
Trial report

Post-consumer film recycling: Processing of LDPE film at Ecoplast



Report of film processing trial at Ecoplast, Austria

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Front cover photography: A photograph of the post-consumer film feed material entering the picking shed at Ecoplast

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Executive summary

This trial report forms part of a suite of reports demonstrating the technical feasibility of using fully comingled post-consumer film packaging to manufacture products that the retail sector can adopt for use within their store networks and as part of their product ranges for customers. The overall project involves a number of upstream recyclers and downstream manufacturers, which are manufacturing a number of different products from post-consumer films. There are a number of individual trial reports available, in addition to a summary report for the whole project:

- Film separation at Biffa Waste Services Limited;
- Processing of LDPE film at Ecoplast;
- CeDo manufacturing trial;
- Agglomeration trial at Hanbury Recycling;
- Centriforce manufacturing trial;
- Protomax manufacturing trial; and
- Post-consumer film recycling (overall summary report).

The reprocessing trial at Ecoplast was the second stage of the CeDo refuse sacks manufacturing trial. The primary objective of the trial was to reprocess different feedstocks of post-consumer film packaging and provide suitable pelletised post-consumer recyclate (PCR) suitable for the manufacture of refuse sacks at CeDo in the UK.

The trials used two feedstocks:

- Post-consumer film material supplied from Biffa Materials Recovery Facility (MRF) at Trafford Park, Greater Manchester. The material was of a higher purity than the standard film bales produced by Biffa as it was collected under modified operating conditions; and
- A mixed feedstock of Sainsbury's front and back of store material, supplied from Jayplas, Birmingham.

The raw materials were split and batch fed through two independent reprocessing lines within the plant (Line 1 and Line 3), where non-target contamination was removed. The product was subsequently extruded into pellets and dispatched to CeDo for the refuse sack manufacturing trial.

During the trials at Ecoplast, it was also possible to perform some initial laboratory tests in order to gauge whether the final product could be used in refuse sack manufacturing trials.

Biffa material

Line 3 at Ecoplast processed 2.990t of feed, producing 1.300t of extruded PCR, equating to a yield of 43.4%. The yield loss was due to material composition, with the main contaminants being polypropylene (PP) film, laminated polyethylene film, metallised film, rigid plastics and paper. The final pellet product contained 7% PP by mass and all of the pellets contained gas. It was not possible to produce a laboratory test film with this product indicating the material would require further de-gassing before it could be used in refuse sack manufacture.

Line 1 processed 2.875t of feed, producing 1.570t of extruded PCR equating to a yield of 55%. Final pellet product contained 3.7% PP by mass and all of the pellets contained gas. A laboratory test film was successfully produced with the final product indicating the material would be suitable for use in the CeDo refuse sack manufacturing trials.

Sainsbury's material

Line 3 processed 2.839t of feed, producing 1.370t of extruded PCR, equating to a yield of 48%. The final pellet product contained 1.1% PP by mass and 1% of the pellets contained gas. A laboratory test film was also successfully produced with the final product indicating the material would be suitable for use in the refuse sack manufacturing trials at CeDo.

Due to unforeseen time constraints, it was not possible to process any of the Sainsbury's feedstock material through Line 1 and this trial was abandoned prior to start up.

Overall

The initial results were encouraging in that the PCR produced in the trials could be successfully used in refuse sack manufacture. However, it was also noted that there was some variation in the final product composition, specifically for PP and gas concentration. Whilst no definite conclusion could be surmised, differences in

feedstock composition, the processing route, and the relatively small quantity of material processed could all be contributing factors. Additional longer production runs are required in order to clarify and understand any variation.

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Glossary

HDPE	High density polyethylene
LDPE	Low density polyethylene
PE	Polyethylene
PET	Polyethylene terephthalate
PP	Polypropylene
PS	Polystyrene

Acknowledgements

Axion Consulting and WRAP would like to thank the staff at Ecoplast for their time and cooperation in delivering this trial. Our thanks also go to Biffa, Sainsbury's and Jayplas for providing the infeed material for the trial.

1.0 Background

WRAP has commissioned Axion Consulting to demonstrate the technical feasibility of using fully comingled post-consumer film packaging in economically and environmentally viable products. The project involves Axion working with a number of manufacturing companies to trial the production of products using post-consumer films.

The manufacturing trial partners and products being trialed are:

- CeDo: refuse sacks;
- Centriforce: rigid panels with a variety of end use applications including hoardings; and
- Protomax: rigid panels with a variety of end use applications including hoardings.

