Plastic waste information pack

Contents

PlasticsEurope
Association of Plastics Manufacturers

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Plastic waste information pack

Introduction

This information pack provides further detail on the use, manufacture, and sustainability of plastic bottles. It goes into more depth than is required by the UK 7-11 and 11-14 national curricula and gives context for teachers, and information for engaged and higher-level students. It is also a valuable resource for 15-16 and 17-18 year-old students.

What is plastic?

Plastic is the general common term for a wide range of synthetic or semi-synthetic materials used in a huge, and growing, range of applications.

Plastics are everywhere; in the clothes we wear, the houses we live in, and the cars we travel in. The toys we play with, the televisions we watch, the computers we use and the CDs we listen to – all contain plastics. Even items that you would not expect to find plastics in, such as shampoo and toothpaste, contain plastics!

The raw materials for plastics production are natural products such as cellulose, coal, natural gas, salt and, of course, crude oil. Plastics are incredibly versatile resources, and can be used in an environmentally responsible way if their whole life-cycle is taken into account.

The term "plastic'' is derived from the Greek word "plastikos'' meaning fit for moulding, and "plastos'' meaning moulded. It refers to the material's malleability, or plasticity during manufacture, which allows it to be cast, pressed, or extruded into a variety of shapes – such as films, fibres, plates, tubes, bottles, boxes, and much more.

There are two broad categories of plastic materials: **thermoplastics** and **thermosetting** plastics.

Thermoplastics can be heated up to form products, and then if these end products are re-heated, the plastic will soften and melt again. In contrast, thermoset plastics can be melted and formed, but once they take shape after they have solidified they stay solid and, unlike thermoplastics, cannot be remelted.

How plastic has changed the world

Plastics have changed the world, and they continue to do so.

Plastics are innovative materials. Many forms of technical progress – e.g. aviation and space flight, automobile and aircraft construction, or electrical engineering and communication technology – would be unthinkable without the targeted use of new materials. Technical progress and material development go hand in hand. In this process, polymeric materials are trailblazers for economic, ecological and social progress. Plastics can efficiently insulate buildings, they provide lightweight and safe packaging, reduce the weight of cars and make them quieter, and help us to harness the sun and wind as energy sources. Also, at the end of their useful life, plastics still have a lot to offer – they are simply too valuable to be thrown away and various different recovery pathways are available to recover their value.

FACT

PET plastic (commonly used to make bottles) can take hundreds of years to degrade in a landfill as it depends on a lot of different factors like acidity. Even as a material PET is sold with a 100+ year guarantee for geotextile use, where it is buried to strengthen the ground around big building projectslike roads!

Over the years since plastics have been used, lots have been thrown away and discarded which has in itself changed the world but for the worse. It is generally acknowledged that there is no place left on the earth where you would not be able to find plastic. Plastics and the way in which we use them; from production, through use, and at the end their disposal and hopefully recycling needs to be managed better. We need to understand the whole life cycle of plastic in order to manage it responsibly as a resource. It is unfortunate that plastic is sometimes used incorrectly or disposed of appropriately, as this can result in a range of negative effects on the environment. It should be reused or recycled wherever possible both in industry and by consumers.

What's the problem with plastic?

Plastics are durable and cheap to manufacture and as a result of this, are often seen as single-use and disposable. A lot of used plastic is sent to landfill; however, it is reported that UK landfill sites will be full by 2018.

Plastic that is thrown away can also end up in our oceans as marine litter, causing pollution and harming wildlife. This can be the result of irresponsible littering, bad waste management and consumer products, such as toothpaste and face creams that contain micro-beads of plastic. The majority of plastics that are thrown away degrade slowly and breakdown into smaller and smaller pieces called microplastics, which can have a number of harmful effects. Plastic waste should be managed responsibly to prevent such negative impacts on the environment.

The history of plastic

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The development of plastic materials started with the use of natural materials with plastic properties (e.g. natural rubber, shellac) then evolved with the development of chemically modified natural materials (e.g. vulcanised rubber, nitrocellulose, collagen) and finally the wide range of completely synthetic material that we would recognise as modern plastics, which started to be developed around 100 years ago. Perhaps the earliest example was invented by Alexander Parkes in 1855. We know it today as celluloid, but he named it Parkesine. Polyvinyl chloride (PVC) was first polymerised between 1838-1872, and a key breakthrough came in 1907 when Leo Baekeland created Bakelite, the first real synthetic, mass-produced plastic.

FACT

In the UK, we use 15 million plastic bottles EVERY day.

Use of plastics

Plastics have been around for about 100 years but they are considered to be modern when compared to traditional materials like wood, stone, metal, glass and paper. In recent decades plastics have enabled numerous technological advancements and design solutions.

The relatively low density of most plastic materials means the end products are lightweight. They also have excellent thermal and electrical insulation properties. However, some can even be made as conductors of electricity when required. They are versatile and can be moulded into complex shapes and forms, allowing them to be used for different functions. The property balances of the plastics can be changed to meet specific requirements.

Plastics are used for a variety of purposes, including:

- Packaging
- Building and construction
- Transportation
- Electrical & electronic
- Agriculture
- Medical & health
- Sport, leisure, design

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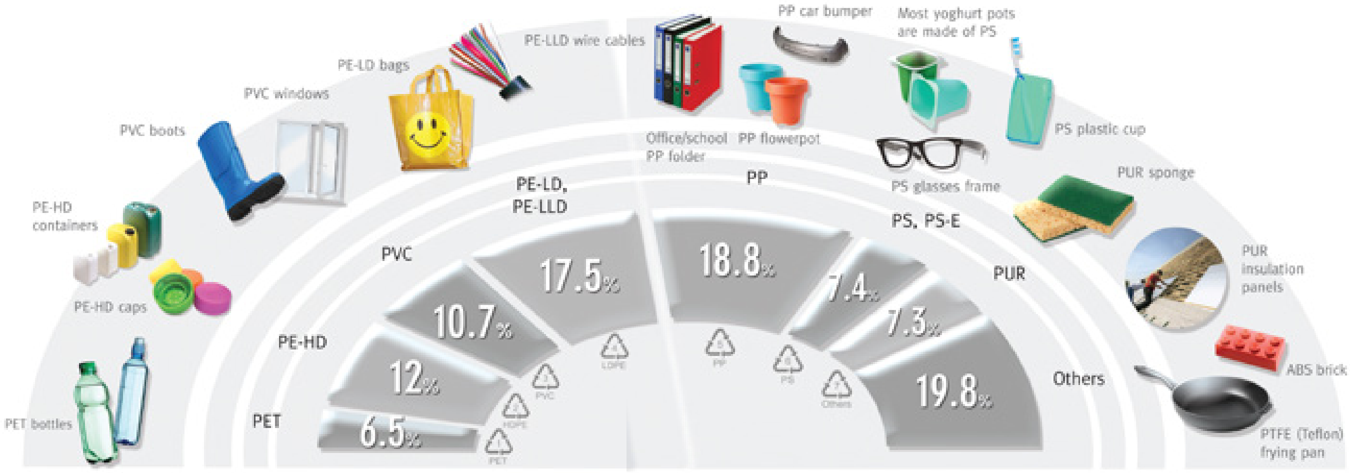
Different plastics for different needs

Plastic vs. plastic

There are various types of plastics featuring different properties. The international recycling codes (ranging from 1 to 7) featured on most plastic products are meant to make (unmixed) separation easy.



