Recycling plastic bottles and flasks

While the general public is not yet that familiar with recycling PET and HDPE bottles and flasks, it is already maturing into a major industry. Demand for recycled materials is increasing, as well as the amounts being collected. Nevertheless, it is not all roses for the recyclers. 'There is still a lot of room for improving the recyclability of PET and HDPE bottles. Moreover, we are seeing new trends that are complicating recycling', says An Vossen, Executive Manager at Plarebel. Mark Ruesink, General Manager at Wellman Recycling, agrees with her: 'Producers are often not aware of the technical challenges of the recycling process and of the impact that their packaging decisions have on that process'. That is reason enough to dedicate a report to the subject in this edition of Preventpack.

prevent pack

Three essential criteria for efficient recycling

The recycling of plastics stems from the reuse of collected waste and residues from the production processes of plastics manufacturers. Today, a third of all packaging plastics brought onto the market in Europe are recycled. All types of plastics can be recycled, but recycling efficiency depends primarily upon three important factors: a constant input of collected materials, a stable market for recycled materials and the quality of the collected fractions, and of the end product.

Volume

Collecting more and more materials

A constant input of materials is essential for an efficient recycling process. Significantly, the selective collection of plastics in Europe continues to increase. In 2011, a total of 6.3 million tons of plastics was collected selectively, of which 5.2 million tons was packaging. 'The recycling process requires a constant supply of materials, in spite of the fact that the bottles are steadily becoming lighter', observes An Vossen. 'To give an example: in 1971, a single-use plastic one and a half litre bottle of SPA Reine weighed 56.6 grams. In 2013, that same bottle weighed only 28.5 grams. It now takes 25% less resources to produce the same number of bottles. And that in just fifteen years'.

PET remains a seasonal product

'PET is a typical seasonal product', notes Mark Ruesink. 'We consume more beverages in PET bottles in the summer time than during the winter. In addition, major events such as the World Football Championships have a noticeable impact on the amounts collected. At Wellman Recycling, we have the capacity to store 7,000 to 8,000 tons, and we really need that buffer to survive the winter. You also see similar volatility on the sales side of recycled PET (rPET). When the weather forecasts predict beautiful weather, large manufacturers order massive amounts of rPET for the production of beverage bottles and packaging trays (partially made out of rPET) for barbecue meat, among other things. This creates a peak in our sales'.

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Market

Continuous increase in the demand for recycled materials

The use of recycled materials is clearly on the rise. Besides the obvious environmental and marketing benefits of recycling, recycled materials are also becoming more interesting from an economic perspective. It requires less—increasingly scarce—primary resources, while simultaneously decreasing energy use. Recycling PET requires up to 60% less energy than producing new PET. There are, however, limits to recycling PET. Today, 40% of the PET recycled in Europe reappears in new food product packaging. This percentage is considerably higher (60%) in Belgium. Use in the food chain means that the quality requirements are very high.

The use of 100% post-consumer recycled PET for the production of new PET bottles is technically feasible. There already exist well-documented examples of companies that use 100% rPET. However, each time a PET bottle is recycled, the material characteristics degrade and the quality of the material diminishes. To compensate for these losses, manufacturers often mix virgin PET with rPET in order to ensure the retention of high quality packaging materials. The treatment of 100% rPET accelerates thermal degradation compared to a mixture of virgin PET and 30 to 50% of recycled PET.

Trend towards more (recycled) PET

There is also a clear trend towards using recycled PET packaging for a wider range of products. However, these recycled plastics often cannot be used in the production of new packaging due to limitations in colour (i.e. grey), odour, and food contact.

PET offers manufacturers various benefits: the material is transparent, has a beautiful gleam, and offers a great deal of design flexibility. An Vossen points out that 'It also opens up the possibility to use recycled materials for the production of new PET bottles. Other packaging, such as fruit and pastry trays, are increasingly made out of recycled PET. Moreover, PET bottles are becoming increasingly thinner, requiring less and less material. In addition, new technologies are making it possible to use PET for the packaging of sensitive products such as wine, beer or milk. 'This was unthinkable until recently'.