There is a suite of individual trial reports available, in addition to a summary report for the whole project:

- Film separation at Biffa Waste Services Limited;
- Processing of LDPE film at Ecoplast;
- CeDo manufacturing trial;
- Agglomeration trial at Hanbury Recycling;
- Centriforce manufacturing trial;
- Protomax manufacturing trial; and
- Post-consumer film recycling (overall summary report).

The trials are using two feedstock materials; plastic films collected through Sainsbury's front of store and back of store collection network and comingled films collected from domestic kerbside recycling schemes.

The processing trial at Ecoplast was the second stage of the CeDo refuse sack manufacturing trial. The first stage was a film separation trial at Biffa Material Recovery Facility (MRF) Trafford Park, Greater Manchester to obtain post-consumer film from household dry recyclable kerbside collections, which is covered in a separate trial report¹.

The purpose of this trial was to process baled post-consumer film packaging to produce a recycled low density polyethylene (LDPE) pellet for CeDo to use in its blown film process to make refuse sacks with recycled content.

2.0 Trial information

Trial host: Ecoplast, Wildon, Austria. Trial date: 9th February 2011.

2.1 Description of trial host/equipment

The trial was undertaken with Ecoplast at its processing facility in Wildon, Austria. Ecoplast is a leading plastics recycling organisation that deals with a range of polymers including LDPE and high density polyethylene (HDPE). It specialises in the processing of post-use LDPE film.

Within the Ecoplast site there are two dedicated lines for the processing of film waste and production of LDPE pellets. The two processing lines are known as Line 1 and Line 3; the lines follow the same basic process. Each line has a capacity of about 1t/hour in normal production.

Figure 1 shows a flow diagram of the process, and indicates where material is lost or contaminants removed.

Bales are manually de-wired and loaded into a feed hopper. The compacted bales are broken down using a bale breaker before non-target material (contamination) is manually removed from the process at a hand picking cabin. The film is subsequently water washed and separated from other non-target material through a complex series of separation stages. Waste material is discharged from the process as a wet sludge.

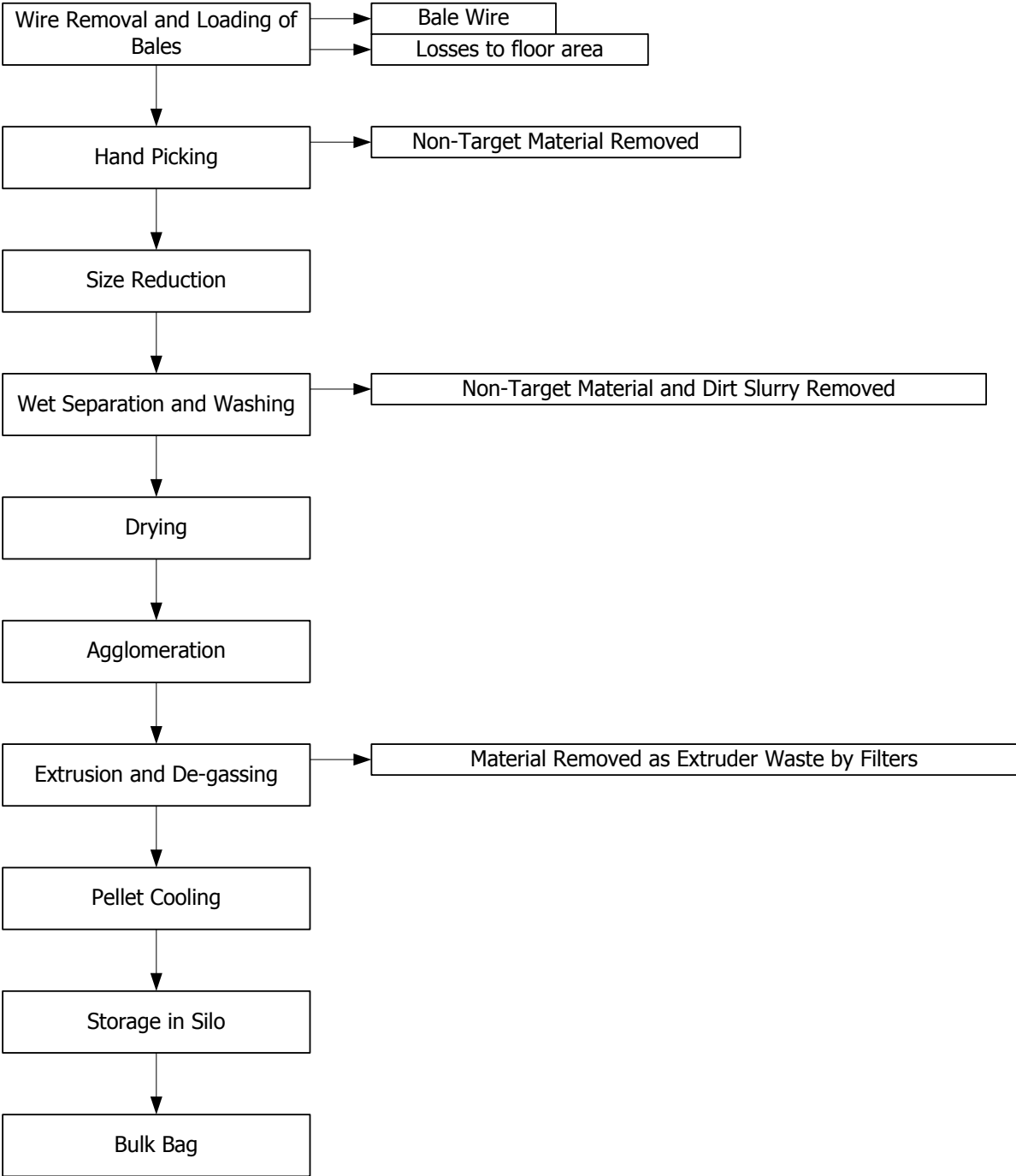
The clean film is dried and passed through an agglomerator to increase the bulk density before it is re-extruded back to pellet form. The extrusion process included vacuum de-gassing and melt-filtration of the material to ensure high quality material is produced. The pelletised product is cooled and stored in a silo before transfer to big bags for onward processing elsewhere.