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Packaging

The commercial success of plastic as a packaging product is due to a combination of flexibility (from film to rigid applications), strength, lightness, stability, impermeability and ease of sterilisation, all of which makes it suitable as a commercial and industrial packaging material.

Plastic food packaging, for instance, does not affect the taste and quality of the foodstuff. The barrier properties of plastics ensure that food keeps its natural taste while protecting it from external contamination. Plastics are often chosen by manufacturers as their preferred material for packaging for the following reasons:

The lightest packaging material: While over 50% of all European goods are packaged in plastics, these plastics account only for 17% of all packaging weight. Furthermore, this weight has been reduced by 28% over the past 10 years. Lightweight packaging means lighter loads or fewer lorries needed to ship the same amount of products, helping to reduce transportation energy, decrease emissions and lower shipping costs. It also helps reduce the amount of waste generated.

Food conservation and preservation: Plastics packaging protects and preserves food. It helps reduce waste and the use of preservatives while maintaining the taste and nutritional value of food.

Convenience and innovation: Nowadays people want packaging with clear identification and labelling that is easy to open and use. Plastic packaging evolves to provide exactly that. In the future, it could integrate printable RFID (Radio-frequency identification) chips based on conductive polymers, providing precious information on the quality and status of products.

Safety and hygiene: Plastic packaging protects against contamination of foods and medicine and helps prevent the spreading of germs during manufacture, distribution and display.

FACT

If you laid all the bottles that Brits have recycled over the past 10 years end-to-end, they'd stretch to the moon and back 10 times!

Plastics and food contact

Plastics that are used to manufacture packaging, containers and utensils for food are known as “Food contact plastics”. Food contact plastics need to protect food against spoilage under a range of shelf life and temperature conditions, meet European packaging standards and they have to be safe for the consumer.

In order to meet the concerns that some scientists have about the impact chemicals from plastic food packaging could have on human health **Stringent EU regulations** provide general legislation that food contact materials must adhere to. This includes an overall limit on the chemicals transferring from the plastic into the food. This is known as the “migration limit.”

If there is evidence that a food contact material or even a chemical involved in the production of the material might be harmful, that material or chemical is placed on the **EU Chemicals Policy, known as REACH**. Currently there are 14 substances relevant to the plastics industry on the list and their use in food contact plastics is either banned or must pass an EU risk assessment.

Some scientists argue more monitoring needs to be done internationally to establish any potential links between food-contact chemicals and chronic conditions such as cancer, obesity, diabetes, and neurological and inflammatory disorders.

Building and construction

In 2010, the building and construction sector consumed 9.54 million tonnes of plastics (21% of the total European plastics consumption), making it the second largest plastic application after packaging.

Although plastics are not always visible in buildings, the building and construction industry uses them for a wide and growing range of applications including insulation, piping, window frames and interior design. This growth is mainly due to the features of plastics, which include:

Durability and resistance: Plastics are durable, making them ideal for applications such as window frames and pipes. In addition, plastics also have anti-corrosive properties which provide the plastic with a lifespan of over 100 years for plastic pipes and 50 years for underground and exterior cables.

Insulative properties: Plastics provide effective insulation from cold and heat, prevent leakages and allow households to save energy while also reducing noise pollution.

Cost efficiency: Plastics components often cost less than traditional materials to produce and install, even in custom-made forms.

Low maintenance: With plastics, maintenance is minimised and often unnecessary. Plastics are easy to install, operate and maintain due to their light weight flexibility, which in the case of plastic pipes allows them to cope with soil movements.

Hygiene: Plastic pipes are ideal for water transportation. Plastics also stand as a hygienic choice for household surfaces and floor coverings as they are easy to clean and impermeable.

Sustainability: Plastics save resources through cost-effective production, ease of installation and long lifespan. IIt is estimated that the amount of energy used to produce a plastics insulation product is saved after only one year of using it in a typical house. Moreover, these plastics can be reused, recycled or turned into energy.

Innovation: Over the past few decades, plastics have been used by architects to design buildings with innovative shapes, features and dimensions. Plastics also have the potential to improve energy efficiency in buildings.

Fire safety: Smoke detectors, alarms and automated fire fighting systems are mostly made of PVC, a plastic that has a higher ignition temperature than many other materials.

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Transportation

When developing transport solutions, designers need to find the right balance between high performance, competitive pricing, style, reliability, comfort, safety, strength, fuel efficiency and minimal environmental impact. Designers often choose plastic components because:

Light weight: Plastic components weigh 50% less than similar components made from other materials.

Sustainability: Using lighter plastic components means a 25-30% improvement is fuel economy compared with other materials. For every kilogram lost, a car will emit 20 kilograms less carbon dioxide over its operating life.

Safety: As well as being lightweight, plastics do not compromise fire safety.

Electrical and electronic

From simple cables and household appliances to smartphones, many of the latest devices created in the electrical and electronic sector use plastics.

Designers of electrical and electronic applications rely on plastics because of their unique features. These include:

Resource efficiency: Polymers can help store energy for longer. LCD (liquid crystal display) flatscreens consume less power than ordinary screens. Invisible resource efficiency takes place due to design flexibility of plastics parts inside household equipment such as a lye container in a washing machine that reduces water consumption.

Light weight: In small appliances like smartphones the use of plastics has increased along with the number of different polymer types being used, to make smaller and lighter headsets.

Resistance: The ability of plastics to isolate electrical currency, combined with their flexibility, durability and their resistance to mechanical shocks and stress, makes them ideal for vital applications such as safe, reliable and efficient power supplies.

Agriculture

For years plastics in agriculture has helped farmers increase crop production, improve food quality and reduce the ecological footprint of their activity. Plastics have also allowed vegetables and fruits to be grown in any season.

Innovation: Plastics enable crops to be planted in desert areas with the use of irrigation pipes and reservoirs.

Sustainability: Plastic films can keep the emissions of pesticides away from polluting the atmosphere.

Yields: Greenhouses and tunnels utilise plastic to create a more favourable environment for crops. Mulching with plastic film can help maintain humidity levels and prevent weeds from growing. This leads to higher crop yields.

Mulching: Mulching, or covering the ground with plastic film, helps maintain humidity as evaporation is reduced. It also improves thermal conditions for the plant's roots, avoids contact between the plant and the ground, and prevents weed from growing and competing for water and nutrients.

Plastic reservoirs and irrigation systems: Water can be stored in dams covered with plastic to avoid leaking and is then distributed to crops via pipes.

Silage: To store animals' grains and hay during the winter it is often wrapped in a layer of plastic.

Medical & health

Plastics are used to make a number of medical products including disposable syringes, intravenous blood bags and heart valves.

Example applications

Unblocking blood vessels: In the latest heart surgery procedures, thin tubes (catheters) are used to unblock blood vessels.

Prosthesis: Plastics are now being used in orthopaedic devices, where they align, support or correct deformities. They can even improve the function of movable parts of the body or replace a body part, taking over its main function.

