# PLASTICS RECYCLING

Plastics cause serious environmental problems. Although they are not intrinsically dangerous, they take up a huge amount of space in landfills and they are made from a non-renewable resource, namely fossil fuels. For these reasons it is important that, where possible, plastics are recycled.

The recycling of plastics is carried out in a five step process.

**Step 1- Plastics collection**
This is done through roadside collections, special recycling bins and directly from industries that use a lot of plastic.

**Step 2 - Manual sorting**
At this stage nails and stones are removed, and the plastic is sorted into three types: PET, HDPE and 'other'.

**Step 3 - Chipping**
The sorted plastic is cut into small pieces ready to be melted down.

**Step 4 - Washing**
This stage removes contaminants such as paper labels, dirt and remnants of the product originally contained in the plastic.

**Step 5 - Pelleting**
The plastic is then melted down and extruded into small pellets ready for reuse.

Some recycled plastic is then used in applications similar to those for which virgin plastic is used. The remaining plastic is made into a variety of objects such as drainage mats and hard board.

## THE RECYCLING PROCESS

**Step 1 - Plastics collection**
Plastics for recycling come from two main sources: post consumer plastics and post industrial plastics. Post consumer plastics are those which have already been used by people. These are the plastics collected in plastics recycling bins and at domestic roadside collections. Post industrial plastics, on the other hand, are rejects from industry — offcuts, damaged batches etc. These plastics are collected either directly from the industry or collected by the local council, squashed into bales and sold to a recycler.

**Step 2 - Manual Sorting**
In theory, every type of plastic can be recycled. In practise in New Zealand only codes 1 (PET) and 2 (HDPE) are recycled. The incoming plastic is manually sorted into these two codes and 'other', and the three separate streams sent off to be chipped. It is particularly important that all PVC is removed from the PET stream as the more sophisticated sorting used later on cannot differentiate between these two types of plastic. Any rocks, nails, metal

**Table 1 - Summary of plastic types**

| Code | Name | Description | Examples |
|---|---|---|---|
|  **PET** | Polyethylene terephthalate | Usually clear or green, sinks in water, rigid, glossy | soft drink bottles<br>biscuit trays |
|  **HDPE** | High density polyethylene | Slightly opaque, low gloss, crackly film | milk bottles<br>supermarket bags |
|  **PVC** | Polyvinyl chloride | Semi-rigid, glossy, sinks in water | detergent bottles<br>pipes<br>raincoats |
|  **LDPE** | Low density polyethylene | Flexible, not crinkly | bread bags<br>six-pack rings<br>shrink wrap |
|  **PP** | Polypropylene | Semi-rigid, low gloss | straws<br>screw-on lids |
|  **PS** | Polystyrene | Often brittle, glossy | polystyrene foam<br>yoghurt containers |
|  **Other** | This includes a variety of copolymers such as ABS acrylonitrile butadiene polystyrene, and multi-layer plastics | — | margarine containers<br>squeezable sauce bottles |

etc. that is mixed in with the plastic is also manually removed at this stage. A summary of the plastics recycling codes is given in **Table 1**.

**Step 3 - Chipping**
Each sorted stream of plastic is then sent separately to a chipper. This is a cylinder of blades somewhat like an old-fashioned lawnmower in a vessel with a 10 mm grill floor. The blades cut the material until it is small enough to fall through the grill.

**Step 4 - Washing**
The chips are then washed to remove glue, paper labels, dirt and any remnants of the product they once contained. Both the "other" stream and the PET stream are washed at around 90$^{o}$C for at least twelve minutes, while the HDPE (which has a much lower melting point) must be washed below 40$^{o}$C to prevent discolouration.