¹ See separate trial report 'Post-consumer film recycling: Film separation at Biffa Waste Services Limited'

There are some differences in each process line, such as production rate and types of equipment used, as the plant has evolved and been optimised over time. The general perception is that Line 1 (the newer line) can produce a cleaner product for extrusion and hence a higher quality pellet product.

It should be noted that there was no scope within the project to review and understand the detailed differences between the processing lines.

Figure 1 Basic Ecoplast process flow diagram



2.2 Objectives of the trial

The objectives of the trial were to:

- Process post-consumer film sourced from a household dry mixed kerbside recycling scheme (Biffa MRF material) to produce post-consumer recyclate (PCR) in the form of pellets to be used in production of refuse sacks;
- Process post-consumer film waste collected from retail front and back of store collections (Sainsbury's/Jayplas material) to produce PCR in the form of pellets to be used in production of refuse sacks; and
- Perform initial laboratory based and observational analysis on the PCR to determine if they are of suitable quality to be blown into new film.

2.3 Trial feed material

There were two sources of material for the trial at Ecoplast.

2.3.1 Biffa MRF material

The first source of material was bales of comingled post-consumer film sorted from household dry mixed recyclable kerbside materials, collected from different locations across the UK. The comingled film material was separated at an automated Biffa MRF in the UK (Trafford Park, Greater Manchester), which is covered in a separate trial report².

For the purpose of this earlier upstream trial, changes were made to Biffa's usual film processing to give a product with a higher quality of polyethylene (PE) film and a lower concentration of contaminants. The changes were made to one of the Near Infrared (NIR) sorting units to improve the purity.

Approximately 6 tonnes of this material was sent to Ecoplast in ten bales of various weights. **Figure 2** shows a photograph of the film bales sourced from the Biffa MRF.

Figure 2 Bales of Biffa MRF material



The composition of the bales produced using the optimised NIR sorting settings was unknown prior to the trial, also the exact nature of the contaminants present in the material. However, the contaminants were likely to be metallised film such as crisp packets, paper and polypropylene (PP) packaging. The majority of LDPE is from supermarket carrier bags, with the rest of the LDPE film coming from food packaging.

In the event that there was not a sufficient quantity of the Biffa material to produce at least a tonne of LDPE pellets for the CeDo manufacturing trial, additional material was sourced from Biffa MRF as a contingency. This additional material consisted of 1.5 tonnes of film material removed by hand from a different stream at the MRF,

² WRAP MDP041 Post-consumer film recycling: Film separation at Biffa Waste Services Limited – Trial report

and also 3 tonnes of Biffa's 'Grade C' bales. These 'Grade C' bales are the film bales typically produced under the standard NIR sorting conditions and therefore of a lower purity.

2.3.2 Sainsbury's film material

The second source of material to be processed was a mixture of back of store retail waste (predominantly shrink wrap) and front of store film material deposited by Sainsbury's customers, primarily carrier bags. This material was collected from Sainsbury's stores across the UK by Jayplas.

The composition of a typical bale of this product is shown in **Figure 3**. It should be noted that this information was gathered from previous work undertaken by CeDo and should therefore only be used as a guide to the composition of the material sourced for this trial.

It can be seen that approximately half of the bale is PE film; however the greatest proportion of this film is from the back of store waste and is from bulk packaging. The film contributed by plastic bags collected through the front of store infrastructure is only approximately 8%.