Artificial corneas: Eye injuries or chronic inflammations can impair sight, and if a transplant has little chance of success, a plastic prosthesis is the only hope.

Hearing aids: People with severely impaired hearing can now have a plastics implant that brings sound back to their ears.

Plastics pill capsules These are used to release the right dosage of drugs at the correct time. The plastic pill capsule gradually breaks down, slowly releasing the active ingredients.

Sport, leisure and design

Plastics have influenced sports in recent years, from athletic tracks to sport accessories. Here are some examples of application:

Plastics in ball games: Plastics materials are used in almost all types of ball games. For instance, football has become faster and more technical than ever before. The newest ball production concept – thermal bonding, using a high-solid polyurethane layer on a seamless glued surface – results in an excellent responsivenes, a predictable trajectory, substantially reduced water uptake and maximum abrasion resistance.

Plastics in sports footwear: Plastics play an important role in today's sports shoe designs, whether the application is running, jumping or hiking. Running shoes can weigh just a few grams yet provide strength and suppleness.

The lining and tongue of hiking boots can be made from polyester fabric that has the potential to repel water and allows moisture to rapidly evaporate from the boot's exterior.

Plastics in tennis: Today, sports manufacturers use plastics to make tennis racquets that are light and strong, with excellent shock-absorbing systems.

Plastics for water sports: Plastic is extremely durable which enables it to be used in the sleek design of motor boats providing greater flexibility, superior performance and faster production speed.

Plastics and children: Manufacturers have used plastics to make toys and products for children and safety devices from bicycle helmets and flotation devices to kneecaps and other protective sporting gear.

How is plastic made?

Plastics are derived from organic products. Almost all plastics are produced from two types of fossil fuel, oil and natural gas. Other materials used in the production of plastics include cellulose, coal and salt.

The production of plastic begins with a distillation process in an oil refinery.

Crude oil is a complex mixture of thousands of compounds. To become useful, it must be processed.

The distillation process involves the separation of heavy crude oil into lighter groups called fractions. Each fraction is a mixture of hydrocarbon chains (chemical compounds made up of carbon and hydrogen), which differ in terms of the size and structure of their molecules. One of these fractions, naphtha, is crucial for the production of plastics.

A common way of producing plastics is called polymerisation, where reactor monomers like ethylene and propylene are linked together to form chains called polymers. Each polymer has its own properties, structure and size depending on the various types of basic monomers used.

How is a plastic bottle made?

1) Almost all plastics are produced from oil or natural gas, two types of fossil fuel. These contain compounds called hydrocarbons.

2) When hydrocarbons are subjected to very hot temperatures, they break down into smaller units, known as monomers.

3) To make plastics, these monomers are joined together in a long chain to form larger molecules called polymers. This can be done through one of two processes called polymerisation and polycondensation.

4) Polymerisation uses heat, high pressure and a catalyst to link together monomers into polymers. The process of polycondensation links monomers in the same way but produces water as well. Creating different combinations of monomers results in different types of plastic (e.g. a clear water bottle made from PET or a coloured shampoo bottle made from HDPE).

5) The end product – delivered to bottle manufacturers in pellet, powder, flake or liquid form – provides the basic plastic for making a plastic bottle.

6) At the bottling factory, the plastic pellets may be combined with recycled plastic pellets. 50% of plastic bottles in the UK are now recycled, and the recycled plastic can be used on its own or mixed with new plastic pellets to create new plastic bottles.

7) Next, the plastic pellets are poured into a machine that heats them to a very high temperature, so it becomes a thick liquid.

8) This is then injected into moulds, where the plastic hardens and sets into a bottle shape.

The Pod has an easy-to-understand infographic available under the Waste Week resources section. Click the image to link to it (you may need to log in to the Pod).

http://jointhepod.org/resources/resource/253

How is a plastic bottle made?

The long answer:

This section goes into more detail than the previous one, with some useful information – pay attention!

Plastic bottles(wikicommons)/CC by 2.0

Plastic water bottle (Ricardo Bernardo)/CC by 2.0

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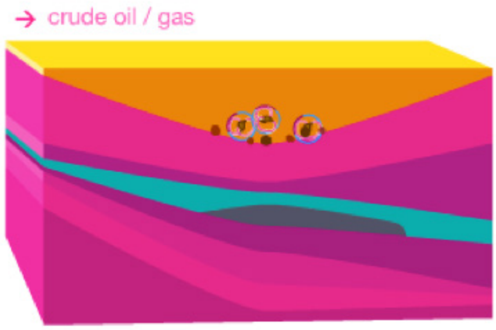
The manufacturing process:

1) Crude oil

The organic nature of plastics

Millions of years ago, the oceans which covered much of the earth's surface teemed with simple microscopic life forms called plankton. Dead plankton sank to the sea bed and were buried in layers of sediment. As the sediment became deeper and deeper, increasing temperature and pressure transformed the plankton remains into petroleum (crude oil) and natural gas (mainly methane and ethane).

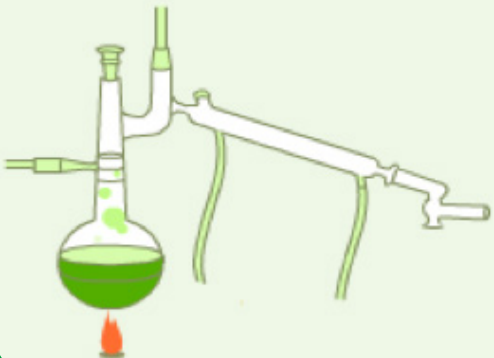


Crude oil can vary in viscosity and colour from a thin clear liquid to a dark, thick, tar-like substance.

Crude oil and natural gas consist mainly of a mixture of different hydrocarbons. Hydrocarbons are molecules composed entirely of hydrogen and carbon atoms, linked together in a wide variety of structures that include chain and ring formations.

2) Refining

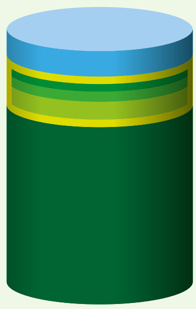
In an oil refinery, crude oil is distilled to separate it into different components called fractions. The oil is heated and converted to a gas, which enters a tall column. As the gas cools, the different fractions, which have different boiling temperatures, condense back into separate liquids. Each fraction is a mixture of hydrocarbon chains which differ in terms of the size and structure of their molecules.



Components

The plastics industry uses only 4% of the products that leave the refinery.

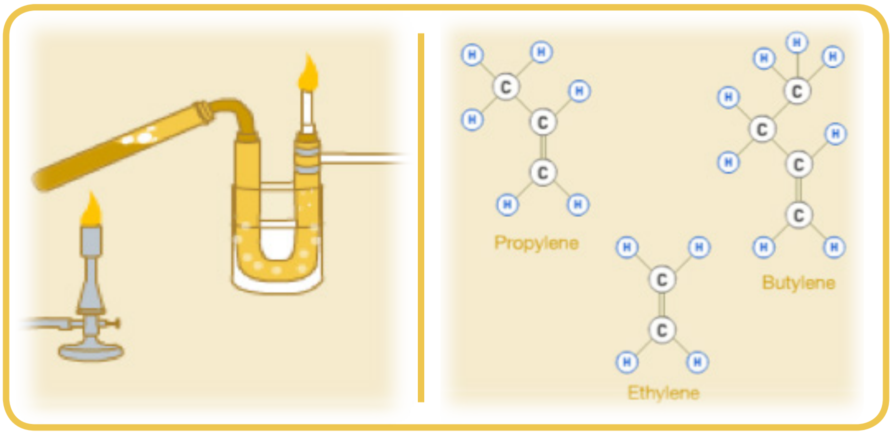
- **70%** Diesel oil and heating oil
- **20%** Naphtha *consisting of:*
  - **13%** Petrol
  - **4%** Plastics raw materials
  - **3%** Other chemical products
- **10%** Others



3) Cracking

Next, the naphtha is broken down into smaller hydrocarbon molecules, in a thermal splitting process called cracking.

