Recycling of Plastics

Introduction

Plastics comprise a wide range of synthetic or semi-synthetic materials which use polymers as a main ingredient. Most modern plastics are derived from fossil fuel-based chemicals like natural gas or petroleum.

Many types of plastic are inherently recyclable. For example thermoplastics do not undergo chemical change in their composition when heated and thus can be moulded repeatedly. Examples include polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC). However, in practice much plastic waste is not recycled in UK, but is either incinerated or exported.

This note looks briefly at recycling of the most common types of plastic.

Common Types of Plastic

Polyethylene (PE)

The most common plastic on Earth, polyethylene can be manufactured in varying densities. Each different density of polyethylene gives the final plastic unique physical properties. As a result, polyethylene is in a wide variety of products.

Two common polyethylene densities are:

- **Low-Density Polyethylene (LDPE).** This density of polyethylene is ductile and used to make products like shopping bags, plastic bags, clear food containers and disposable packaging.
- **High-Density Polyethylene (HDPE)**. More rigid than LDPE, HDPE is used in products such as plastic bottles, pipes for water and sewers, snowboards, boats and folding chairs.

Polyethylene Terephthalate (PET)

The most common thermoplastic resin of the polyester family, PET is the fourth-most produced synthetic plastic. Polyethylene Terephthalate has excellent chemical resistance to organic materials and water and is easily recyclable. It is used in containers for food and liquid, fibres for clothing (for example Polar Fleece, Terylene), glass fibre for engineering resins, and many other products.

Polypropylene (PP)

Polypropylene is a thermoplastic polymer and the world's second-most widely produced synthetic plastic. It is widely used because polypropylene is durable, flexible, heat resistant, acid resistant, and cheap. Polypropylene sheets are used to make laboratory equipment, automotive parts, medical devices, food containers and many other products.

Polycarbonate (PC)

Polycarbonate is an engineering plastic that is tough, stable, and transparent, and stronger than glass and acrylic. Clear polycarbonate sheets are also easily worked, moulded, and thermo-formed or cold-formed. Polycarbonate plastic is in a wide variety of products including greenhouses, DVDs, sunglasses, and police riot gear.

Polystyrene (PS)

Polystyrene is a synthetic polymer made from the monomer known as styrene. Polystyrene can be solid or foamed. General-purpose polystyrene is clear, hard, and brittle. It is an inexpensive resin per unit weight, and is one of the most widely used plastics. Uses include protective packaging (such as the cases for storage of optical discs such as CDs), containers, lids, bottles, trays, tumblers, disposable cutlery, in the making of models, and as an alternative material for phonograph records.

Polyvinyl Chloride (PVC)

The third-most produced synthetic plastic polymer, PVC can be manufactured to possess rigid or flexible properties. The rigid form of PVC is commonly used in construction materials, doors, windows, bottles, non-food packaging, and more. With the addition of plasticizers such as phthalates, the softer and more flexible form of PVC is used in plumbing products, electrical cable insulation, clothing, medical tubing, and vinyl flooring.

Acrylic or Polymethyl Methacrylate (PMMA)

Well-known for its use in optical devices and products, acrylic is a transparent thermoplastic used as a lightweight, shatter-resistant alternative to glass. Acrylic is typically used in sheet form to create products such as acrylic mirrors and acrylic plexiglass. The transparent plastic can be made coloured and fluorescent, abrasion-resistant, bullet-resistant, UV-tolerant, non-glare, anti-static and many more. It has many applications.

Acrylonitrile-Butadiene-Styrene (ABS)

Created by polymerizing styrene and acrylonitrile in the presence of polybutadiene, ABS is robust, flexible, glossy, highly processable, and impact resistant. With a relatively low manufacturing cost, ABS plastic sheeting is typically used in the automotive and refrigeration industries but is also in products such as boxes, gauges, protective headgear, luggage, and children's toys.

Domestic kerb-side collection of plastics

Resin Identification Codes

Resin identification codes were introduced in 1988 in USA as an attempt to provide a consistent way of identifying the different types of plastic which might be encountered by domestic consumers. Plastics having a lower Resin Identification Code are easier to recycle, and therefore such products are more likely to be collected in kerb-side collections.