Figure 3 Composition of typical Sainsbury's film bale

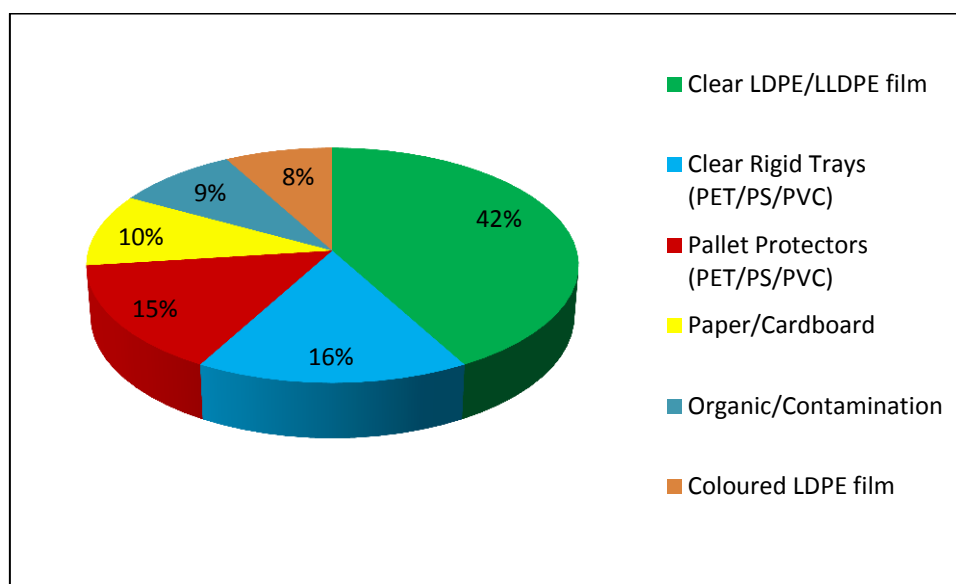


Figure 4 shows a photograph of one of the Sainsbury's film bales sourced for this trial. In contrast to the Biffa MRF material the Sainsbury's/Jayplas film material appeared to contain far fewer types of polymer and non-polymer material, with a much higher percentage of clear film.

Figure 4 Sainsbury's/Jayplas film bale



2.4 Trial methodology

The first stage of the trial was to establish how best to run the material through the plant. It was decided to trial the higher purity Biffa MRF material first, splitting it in half and processing half of the material on each line, before processing the Sainsbury's/Jayplas material in the same manner.

The bales of Biffa MRF film material were weighed and their mass recorded and split between the two processing lines accordingly. During the weighing process the lines were run empty from the previous shift to ensure that contamination with other material was avoided.

Line 1 was cleared first and the material was then processed under normal operating conditions. The material was processed through the separation stage of the plant and was held at the drying stage allowing more material to be accumulated before agglomeration took place.

Once Line 3 was cleared material was processed in the same manner.

All of the material which had been removed by hand pickers was put into cages so it could be weighed after processing. Two grab samples were taken from the inlet to the hand picking stage and sorted into target film and non-target material in order to estimate an expected yield. The start and end times for this stage were recorded in order to calculate approximate throughput estimates.

Once a buffer of material had built up at the drying stage it was passed through the agglomeration and degassing and extrusion stages. As with the previous processing stage the start and end times were recorded.

Once the extrusion process was running under steady state, a snap sample of extruded pellet was taken for laboratory analysis and applications testing. The pellets produced were also observed throughout the run, visually assessing if any surface defects or deformities were present. Defects would indicate insufficient degassing prior to extrusion and would lead to problems in downstream processing. For applications testing, a blown film was produced and assessed in the onsite laboratory.

After the trial was completed the normal operational quality control checks were carried out by Ecoplast, to determine the physical properties of the PCR. These tests included gas level measurement within the product and percentage of PP present in the finished PCR.

Once the Biffa MRF material had finished processing the same methodology was then applied to process the Sainsbury's/Jayplas material and record the same information.

This approach would yield four categories of PCR product; Biffa Line 1, Biffa Line 3, Sainsbury's/Jayplas Line 1 and Sainsbury's/Jayplas Line 3. It should be noted that the Sainsbury's/Jayplas Line 3 material was not processed as planned.

3.0 Results and discussion

3.1 Trial data

The delivery of the processing trial at Ecoplast was straightforward with only one complication. Due to unforeseen time constraints on the plant, it was not possible to process the Sainsbury's/Jayplas material on Line 1, and therefore only three PCR products were made. Otherwise the trial went according to plan and approximately 1.5 tonnes of LDPE pellet was produced from each trial/infeed material.