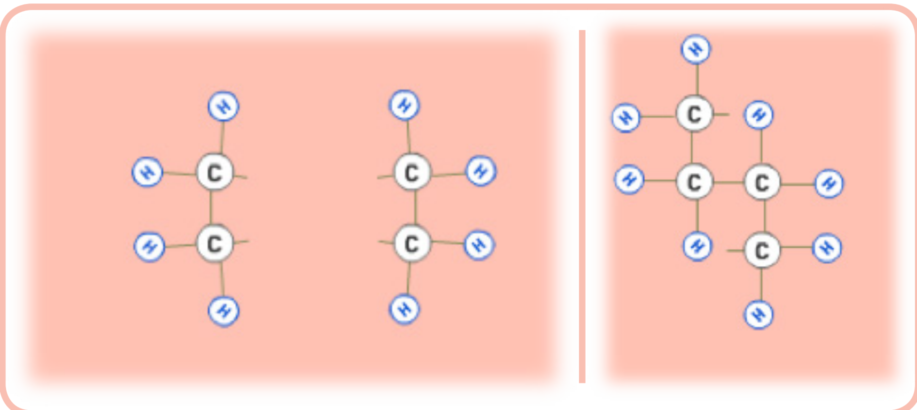
Cracking involves heating and splitting to get the basic molecules of plastics. The naphtha is broken down into smaller hydrocarbon molecules, such as ethylene, propylene and butylene.



4) Polymerisation

A game of twins

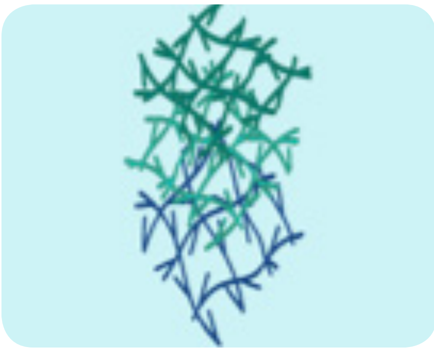
Molecules of hydrocarbons like ethylene and propylene are the basic building blocks of plastic production. In a chemical reaction called polymerisation, a large number of individual molecules are linked together to form a polymer chain.



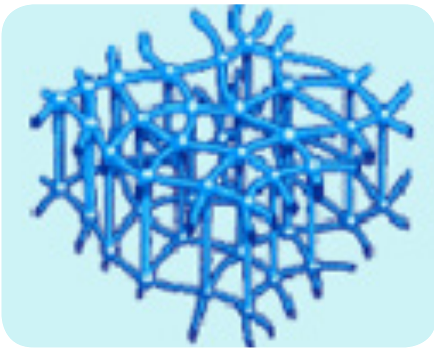
5) Thermoplastics and thermosets

How polymers can be structured

Different plastics have different polymer chain structures which determine many of their physical characteristics. There are two main polymer families: thermoplastics and thermosets.



Thermoplastics soften when heated. This is because their molecules are separate from each other and can move about easily at higher temperatures. Their structure can be linear or branched, and the polymer molecules can be of different sizes. But in all cases they can be melted and reshaped an indefinite number of times.



When thermosetting polymers are first moulded, additional chemical bonds are created between the molecules to produce a three dimensional, tightly woven network. Because of these additional chemical bonds, thermosets cannot be re-melted and changed in shape.

Once the plastic has been made, it is shaped into the final product. For thermoplastics, the conversion from granules, flakes and powders into various shapes typically involves the steps of melting, shaping, and solidifying. In the case of thermosets, liquid components are usually mixed and transferred into a mould, where they react and form a 3-dimensional, cross-linked structure.

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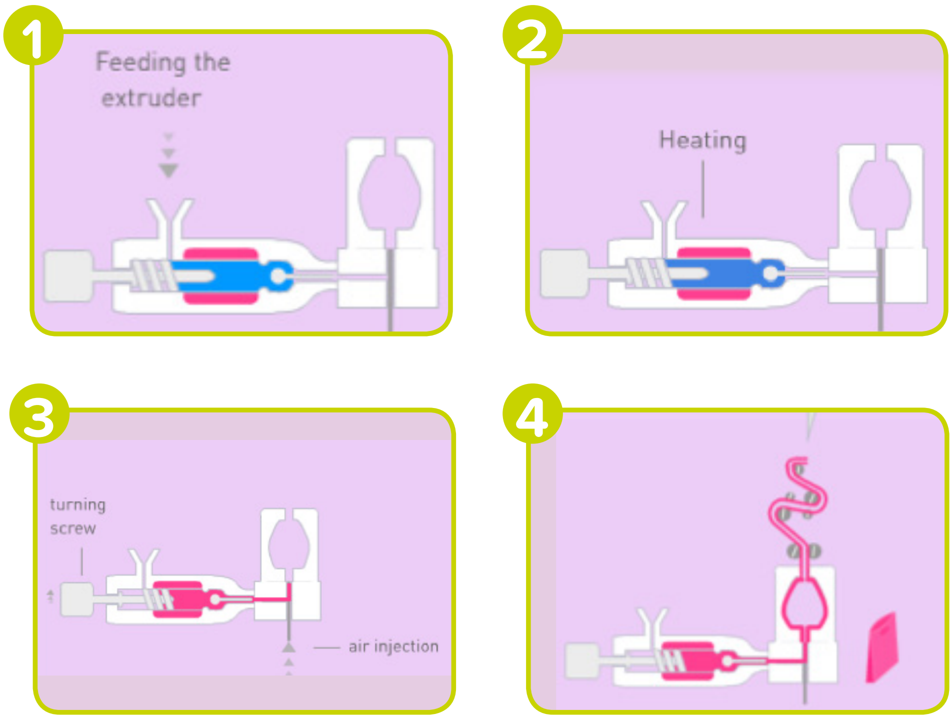
Getting into shape