Code Number	Type of plastic	Code Text
1	Polyethylene Terephthalate	PET or PETE
2	High-Density Polyethylene	HDPE or PE-HD
3	Polyvinyl Chloride	PVC or V
4	Low-density Polyethylene	LDPE or PE-LD
5	Polypropylene	PP
6	Polystyrene	PS
7	Other (includes acrylic, nylon (PA), ABS, polycarbonate, polylactic acid (PLA)	OTHER or O

The Resin Identification Code scheme has attracted some criticism, since some consumers interpret the existence of a Resin Identification Code as a sign that the product is recyclable, and this may not be the case. An alternative set of labels is sometimes seen, focusing not on the type of plastic but on whether it is usually collected in kerb-side collections:

- Widely recycled
- Limited recycling
- Not yet recycled
- Store drop off

Plastic waste collection in London Borough of Croydon

For kerb-side collections, the instructions issued by Croydon Council are as follows:

Collected	Plastic bottles, plastic pots, tubs, trays etc
Not collected	Plastic bags, plastic film, hard plastic (toys etc), polystyrene

In practice, this means that the kerb-side collections will mainly comprise PET, HDPE and PP products. Soft plastics such as LDPE are not recycled from kerb-side collections.

Facilities also exist at the community recycling centres for the collection of a wider range of rigid plastics.

The journey from kerb-side collection to recycling involves several stages:

- bulking up of the collected waste (mixed plastic, glass and cans) at waste transfer sites in Croydon, Sutton or Kingston;
- transport to a sorting facility, where the mixed material is separated by machine and by hand, and then baled;
- transport of the baled plastic waste to specialist processors for recycling.

Recycling of plastics

In principle, most types of plastic are capable of being recycled. Whether or not a particular type of plastic is actually recycled depends on a number of factors, such as the proximity of recycling facilities and their effectiveness for the type of plastic, and the cost of the process, particularly in comparison to the cost of production of new plastic.

The traditional method of recycling plastic material involves a mechanical process. This method is currently the most widespread in the industry. The main steps in the process are typically as follows:

- The mixed plastics are sorted by colour and by type of plastic;
- The sorted materials are washed to remove impurities such as labels, dirt, particles, glue etc;
- The materials are shredded;
- The shredded materials are smashed and heated to turn them into plastic pellets, which can then be turned into new plastic products.

Alternative techniques for recycling plastics have been described, though the techniques have not yet been widely implemented:

- Pyrolysis (thermal decomposition of material at elevated temperatures in an inert atmosphere) can be used to convert mixed waste plastic into biofuel;

- Chemical depolymerisation, in which the polymers forming the waste plastic are converted into monomers, which are in effect the building blocks for new plastic materials;
- Gasification in which the waste plastic is heated with a chemical agent to produce synthetic gas, which in turn can be used to create ethanol and hence polyethylene.

Recycling rates

Figures collected by the British Plastics Federation show the approximate recycling rates achieved by the UK:

- 77% of plastic bottles
- 50% of plastic packaging
- 32% of all plastic

Recycling is currently devolved to local authorities in the UK. So local councils choose what to collect for recycling and often base their decisions on the prices at which they can sell the collected material, and what specific materials are processed by nearby recycling facilities.

Owing to the shortage of specialist facilities for plastic recycling in the UK, much plastic waste is exported. For example in 2019, 61% of plastic packaging waste was exported from the UK.

Compostable Plastic

In recent years, compostable plastic has been introduced as a possible way to reduce the environmental impact of packaging. Clearly such plastic needs to be kept separate from recycling streams, to avoid the risk of loss of integrity or shorter lifetimes in recycled products where long life is important, such as water pipes.

UK Plastics Pact

The UK Plastics Pact is an initiative by over 120 businesses, local authorities, non-governmental organisations and government. The pact includes the following targets for 2025:

- Eliminate problematic or unnecessary single-use packaging through redesign, innovation or alternative (reuse) delivery model.
- 100% of plastics packaging to be reusable, recyclable or compostable.
- 70% of plastics packaging effectively recycled or composted.
- 30% average recycled content across all plastic packaging.

Government initiatives to encourage plastics recycling

In April 2022 the Plastic Packaging Tax will be introduced on all plastic packaging materials which contain less than 30% recycled plastic. The tax rate will £200 per ton.

In August 2023 the Scottish government will introduce a deposit return scheme for all single-use drinks containers (plastic, glass and metal). The deposit has been set at 20p. The UK government has conducted consultations about a similar scheme but it is understood that deliberations continue and the scheme, if it proceeds, will not start until 2024 at the earliest.

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