The results from the trials are shown in the following tables. **Table 1** shows the weights of outputs, throughputs and yields for each trial undertaken.

Table 1 Key trial data: weights, throughputs and yields

	Biffa Line 1	Biffa Line 3	Sainsbury's/Jayplas Line 3
Net time of processing through separation stage (hr)	4.92	3.00	3.50
Net time of processing through extrusion stage (hr)	1.58	2.42	2.00
Net time for material to pass through the whole process (hr)	6.5	4.6	4.25
Mass of material fed into process (t)	2.875	2.994	2.839
Mass of material removed by hand pickers (t)	0.488	0.424	0.865
Mass of pellet product (t)	1.570	1.300	1.370
Mass of slurry/heavies removed by separation process and mass of material removed by extrusion filters (t)	0.817	1.27	0.604
Rate of production based on extrusion times (t/hr)	0.99	0.53	0.69
Yield %	55%	43%	48%

Table 2 shows the results from the hand sorts performed on the infeed of each material stream. The hand sort offers an insight into the expected yield whilst the trial was in progress.

Table 2 Hand sort infeed material

	Biffa Line 1		Biffa Line 3		Sainsbury's/Jayplas Line 3	
Mass of target film in infeed sample (g)	516.6	522.9	482.3	689.4	520	492.4
Mass of non-target material in infeed sample (g)	129.4	129.7	314.9	460.7	332.5	138.2
Estimated % yield	80%	80%	60%	60%	61%	78%

Table 3 shows the results from the physical quality checks performed on the final products by Ecoplast. These tests are carried out on standard Ecoplast products in order to assess the effectiveness of upstream cleaning and separation to produce a high quality LDPE pellet.

Table 3 Quality check results

	Biffa Line 1	Biffa Line 3	Sainsbury's/Jayplas Line 3
% of PP in product	3.7	7	1.1
% of pellets containing gas	100	100	1
Bulk density of product (g/l)	477	316	520

3.2 Discussion and observations

During the first stage of the trial, up until agglomeration, all the trial material ran through the plant without any significant problems. It was noted, however, that the trial throughput was lower than the post-consumer comingled film that Ecoplast normally processes. This was attributed to the higher level of contaminants in the trial material in comparison to the film material typically processed on the plant. The usual production rate is 0.85t/hr on Line 3 and 1.1t/hr on Line 1, and the typical yield achieved is 75 – 85%.

In order for the hand pickers to effectively remove as much non-target material as possible, the feed rate was reduced. The feed rate through the plant can be controlled by the hand pickers to allow them to effectively remove non-target material. As the trial material appeared to have a higher level of non-target material than Ecoplast's typical material, the feed rate was reduced in order to produce a relatively clean product.

The results of the laboratory analysis showed clear differences between the extrusion stages of the two lines when processing the Biffa MRF material. The product made from the Biffa material processed on Line 3 was unable to be blown into test film and the pellets displayed clear surface imperfections. Furthermore, during the

trial the experienced staff at Ecoplast anticipated that more gas was likely to be present in the Biffa Line 3 PCR due to its odour. In spite of this, however, the applications tested on both the Biffa Line 1 and Sainsbury's/Jayplas Line 3 PCR were successful and laboratory film was blown.

3.2.1 Biffa material

Yield

The yield achieved on the Biffa material was 55% on Line 1 and 43% on Line 3. These yields were in line with what Ecoplast thought was achievable from initial observation of the bales. However the yield was significantly lower than the hand sorting samples shown in **Table 2** would suggest. This was because only a few snap samples were taken and each sample was relatively small in size, with large items of material markedly affecting the results. It is acknowledged that the snap samples were not representative but were taken in order to give an indication of the yield that might be expected. The overall yield from the trial offers a much more accurate estimation of the yield that can be expected in the long term.

The contaminants within the feed were largely of a film nature themselves, either PP film, laminated PE film or metallised film. **Figure 5** shows typical contaminants found in the Biffa material.

Figure 5 Typical contaminants in Biffa material



As can be seen in the photograph, the Biffa material contained PP film as well as HDPE bottles and PET packaging.

Table 1 shows that a similar mass of contaminants was removed from both lines by the hand pickers and that the major difference in losses arose during the wet separation and extrusion stages. Line 1 utilises a more efficient system regarding the separation and filtration to produce a higher quality pellet. This may account for a lower level of material loss from these stages on Line 1.

As there were also physical differences in the extruders this may suggest that the extruder on Line 1 was more suited to the application, removing less product as extruder waste. **Figure 6** and **Figure 7** show the percentage removed during each stage from the Biffa Line 1 material and Biffa Line 3 material respectively.