The wash solution consists of an alkaline detergent in water, which removes dirt and grease and degrades protein. The detergent used is an alkaline, cationic detergent (i.e. an alkaline solution containing a cationic surfactant). Dishwashing detergents are usually anionic, because glass, china etc. usually build up a negative surface charge. This means that positively charged dirt particles are attracted to them, so an anionic detergent is needed to remove the dirt. If a cationic surfactant were used it not only would be incapable of removing the dirt, but it would itself stick to the surface to be cleaned, making it greasy. However, plastics aquire a positive surface charge, meaning that a cationic detergent is needed to clean them. Cationic surfactants are much less common than anionic ones, but they are used for shampoos and for fabric softeners[1]. Surfactants are explained in more detail in the article on soaps and detergents.

During washing the agitator in the wash tank acts as an abrasive, grinding off the glue of the labels and reducing any paper labels to fibres. The plastics are then separated from the glue, paper, dirt etc. in a spinning tower in which this very fine material is forced out through small holes, while the plastic itself remains inside. The plastics are then further rinsed and then (in the PET and HDPE streams) separated on the basis of weight. This is done using a water cyclone which is designed to separate out the given plastic from all the others. In the case of PET, it is heavier than all the others and so 95% of the PET falls to the bottom while the remainder of the PET and everything else rises to the top. Unfortunately, PVC is of about the same weight as PET and so cannot be separated in this step. For this reason it is very important that all the PVC was removed during manual sorting.

The product at this stage can be sold for extruding, but it is only appropriate for extruding through wide extrusion nozzles as it doesn't pack efficiently enough for narrow nozzles, hence most of it is pelleted before sale.

**Step 5 - Pelleting**
This is done by melting the chips and extruding them out first through a fine grill to remove any solid dirt or metal particles that have made it through the treatment thus far and then through a die of small holes. If the plastic was simply allowed to extrude from these holes it would come out as spaghetti-like strings and quickly tangle together. However, it is sprayed with water as it comes out (to prevent the plastic from sticking together) and cut off by rotating knives to give small, oval pellets.

[1]Most fabrics are negatively charged, so the cationic sufactant attaches to the fibres, giving them a lubricating coating that reduces friction and static.

**Uses of recycled plastic**

Recycled plastic can be used for anything that virgin plastic is used for except the packaging of food. In general, the pelletised plastic is sold by the recycling company to other companies for moulding into a wide variety of products. Some of it is used locally and the remainder is exported to Asia and the United States. PET is often made into fibres to make carpet and clothing, while the "other" stream is usually used to make a wood substitute. Two products that are made on site by New Zealand Recycling Ltd. are:

- A hardboard substitute made from HDPE. Most of the HDPE received is from milk bottles, but a small proportion is made from containers that have held strong-smelling substances such as toilet cleaners. The perfume remains in the plastic, so they are unsuitable for normal re-use. However, NZR has recently developed a board made of this plastic sandwiched between two layers of LDPE. These will be used industrially as a cheap, durable and recyclable hardboard substitute.

- FLOMAT™ is an American product which is used instead of scoria as a drainage material. The mats consist of a series of fabric pockets filled with chipped plastic from the "other" stream. Water drains down through the plastic to a drainage pipe attached to the base of the mat. So long as well-washed plastic is used (so that the mat contents do not rot) these are a very long-lasting and space efficient alternative to scoria draining behind retaining walls etc.

## ENVIRONMENTAL IMPLICATIONS

As stated above, plastic recycling prevents damage to the environment *via* excessive landfilling and use of non-renewable resources. The process is also largely environmentally safe, with the only effluent being from the washwater. This is recycled in the plant as much as possible to minimise water use and when it is finished with it is still sufficiently clean to be dumped into the sewers.

## FINANCIAL ASPECTS

Plastic recylcing is an expensive business. The process uses huge amounts of electricity, particularly during the extruding step, and the equipment used is also expensive leading to high overheads. In addition, sale prices are variable: people prefer to buy virgin plastic if it is available, thus prices fluctuate with the availability of virgin plastic.

Article written by Heather Wansbrough with assistance by David Yuen after being shown around New Zealand Recyclers Ltd. by Colin Ball and with reference to:


- Selinger, Ben; *Chemistry in the Marketplace (3rd edition)*; Harcourt Brace Jovanovich; 1986