Blow extrusion – making plastic bags

1 Plastic pellets are fed from a hopper into the barrel of the extruder.

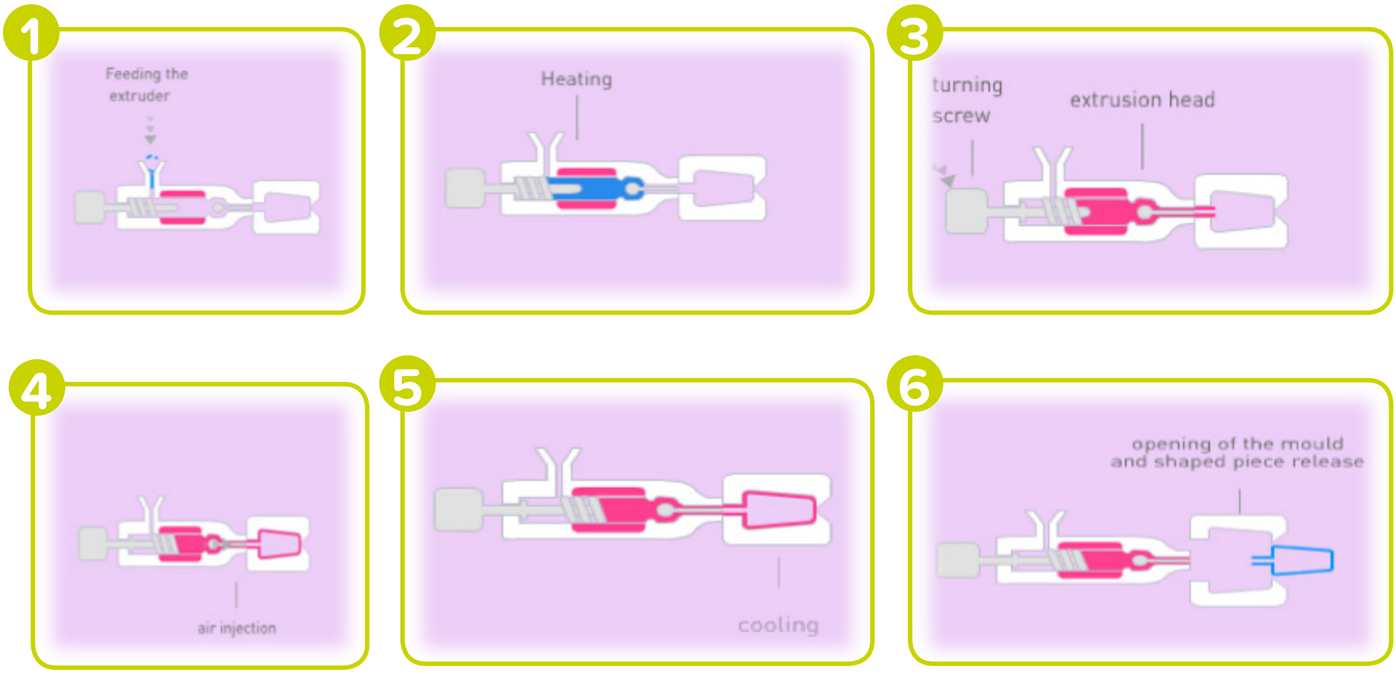
2 and 3 The pellets are gradually melted by mechanical energy generated by a turning screw and by heaters arranged along the barrel.

4 The molten extrudate is forced past a tubing mandrel, expanded into a balloon shape by a steam of air, drawn upward by rollers and pinched into a collapsed sheet to be cut into plastic bags.



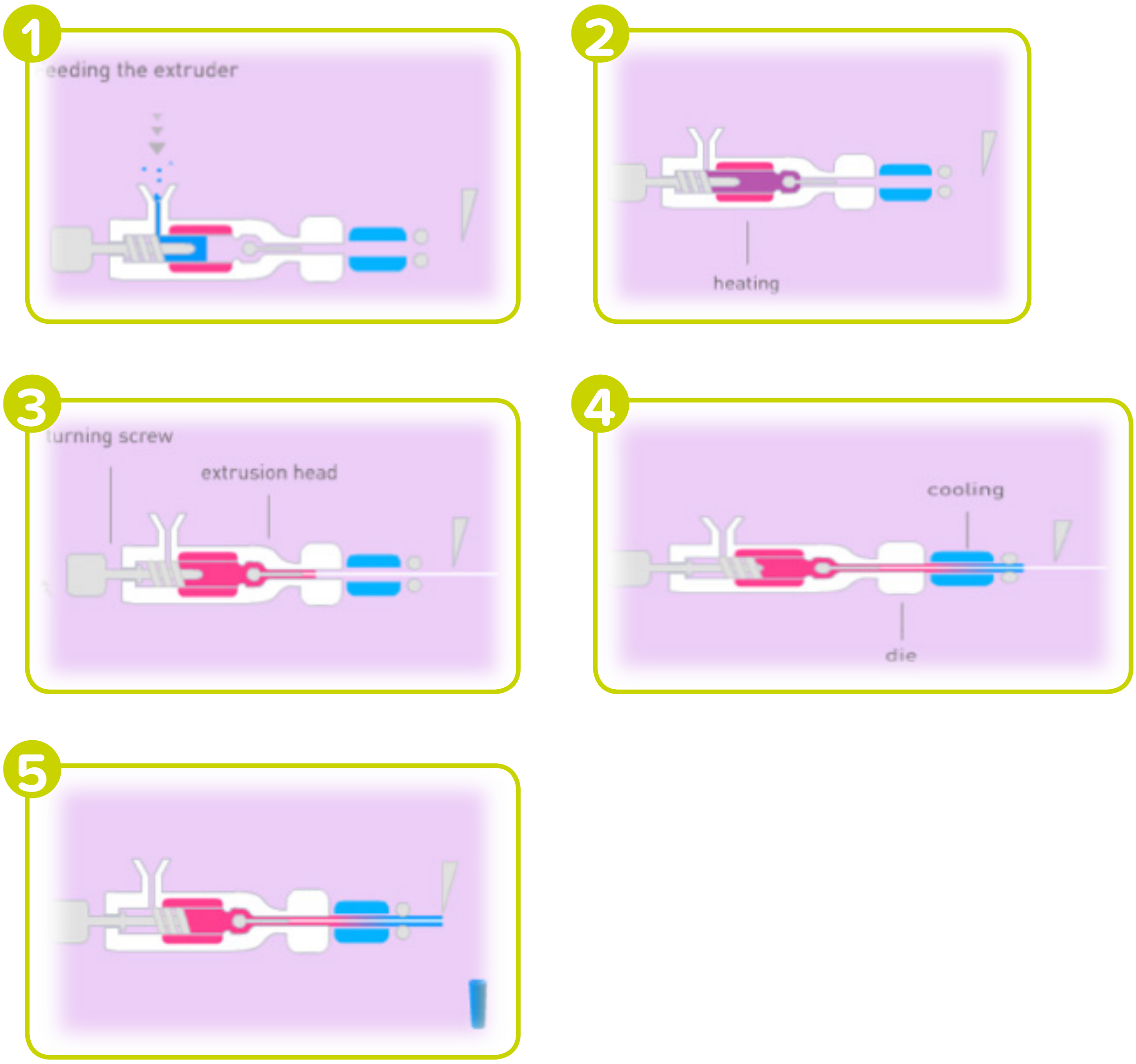
Blow moulding – making plastic bottles

For thermoplastics, the conversion from granules, flakes and powders into various shapes typically involves the steps of melting, shaping, and solidifying. In the case of thermosets, liquid components are usually mixed and transferred into a mould, where they react and form a 3-dimensional, cross-linked structure.