Figure 6 Material removed from Biffa Line 1

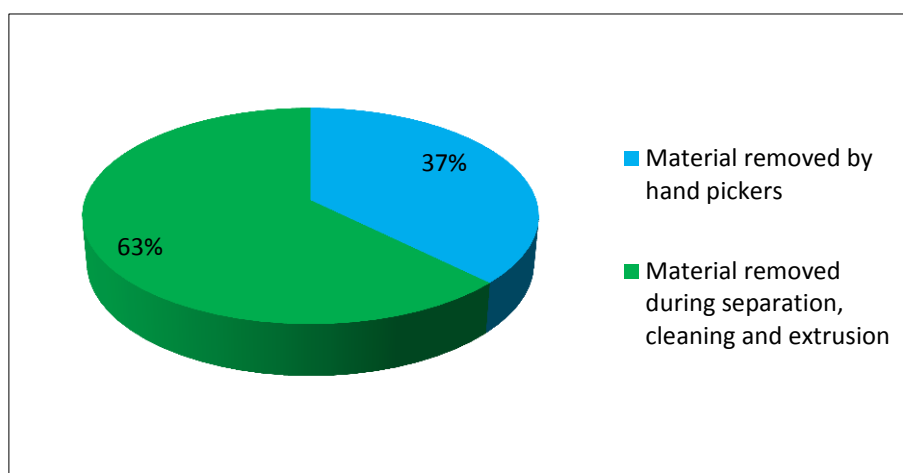
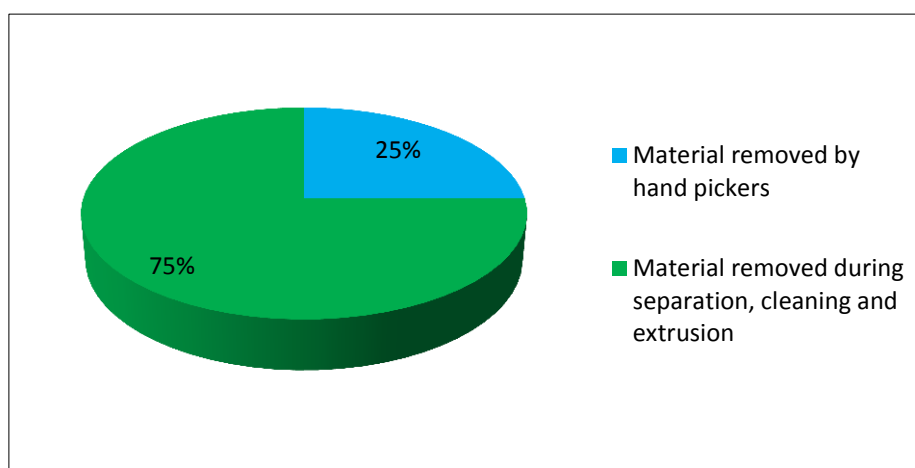


Figure 7 Material removed from Biffa Line 3



Another reason for the increased yield could also be due to the quality of the feed to Line 1 being higher than that of the Line 3 feed. This is suggested from **Table 2**; however as stated previously the hand sort samples were not necessarily representative, and therefore are not solid evidence to support this theory. Theoretically there should be little difference between the purity of bales as they were produced under the same conditions and randomly split across the two processing lines at Ecoplast; however there is a possibility for variation arising from the fact that the feed to the Biffa MRF is not of constant composition.

Therefore it could be that the feed to the MRF which was sorted to create the bales subsequently fed to Line 1 had a higher film concentration, producing a purer film stream. On the other hand, due to the fact that the actual yields were relatively similar and that more material was handpicked from the Line 1 material indicates the composition of the feeds to the two lines were not as different as the hand sorting suggests.

Production rate

Table 1 shows the rate at which pellet was extruded on each line. Line 1 had a higher rate of 0.99t/hr whereas Line 3 had a rate of 0.53t/hr. Line 1 usually has a higher extrusion rate than Line 3 although the observed rates were lower than that of the typical rates as stated previously and the time to process the material from start to finish was also longer than is normal. This is due to the material processing through the separation stage at a lower rate than standard because of the high level of contamination within the feed which requires prolonged hand picking. Therefore the rate of the upstream separation was unable to match that of extrusion. In order to maximise the rate and prevent the separation stage from being rate limiting more hand pickers would be required to process this material.

Product analysis

Table 3 shows that the Biffa Line 1 PCR had a lower percentage of PP present in the final product. The Biffa Line 1 PCR contained 3.7% PP, whereas the Line 3 product contained a higher percentage of 7% PP. The presence of PP can cause the reprocessed film to be brittle, or make it impossible for new film to be blown from the reprocessed pellets. PP and PE cannot be separated using wet separation techniques such as those used at the Ecoplast processing site.