Quality

Quality is the biggest challenge

The biggest challenge is and remains the quality of the collected materials. 'We recyclers are dealing with quite a contradictory situation', says Mark Ruesink. 'The input quality is deteriorating, while the quality requirements for end products—especially for food products—are becoming more and more demanding. 'The drop in quality is in fact due to the increasing complexity of the packaging. Manufacturers are adding more and more layers, barriers and additives to their packaging. This is good—and often necessary—for the preservation and protection of the product. However, it is often a nightmare to recycle such packaging. In many cases, the added materials incinerate or degrade during the melting process, making the end product brown or yellow and thereby limiting its usefulness. Moreover, the added materials are more difficult to remove—they are molten (blend) when added to the PET before forming—and the layers are becoming increasingly thinner (multilayers).

Manufacturers can help

'As recyclers, we continuously invest in new techniques and search for creative solutions to cope with these challenges', explains Mark Ruesink. 'Simultaneously, we also ask manufacturers to avoid materials that are not compatible with the recycling process. This is actually also better for them because they, in turn, can then use more recycled materials. We note that manufacturers are becoming increasingly aware of the fact that what they are doing also affects the recycling process. However, they do not always have a full insight into the recycling process and the technical challenges it presents. The exchange of information between manufacturers and recyclers is essential as we evolve towards closed loops'.

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How to optimize the recyclability of packaging?

Combining materials

Density essential for the separation of plastics

The float/sink separation technique (also known as flotation separation) is essential for recycling plastics. By using density differences, various types of plastics can be separated perfectly and cost-effectively. Mark Ruesink illustrates this point with an example: 'The HDPE caps that are used on most of the PET bottles are ground together with the bottles and afterwards sent to a flotation tank filled with water. The HDPE fraction floats, whereas the PET fraction sinks'.

The problems, however, start when two materials with the same density are combined. This is the case with PVC and PET, for instance. A second phenomenon undermining the efficiency of the flotation process is the use of (cheaper) filler materials in HDPE packaging. Even a small percentage can affect the material's density, making the materials no longer separable via the flotation technique.

Metals in plastic packaging not a good combination

Plastic packaging may have a small amount of metal. For instance, plastic siphons containing cleaning product are equipped with a metal spring and ball. Labels, caps, and lids often contain an aluminium component, for example, the aluminium clips in the lids of HDPE milk bottles. Generally, metals can be separated from plastics fairly easily using metal detectors and magnets.

Nevertheless, the presence of metal hampers the efficiency of the production process. 'Metal detectors are often very sensitive, causing the production process to be stopped continually', explains Mark Ruesink. 'The aluminium in labels and caps is also difficult to remove'.

PVC, negative impact on rPET quality

Special attention is given to PVC. 'The presence of PVC has a negative impact on the quality of recycled PET', states An Vossen. 'During the melting process, PVC will incinerate and give the product a dark brown colour. Even 25 grams of PVC in a bale of 250 kilograms is enough to make the end product unusable. In addition, PVC and PET are very hard to distinguish visually. And since they have a similar density, both sink during the flotation process. As a result, they cannot be separated in that phase. Fortunately, the use of PVC as packaging material has decreased considerably. Nevertheless, the material is increasingly present in the sleeves around bottles (see also text box 'Sleeves)'.

good to remember

- **Avoid combinations** of materials and ensure that other materials can be **removed easily.**
- Limit the use of **metals** in plastic packaging to an **absolute minimum.**
- Avoid the use of PVC in combination with PET and **take into account** the **density** of the various **plastics** that you combine.

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Mutlilayers, barriers and additives

Protecting the product versus recycling packaging

Modern packaging is becoming more and more complex and contains various materials and substances to better preserve and protect the product. Barriers in packaging reduce the permeability of gases and protect products against oxygen and other external influences. AA blockers block the transition between plastics and the product, and avoid the taste of plastic in bottled water. PET brighteners make bottles more transparent and make them shine. External coatings, usually as a spray or dip, harden the outside of the packaging, limiting the permeability of gases. Plasma coatings on the inside use carbon or silica (a very thin gas layer). And finally, multilayer bottles combine three to five layers (nylon, EVOH, et cetera) in order to protect very sensitive products such as fruit juice, beer or milk.