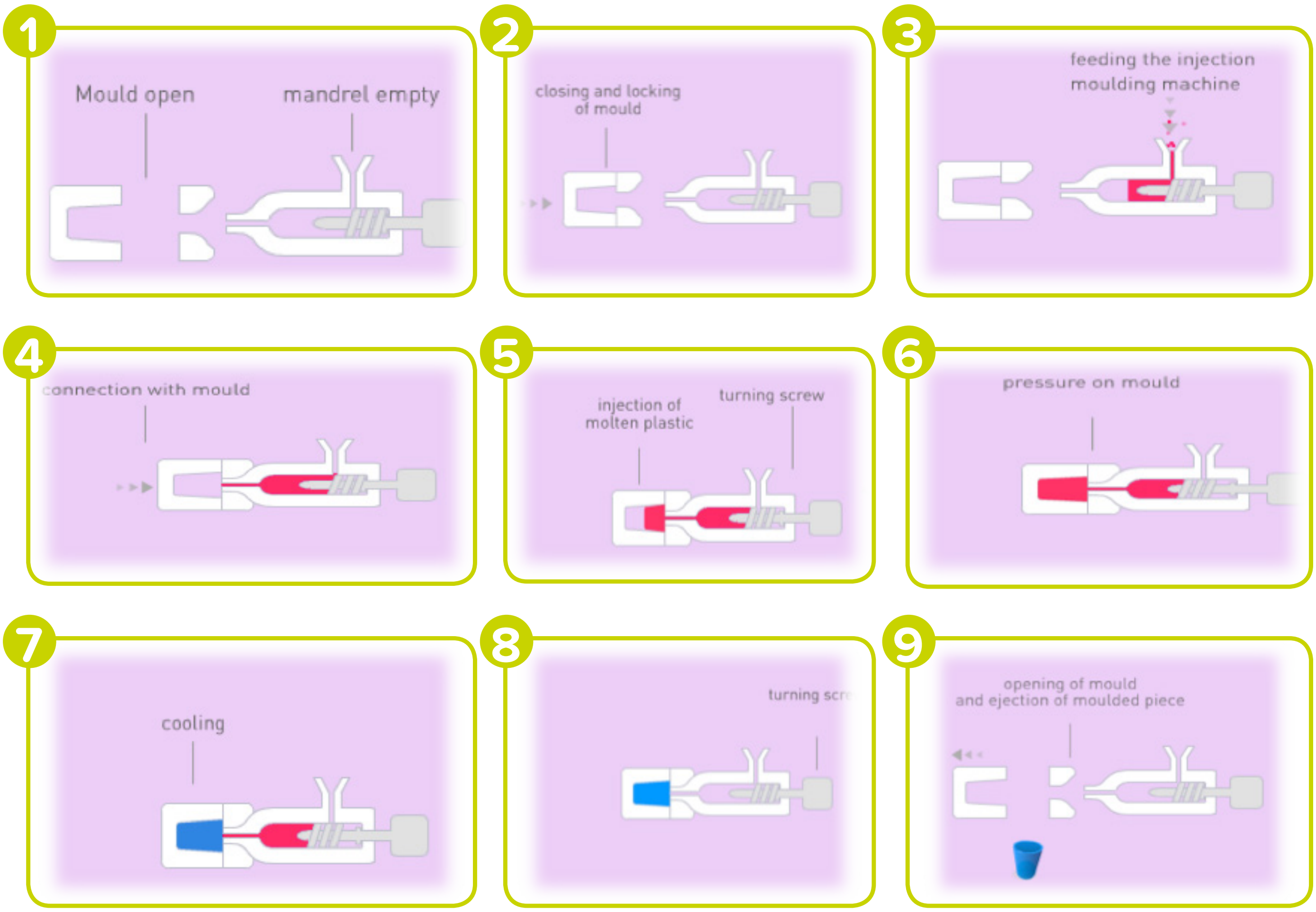
Extrusion – making plastic tubes

Plastic pellets are fed from a hopper into the barrel of the extruder. The pellets are gradually melted by mechanical energy generated by a turning screw and by heaters arranged along the barrel. The molten polymer is forced through a die which shapes the extrudate into tubes.



Injection moulding – making plastic cups

Plastic pellets are fed from a hopper into a reciprocating screw injection moulding machine. The pellets are melted by the mechanical energy exerted by a turning screw and by heaters arranged along the barrel. The screw moves forward, injecting the molten plastic into a mould. After the plastic has solidified, the mould is opened and the moulded piece ejected.



Types of plastic

Although the word “plastic” suggests just one material, there are in fact several hundred different plastic polymers.

Each one has a combination of properties that make it suitable for specific applications.

The following table illustrates the most common types of plastics used, their applications and the symbol which is often used to identify them on forms of plastic packaging.

As you can see, the vast majority of plastics used are thermoplastics. It is much more difficult to recycle thermoset plastics.

Polymer Types	Examples of applications	Properties	Symbol	Type
Polyethylene terephthalate (PET)	Fizzy drink and water bottles. Salad trays.	Clarity, strength, toughness, barrier to gas and moisture.	1 PET	Thermoplastic
High density polyethylene (HDPE)	Milk bottles. Bleach, cleaners and most shampoo bottles.	Stiffness, strength, toughness, resistance to moisture, permeability to gas.	2 HDPE	Thermoplastic
Polyvinyl chloride (PVC)	Pipes, fittings, window and door frames (rigid PVC). Thermal insulation (PVC foam) and automotive parts.	Versatility, ease of blending, strength, toughness.	3 PVC	Thermoplastic
Low density polyethylene	Carrier bags, bin liners and packaging films.	Ease of processing, strength, toughness, flexibility, ease of sealing, barrier to moisture.	4 LDPE	Thermoplastic

Polymer Types	Examples of applications	Properties	Symbol	Type
Polypropylene	Margarine tubs, microwaveable meal trays. Fibres and filaments for carpets, wall coverings and vehicle upholstery.	Versatility, clarity, easily formed.		Thermoplastic
Polystyrene	Yoghurt pots, foam hamburger boxes and egg cartons, plastic cutlery, protective packaging for electronic goods and toys. Insulating material in the building and construction industry.	Versatility, clarity, easily formed.		Thermoplastic
Epoxy resin	Paints, coatings, adhesives, molds, electrical and electronic insulation, aircraft and marine construction and repair. Is often used as the matrix in glass- or carbon-fibre materials.	Depends on combination of ingredients. Often comes in two parts, that are mixed together and 'cured'.		Thermoset
Polyeurethane	Foam cushions, vehicle suspension, electrical insulation, carpet underlay, hard plastic casings and parts, e.g. in electronics, door and window frames.	Rigid, tough, weather-resistant.		Thermoset
Unallocated references	Any other plastics that do not fall into the above categories – for example polycarbonate which is often used in glazing for the aircraft industry.	Dependent on polymers or combination of polymers		Thermoplastic, thermoset, or a mixture

Plastics and sustainability

Plastic plays a major role in delivering and sustaining the quality, comfort and safety of modern lifestyles. But meeting the needs of society is not just about "today". Meeting the needs of tomorrow is the foundation of the concept of "Sustainable Development".

Plastics are mostly made from non-renewable resources, and many take a very, very long time to break down – up to hundreds of years – therefore it is not sustainable to throw them away, send them to a landfill or discard them in the environment. Their use and disposal must be carefully and responsibly managed.