Therefore the only available opportunity to remove the PP from the PE is during the hand picking stage. The lower level of PP in the Biffa Line 1 PCR could again be either due to more efficient hand picking or due to the Line 1 feed having fewer contaminants. As commented on previously it is likely to be due to the more efficient hand picking, which is suggested by the lower throughput and higher mass of material removed at this stage on Line 1. Recycled LDPE can still be used for some injection moulding applications if the percentage of PP is too high for it to be blown into film.

The level of gas retained in the PCR pellets was also measured. The analysis shows the percentage of pellets which contain gas but does not give the amount of gas present in the product as a whole. **Table 3** shows that 100% of the pellets of both the Biffa products contained gas. The gas can prevent the pellets from being blown into new film.

The gas arises from the presence of fats and other oil based dirt which cannot be removed by washing with water. The gas emitted by the dirt can be removed from the polymer product during extrusion through a process known as degasification. The efficiency of degasification is related to residence time within the devolatilisation zone of the extruder, the level of vacuum applied as well as the melt temperature. During extrusion the material is heated and the oil based contaminants evaporate.

Pellets from both Biffa Line 1 and Line 3 contained an unknown quantity of gas. However the bulk density in **Table 3** suggests that the Biffa Line 1 material contains less gas as it has a higher bulk density. Furthermore visual analysis of the Biffa Line 1 PCR suggests the level of gas was lower, which was further supported when test film was able to be blown from the pellets.

The difference in the Biffa Line 1 and Biffa Line 3 PCR pellet can be seen from **Figure 8** and **Figure 9**. It can be seen that the Biffa Line 3 PCR has more surface defects and deformities, suggesting that the levels of gas within the pellet were higher. The odour of the Biffa Line 3 product also suggested the level of gas was higher than that of the Biffa Line 1 product. These observations and laboratory analysis suggests that the modifications made to the Line 1 extruder have increased its de-gassing abilities, since the feed material should have the same concentration of non-soluble dirt and if there was no difference in the extrusion stage both products would show the same characteristics.

Figure 8 Biffa Line 1 product



Figure 9 Biffa Line 3 product



3.2.2 Sainsbury's/Jayplas material

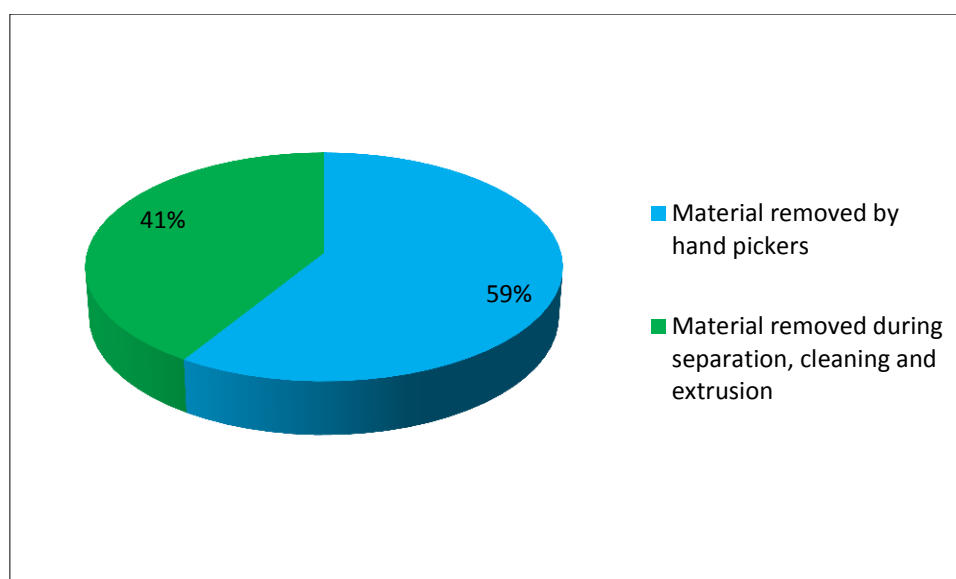
Yield

The Sainsbury's/Jayplas material achieved a yield between that of the Biffa Line 1 and the Biffa Line 3 material of 48%. Once again this is lower than the hand sorted samples shown in **Table 2** would suggest, due to the difficulty of taking a representative sample.

From **Table 2** it can be seen that the mass of material removed by hand picking from the Sainsbury's/Jayplas film bales was almost double that of the material removed from the Biffa film bales. This was likely to be due to the nature of the contaminants in the Sainsbury's/Jayplas material; the contaminants were generally large pieces of heavy plastic, which were easy to identify and remove. Furthermore the PE film within these bales was largely clear or orange and therefore little confusion between different types of film could occur. In contrast the contaminants within the Biffa material were on average much smaller and more difficult to hand sort from the wide range of PE film types within the bales.