On the one hand, these new trends and technologies are a good thing, causing fewer food products to perish. This is and will no doubt remain the primary function of packaging. On the other hand, each additive, each additional barrier and each layer has its own specific impact on the recyclability and quality of the end product. 'The characteristic most affected is the colour of the recycled product', states Vossen. Layers of nylon, for instance, incinerate during the melting process and give the product a brown colour, making the end product unsuitable for its normal uses. The presence of the many additives and barriers make the recycled product less transparent. PET brighteners give the end product a kind of fluorescent glow, an undesirable effect for many applications'.

In addition, most of the products are difficult or impossible to separate. 'Blends are molten when applied to PET, making it impossible to remove them', says Mark Ruesink. 'Layers and coatings are becoming increasingly thinner. We cannot remove them without also removing a part of the PET material. The fact that the layers are becoming thinner makes it even more difficult'.

good to remember

- Balance the **optimal protection** of the product and the **recyclability** of the packaging.
- **Do not use blends** in your packaging.
- Use **barriers and additives** that are **compatible** with recycling.

Recycling plastic bottles and flasks

Sleeves, a very specific problem

The use of so-called full-body sleeves is becoming increasingly popular. Sleeves make PET bottles—which are becoming increasingly thinner—more robust and open up a vast array of opportunities to make the product stand out from its competitors on shop shelves. However, they also cause problems during recycling. Mark Ruesink explains: 'First of all, they make it more difficult to recognize the material the bottles are made of. During sorting, the surface of the bottle is scanned. In many cases, sleeves cover the entire bottle, making it impossible to recognize the material. The result is that the material is lost'. Moreover, the sleeves are difficult to remove during the pre-wash, because they tend to shrink when heated. Nevertheless, the biggest problem is the material the sleeves are made of. 'PVC is a very popular material for sleeves, because it has a beautiful gleam and it fits the bottle well', notes An Vossen. 'Even a small fraction of PVC has a large impact on the end product's quality'.
On the other hand, a good choice of sleeve and ink can aid the recycling. Such labels require no glue and the PET or HDPE bottles remain uncoloured.

Where can you find more information?

Fost Plus – tools and first-line advice

At **www.pack4recycling.be** (a Fost Plus website) you will find a free online tool to identify the recyclability of your packaging. You will also find information regarding all of the criteria that are taken into account when estimating recyclability, as well as tips and advice on how to improve the recyclability of your packaging.

You can also contact Fost Plus for personal—and of course strictly confidential—advice. Contact us for more information: prevention@fostplus.be.

EPBP – and guidelines

The European PET Bottle Platform (EPBP) is a voluntary initiative that unites technical experts in the field of PET production and recycling. The EPBP has developed a number of test procedures that enable you to cost-effectively test the recyclability of new PET bottles and specific components such as barriers, caps, labels and glues. A number of tests are easily executed in your company. However, you can also order lab tests that study the mechanical characteristics and visual aspects of the recycled product in detail.

The EPBP has also developed a series of guidelines to help you make the right choices when designing new PET packaging. You will discover which materials—including barriers, additives, caps, labels, and glues—are compatible with recycling and ensure that components made out of other materials can be removed quickly and efficiently. The guidelines take into account adequate preservation and protection of the products as well as recyclability.

good to remember

- **Avoid** the use of **PVC in sleeves**. PE and PP are excellent alternatives.
- Use **inks that do not detach** in water.
- Test the recyclability of your packaging on **www.pack4recycling.be** and consult, for PET, **www.petbottleplatform.eu.**

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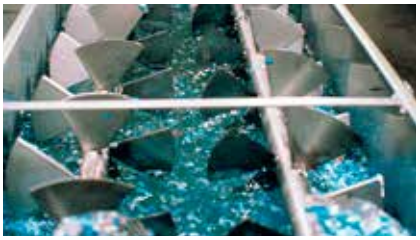

How are HDPE and PET bottles recycled?