Zero plastics to landfill

At the end of their service life, plastics are still much too valuable a resource to be simply thrown away. They can be recycled back to their original forms or into a new product, and where this is not possible they can be used for energy recovery as a substitute for virgin fossil fuels. In fact, exploiting the full potential of plastics recycling and recovery options, and applying today's best practices and technologies in an eco-efficient manner, could:

- save natural resources equivalent to 25% of France's annual oil consumption
- reduce CO_2 emissions by 9 million tonnes per year in Europe.

Whilst approximately one-third of the world's countries already achieve over 80% plastics recycling and recovery, many fall way below this and in some cases do not even achieve the targets required in waste legislation.

Plastics recycling and recovery

Waste Collection

The first step of any waste management process is the "collection" process. All local authorities have different collection schemes. These schemes determine the composition of waste streams, and therefore their suitability for further pre-treatment, sorting and recovery operations. For example, some authorities collect plastic in the same bin as other materials, such as paper and food cans. This is known as "co-mingled" recycling. Other authorities collect plastic separately.

Many successful collection schemes exist in Europe. These systems aim to maximise recovery of recyclables and recover value from waste by diverting this valuable resource from landfilling.

WASTEBUSTER

FACT

50% of plastic bottles are recycled in the UK. That's good news, but it means 50% of bottles are still going to landfill.building projectslike roads!

Waste pre-treatment and sorting

There are many different types of technology used in the waste pre-treatment sorting process, including:

- manual dismantling
- shredding
- sieving
- air/liquid/magnetic separation
- highly sophisticated spectrophotometric sorting techniques (UV/Vis)

Plastics used in other products such as vehicles and electronic equipment need to go through a different process. These processes are usually designed to regain the precious metals, rather than plastics.

Mechanical recycling

"Mechanical recycling is a method which is used to recycle materials into 'new' raw materials without changing the basic structure of the material".

Clean and homogenous types of plastics

When available in large amounts, clean and homogenous types of plastic are ideal for mechanical recycling. This process involves the grinding down and sorting of used plastic directly into re-processable granules or recyclates. The chemical structures remain almost unchanged. A good example of this type of recycling are used PET bottles (such as water bottles). However, if plastics contain waste material they cannot be sustainably recycled. In this case, other recycling operations, such as feedstock recycling and energy efficiency recovery, can be used.

Feedstock recycling

Mixed and contaminated plastics

Feedstock recycling is a good option for difficult-to-recycle plastics that can't be recycled through mechanical recycling. Suitable material includes mixed waste material and low quality mixed plastics, or plastics contaminated with food, as the process allows them to be used in other applications. It involves the breaking down of plastics into their chemical components (mostly oil and gas) using heat or chemical reaction.

Energy Recovery

Energy recovery is suitable for plastic-rich waste fractions when plastics cannot be sustainably recycled. Not all plastics can be recycled as their recyclability is influenced by a number of factors such as

- The material composition of products
- The amount, cleanliness and composition of the collected waste streams
- Available technology for sorting

Combined heat and power plants:

This is the combustion of plastic waste, while simultaneously using the energy for generating electricity. Some plastic-rich waste products cannot always be recycled; for these waste products energy recovery is the most resource efficient solution when compared to landfilling or enforced recycling. Today, combined heat and power recovery plants (CHP plants) use waste plastics together with other high calorific input materials. By doing so, they provide a valuable source of heat and power which many countries estimate can account for 10% of their energy needs.

Plastic waste information pack

The Plastic Bottle Recycling Journey

In most cases, household recycling is sent to a Materials recovery facility (MRF), where it is sorted by type (e.g. glass, plastics) before it begins its journey through the recycling process.

Stages	Description
1	Infra-red technology is used to sort the mixed bottles into specific types e.g. high density polyethylene (HDPE) or polyethylene terephythalate (PET). They are then sorted by colour and packed by plastic type ready for recycling.
2	The bottles are then shredded into plastic flakes (PET) or granules (HDPE)
3	These flakes are washed to remove dirt, labels and any leftover contents before being dried
4	The flakes are melted down and processed into pellets, which can then be used for fencing, plastic bags or even more bottles. The pellets are melted down again to become a thick liquid. This is then injected into moulds, where the plastic hardens and sets into a bottle shape. And the cycle begins again...

Positive environmental impacts of recycling plastic:

- Conserves non-renewable fossil fuels
- Reduces consumption of energy
- Reduces the amount of solid waste going to landfill
- Reduces greenhouse gas emissions

Mythbuster

The myth

The chemicals in my shampoo and cleaning products mean the bottles can't be recycled.

The truth

This is untrue. More or less the only thing that is important when recycling plastic is the type of plastic you have. Whether the container had shampoo or general household cleaning chemicals in it doesn't matter, as they are thoroughly washed and cleaned in the recycling process. Plastics should be loose, clean, and dry when they're put out for recycling as this makes the sorting process easier and lessens any risks of contamination.

There are many different types of plastics; to find out what type of plastic your container is look for a small triangle (often on the base) that contains a number. This number will identify the type of plastic you have. The most common, and most commonly recycled, are type 1 (PET) and type 2 (PE-HD) although some local authorities will recycle others too (look on your local authority's website for details).

More myth busting waste and recycling facts can be found at: **www.wastebuster.co.uk/mythbuster**

Plastic and the oceans

Marine debris, especially plastics, has an impact not only the environment but the economy, human health and safety. The extent of the impact depends on the type of marine debris and where it settles in the ocean. It is not just plastic originating from marine activities that causes marine litter; there are various sources ranging from fishing nets and lines to many disposable items, such as cotton buds and straws that end up being washed into the sea via our wastewater treatment systems. Recently plastic grains or "microplastics" have been identified as an environmental hazard affecting the oceans.


Trapped (Ross Pollack)/ CC by 2.0


Plastic1 (the big good bye)/ CIC by 2.0


Nurdles. (Wikipedia)/CC by 2.0

The information in this section is from
Plastic Oceans Foundation
http://www.plasticoceans.net/

PlasticOceans

Plastic waste information pack

Annual plastic production and consumption has increased from around 50 million tonnes in 1950 to just under 300 million tonnes today, but recently the most significant growth has been in single-use disposable products. We throw away around a staggering 50% of the products we use after using them just once. Doesn't it seem strange that we so willingly throw away something that is virtually indestructible? Packaging has become the largest end-use market segment, accounting for around 40% of the total plastic usage, and not surprisingly it is the major pollutant. A newspaper article reported that according to water-filtration company Brita, Americans throw away 38 billion plastic water bottles per year.

Much of this plastic ends up in our lakes, rivers and oceans. While plastic waste only accounts for about 10% of the total amount of rubbish we generate, plastic is responsible for up to 80% of the waste that accumulates in our oceans. A survey by the Marine Conservation Society showed that 50% of the litter collected from beaches in the UK was plastic, but this only a small portion of the problem. So just how big is the problem?

Newspaper reports about the Great Pacific garbage patch give the impression of a huge floating plastic island 3 times the size of France swirling around off the coast near San Francisco. They also suggest that this floating mass measures ten metres deep. However, this is somewhat misleading as gyres are not necessarily visible from the surface of the water and measuring the true size and exact location of them is extremely difficult.