Figure 10 shows the percentage of material removed from the Sainsbury's/Jayplas infeed and the location of the removal. It is clear from the diagram that more material was removed during the hand picking stage when processing the Sainsbury's/Jayplas material than when processing the Biffa material.

Figure 10 Material removed from Sainsbury's/Jayplas infeed



It was observed during extrusion of the Sainsbury's/Jayplas material that less material was being removed as extruder waste by the filters than when processing the Biffa material on Line 3. This is likely to be because of the lower level of contaminants and more efficient hand picking.

Production rate

The Sainsbury's/Jayplas material achieved the highest throughput of all the materials processed. The rate of extrusion achieved was 0.69t/hr. This, like the Biffa material, is lower than standard production rates again due to the separation stage taking longer.

Product analysis

Table 3 shows that the Sainsbury's/Jayplas PCR had the lowest percentage of PP present in the final product. Due to the nature of the source of the material it was unlikely to contain a significant amount of PP initially, as can be seen from the bale analysis in **Figure 3**. Furthermore as stated previously the contaminants were easier to remove from the Sainsbury's/Jayplas material and so any PP present could easily be removed.

Table 3 shows only 1% of the pellets of the Sainsbury's/Jayplas product contained gas. The Sainsbury's/Jayplas material contained a minimal percentage of gas, due to the nature of the material. The Biffa material is post-consumer material collected at the kerbside and therefore has been in contact with sources of organic contamination. Whereas the Sainsbury's/Jayplas material is collected from back of store (clean, non-food contact packaging) and front of store (primarily carrier bags) and doesn't contain a significant amount of the fats or oil based dirt.

Figure 11 shows a picture of the Sainsbury's/Jayplas final pellet product. In comparison to the Biffa products the pellets are more uniform and contain fewer surface defects. In addition to the lack of defects, test film was able to be blown for the PCR showing that the level of de-gassing was sufficient.

It must be noted that the differences in colour shown in the photographs are largely due to lighting conditions rather than differences in the material.

Figure 11 Sainsbury's/Jayplas Line 3 product



Although it was not possible to process the Sainsbury's/Jayplas material on Line 1, it is believed that it would give a similar yield with a similar quality as Line 3. This is because the modifications have improved the processing of the film by aiding the de-gassing process. However since the level of gas within the Sainsbury's/Jayplas PCR was significantly lower there would have been little advantage to running it on Line 1.

4.0 Conclusions and recommendations

The key conclusions from the film processing trial at Ecoplast are as follows.

Line 1 successfully processed 2.875t of post-consumer material collected from the Biffa MRF, producing 1.570t of extruded PCR equating to a yield of 55%. The final pellet product contained 3.7% PP by mass and 100% of the pellets contained gas, but within tolerance levels. A piece of test film was made from a sample of the product suggesting it was suitable for further processing.

Line 3 successfully processed 2.990t of post-consumer material collected from the Biffa MRF, producing 1.300t of extruded PCR, equating to a yield of 43.4%. The final pellet product contained 7% PP by mass and 100% of the pellets contained gas.

The bulk density of the Biffa Line 3 PCR was lower of that than the Biffa Line 1 PCR and a piece of test film was unable to be made, suggesting that the concentration of gas was too high in this material. It is likely the material will require further de-gassing before it can be successfully blown into film.

Line 3 successfully processed 2.839t of film collected from Sainsbury's (front and back of store), producing 1.370t of extruded PCR, which equates to a yield of 48%. The final pellet product contained 1.1% PP by mass and 1% of the pellets contained gas. A piece of test film was made from a sample of the product suggesting it was suitable for further processing.

There is still a possibility that the difference in the Biffa products concerning the PP and gas concentration could be due to a difference in feed composition or alternatively the difference is the processing routes. In order to truly assess the differences in the processing lines at Ecoplast it is suggested a larger amount of material would have to be processed in order to remove any variation in feed composition leading to different results.

On completion of the Ecoplast trial all of the PCR produced was sent to CeDo's film manufacturing facility in Telford, UK³. The material was to undergo a film blowing trial to assess whether the LDPE processed at Ecoplast was of high enough quality to use in the manufacture of refuse sacks. 1.570t of the Biffa Line 1 material was sent along with 1.300t of Biffa Line 3 and 1.370t of the Sainsbury's/Jayplas material.

³ See separate trial report 'Post-consumer film recycling: CeDo manufacturing trial'

**Waste & Resources
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