost impact of EPET in recycled plastic streams

Figure 7 shows the process used by the reprocessors to recover this PP material.

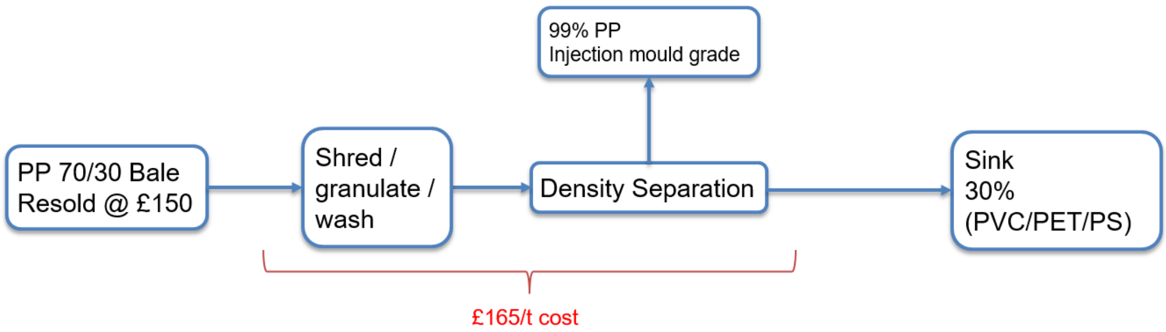

Figure 7 70/30 bale reprocessing flow

The bale is inputted to the process at ~£150/tonne, with 70% of the material recovered into a PP rich material. This will be of injection mould quality and therefore is applicable to a wide end market. This allows the material to be easily sold/traded by the reprocessor at a relatively high value (~£550/tonne). This kind of material is bought in the UK by compounders such as Regain, Luxus, Aurora and PTS. Internationally Veoila Holland has a demand for such materials at circa ~70,000/tonnes an annum.

The end market is typically for automotive use, especially in under car components where a black plastic can be used.

The sink fraction is usually sent for chemical recycling (pyrolysis) or more commonly to EFW (energy from waste) at a gate fee (cost to the reprocessor). A typical value analysis of this 70/30 bale is shown below in figure 8, from the prospective of the reprocessor.

Column 3 is the price in £ per tonne a recycler can expect from selling the material. The negative value indicates a gate fee. Column 4 shows the yield value, which is a calculation of the sale price x the expected yield % shown in column 2. The net value is the yield value of the produced plastics, minus the input material cost. Final profit is calculated by subtracting the processing cost from the net profit. Processing cost is based on an average of the operating costs of 3 different reprocessors in the UK which includes rent, rates, electricity, staffing and all other business costs.

	%	£/pricing	£/tonne
Input		150	150
PP	70%	550	385
Sink	30%	-50	-15
Net			220
Cost			165
Profit			55

Figure 8 value analysis for the reprocessing of a 70/30 bale

The profit, while small, allows a reprocessor to run a business and creates a market demand for the material.

However, if the material is contaminated with foamed, or expanded material such as EPET, it will lower the value of the PP significantly. In figure 9, the effect on the value analysis can be seen.

	%	£/pricing	£/tonne
Input		150	150
PP	70%	300	210
Sink	30%	-50	-15
Net			45
Cost			165
Profit			-120

Figure 9 value analysis for a 70/30 bale contaminated with EPET

As the PP is reduced in quality, its price steeply declines. This is because it is more costly/difficult to compound and will have reduced material properties (especially melt flow rate) which makes it a much less valuable product. The decline in MFR makes it unsuitable for automotive and limits the markets where the material is suitable, reducing value further.

Because the reprocessor is no longer able to make a profit from this material, they will switch their attention to another feedstock where profit can be made, and this material will be left with no home. It will either be exported, sent to EFW or in many cases be landfilled.

The loss therefore to the supply chain can be significant. Less PP makes it to the automotive industry, forcing the industry to use higher virgin plastic content as a suitable recycled material is not available. Further more, there is a loss in value to the recycling chain, and as the profitability is not present in sorting the material, it will become untouched at source and ultimately landfilled.

5) End Market for recycled expanded PET and other considerations

Further considerations in the use of expanded PET when designing for recyclability should be;

A) Transportation and handling
B) End market and use of recycled material

Transportation and Handling

Due to the very low density of EPET the storage and transportation of the material becomes costly. A typical recycled flake will have a bulk density of ~500kg/m3, allowing a typical 40ft curtain sider to be loaded with between 20 and 22 tonnes of plastic jazz regrind.

However, regrind with a high quantity of expanded product will be lower in bulk density. The bulk density can be estimated as 200kg/m3 once regrind has been produced (this assumes the EPET is mixed with the rPET and therefore cannot be compressed). This has the effect of more than halving the weight of plastic which can be transported at one time. With a typical transport cost of plastic at £30/tonne, this reduction in quantity could increase transportation costs to £60 - £70/tonne and therefore make the plastic uneconomical to process.

End Market

It is important when considering the recyclability of a product to look at the end market the recycled material is likely to end up in. It is typically too expensive to return plastic packaging to its original use due to the strict controls on food grade materials and the lack of traceability of what the recycled plastic may have been exposed to. Where there is traceability the costs usually outweigh the benefits.

Therefore, alternate uses need to be found.

The most common plastics in the supply chain, PP and HDPE, have solid reuse channels. PP is commonly used in automotive body work parts, while HDPE is an ideal polymer for making drainage pipes, street furniture and a variety of other similar products.

Markets for recycled PET have however struggled. WRAP published a report in March 2015 which explores these markets. [ii]

6) Recommendation

Due to the likelihood of an EPET contaminating the valuable PP recycled material, it is the recommendation of SPRCOE that alternate materials are used to ensure the recyclability of your products.

This could be achieved by using standard PET which will be processed as normal during reprocessing, or using a simple PP material which can easily be recovered and has a large end market.

For further information and discussion you can contact the Scottish Plastic Recycling Centre of Excellence on 01324 489 182, or via email at steven.burns@impact-solutions.co.uk

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[i] Project Loanstar 2017

[ii] http://www.wrap.org.uk/sites/files/wrap/Developing_End_Markets_For_PET_Pots_Tubs_And_Trays.pdf