1 → Detach

The pressed bales originate from the sorting centres and only contain HDPE or PET bottles, the last ones being sorted by colour. After inspection, the bottles are mechanically detached from the bales.

2 → Pre-wash (only for PET)

The bottles are washed with warm water to remove dirt, labels and glue residues.
60% of the glued labels are removed in this phase.

3 → Sort

During recycling of PET bottles, materials such as metals, drink cartons and other types of plastics are removed.
Sorting can be executed manually or automatically (metal detection, infrared, laser, et cetera). During HDPE recycling, only metals are removed at that step.

4 → Grind

Bottles are ground in a shredder into flakes of 8 mm to 12 mm.

5 → Friction wash

The flakes are washed by rubbing them against each other. The last glue residues, paper, and dirt are removed in this phase.

6 → Flotation

Flakes are poured into water (density = 1.000 kg / m^3). Denser materials sink (PET, PVC, metals, et cetera) while less dense materials float (HDPE, PP, et cetera). This technique always results in 2 fractions. The PET recycler uses it to separate PET bottles from sleeves and caps in PP or HDPE. The HDPE recycler uses only the floating materials.

7 → Rinse and dry

Once again, the flakes are rinsed, dried, and then stored. When the recycled plastic is destined for use in food applications, additional sorting and cleaning steps are required—until the quality is high enough.

8 → Melt

The flakes are melted. A considerable number of gases are released during the melting process and an additional step is performed to clean the plastic using filters. The resulting granules are known as re-granulate and are fit for use in new products.

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How are the recycled materials used?

HDPE

Construction sector. Approximately 75% of the recycled HDPE is used in the construction sector. Applications include drainpipes, irrigation canals, and cable gutters among others. Recycled HDPE is usually (dark) grey, limiting the possibility of creating new applications in coloured HDPE.

Various plastic applications. Crates, pallets, garbage containers, watering cans, et cetera.

New bottles and flasks. Recycled HDPE is also used for new bottles and flasks, but it is not suited for use in food applications. Nearly half of the HDPE packaging collected contained detergents; the other half milk products. HDPE is more sensitive to absorption than PET, enabling detergents to infiltrate into the material.

PET

Fibres for use in the textile and construction sectors. Fibres from recycled PET (also known as polyester fibres) are used in the textile industry as filler material in pillows, comforters and toys. The fibres are also used in the construction sector as insulation and roofing material. Finally, the fibres are used in the automotive sector for the upholstery of the interior and the wheel house.

Sheets. The recycled molten PET is poured into thin sheets, which are then placed into a mould of choice. Typical applications are plastic trays for fruit, pastry, and ready-to-eat meals, among other items.

New bottles. Approximately one-third of all recycled PET is used in new bottles. In practice, 10 to 50% of recycled material is added in the mix.

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About Plarebel

Promoting the recycling of plastics

Plarebel is a non-profit organization that promotes the recycling of plastics in Belgium. Plarebel also acts as the centre of expertise for Fost Plus with regard to the collection, sorting and recycling of household packaging waste in Belgium. The goal is to reach an efficient and maximum level of recycling of collected packaging. Plarebel collects and develops the required knowledge and expertise and conducts quality field checks.

About Wellman recycling

Pioneer in PET recycling

Since the early 1970s, Wellman Recycling has been recycling and recovering plastics from production waste and residues, among other sources. By the end of the 1980s, the company was focusing on the recycling of PET bottles and flasks. Wellman Recycling has built a strong reputation as a pioneer in this domain. Today, the recycling site in Spijk, the Netherlands, recycles 1.8 billion plastic bottles from all over Europe into high-quality resources for the plastics industry. The site employs 85 people.

More **information**

www.wellman-intl.com | www.pack4recycling.be | www.petbottleplatform.eu