There are 5 main ocean gyres (currents that circulate the 5 oceans) and many sub-gyres within them, so the problem is not only in the North Pacific; it's global. The area we know least about is the Indian Ocean, however we do know in this regard that over a relatively short space of time the region has developed a high concentration of plastic debris. This is only likely to get worse as the population in the region continues to grow along with a more consumer-oriented economy. Also, if you were to swim in the middle of the Pacific Gyre, you would be in apparently crystal clear blue waters, or washing up on the shores of a 'plastic island'. Plastic is broken down over time into minute particles. It takes many years, but when spread over such a vast area they can be impossible to see – scientists call it 'plastic soup'. The final point is, although 45% of plastics float, they attract encrusting organisms which eventually change the density of the material, also making it sink and therefore extremely hard to track.

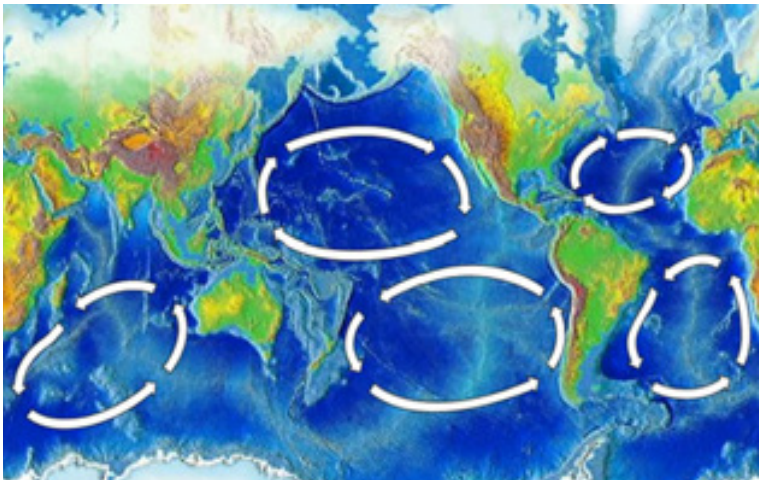


Figure 1 http://en.wikipedia.org/wiki/File:Oceanic_gyres.png

The damage that this plastic waste causes to the environment is quite well known.

There are three major impacts on marine life.

- Entanglement, which occurs when animals become trapped as a result of mistaking the plastic for food, or by accidentally swimming into it. Over 250 species have been known to have ingested or become entangled in plastic, and entanglement rates of up to 7.9% have been discovered in some species of seals and sealions.
- Ingestion, a problem that affects a number of species, with birds and marine mammals being particularly susceptible. Over 100 species of sea bird are known to have ingested plastic artefacts, with filter-feeding fish and mammals also prone to doing so.
- Transportation of invasive species when species that are not native to an area can ride on, or in floating plastic waste to new areas where they are likely to unbalance the current eco-system. The increase in marine litter has resulted in a corresponding increase in species invasion, which is becoming a widespread problem.

The suspended and surface plastic particles mingle with small marine organisms, and in the centres of the gyres they can far outnumber the plankton. In the same way that turtles consume plastic bags, mistaking them for jellyfish, fish and filter-feeders innocently swallow plastic particles, gaining no nutritional value – and effectively starving to death.

Research has also shown that plastic particles act as transport vehicles for toxins in the water. Persistent organic pollutants (POPs) that we have put into our oceans over the years, stick to the surfaces of the plastics, “hitch-hiking” their way around the ocean. These POPs, such as dichlorodiphenyltrichloroethane (DDT), enter the food chain and become concentrated as they go, ultimately ending up at the top predator level – human beings.

Microplastics

There is no single definition for microplastics, however researchers suggest that all plastic particles smaller than 1mm are considered to be microplastics.

Microplastics originate because the majority of plastics do not degrade but instead break down into smaller and smaller pieces as detailed in the “Plastic oceans” section, above. These microplastics are then free to enter the food chain where they can release any chemicals or pollutants they have been able to absorb, or collect in digestive tracts, inhibiting digestion and metabolism.

Another way microplastics are entering the environment is through their addition to products. They can be called “microbeads” and are often used in exfoliating facial scrubs, as well as for abrasion in toothpastes, and many other products. Plastic fibres from synthetic clothing also get washed into our waste water every time we do our laundry. It may not seem like much from one household, but it adds up across the world.

Microplastics also could have a number of other worrying effects, they float just below the water’s surface and therefore may affect the wavelengths of light passing through to organisms such as corals and they may even become common enough to blanket and suffocate areas of ocean, causing whole swathes of deserted habitats.

Mythbuster

Biodegradable plastic is better for the environment

The myth

All biodegradable plastics are better for the environment.

The truth

There is a difference between biodegradable and compostable plastics. Biodegradable plastics are plastics that degrade (break down) naturally, but these are not necessarily good for the environment. A lot of plastics categorised as **biodegradable** decompose into toxic or polluting materials.

Compostable plastics on the other hand are plastics that break down into safe materials, and in fact the current standards (EN13432 European Standard for commercial composting) require compostable plastics to decompose by 60-90% within 3-6 months, and that the resultant decomposed materials are indistinguishable and non-toxic.

Find out more about compostable plastics on page 42.

Further information can be found on the WRAP website **www.wrap.org.uk**

More mythbusting waste and recycling facts can be found at: **www.wastebuster.co.uk/mythbuster**

Environmental impacts of Marine Debris

Environmental impacts are wide ranging and can be both direct and indirect. Direct impacts occur when marine life is physically harmed by marine debris through ingestion or entanglement (e.g., a turtle mistakes a plastic bag for food) or marine debris physically alters a sensitive ecosystem (e.g., a fishing net is dragged along the ocean floor by strong ocean currents and breaks and smothers a coral reef). Environmental impacts can also be indirect, such as when a marine debris cleanup results in ecological changes.

Direct Environmental Impacts

Ingestion

Seabirds, sea turtles, fish, and marine mammals often ingest marine debris that they mistake for food. Ingesting marine debris can seriously harm marine life. For example, whales and sea turtles often mistake plastic bags for squid, and birds often mistake plastic pellets for fish eggs. Moreover, a study of 38 green turtles found that 61 percent had ingested some form of marine debris including plastic bags, cloth, and rope or string (Bugoni et al., 2001).

At other times, animals accidentally eat the marine debris while feeding on natural food. Ingestion can lead to starvation or malnutrition when the marine debris collects in the animal's stomach causing the animal to feel full. Starvation also occurs when ingested marine debris in the animal's system prevents vital nutrients from being absorbed. Internal injuries and infections may also result from ingestion. Some marine debris, especially some plastics, contain toxic substances that can cause death or reproductive failure in fish, shellfish, or any marine life. In fact, some plastic particles have even been determined to contain certain chemicals up to one million times the amount found in the water alone (Moore, C., 2002).

Entanglement

Marine life can become entangled in marine debris causing serious injury or death. Entanglement can lead to suffocation, starvation, drowning, increased vulnerability to predators, or other injury. Marine debris can constrict an entangled animal's movement which results in exhaustion or development of an infection from deep wounds caused by tightening material. For example, volunteers participating in the 2008 International Coastal Cleanup event discovered 443 animals and birds entangled or trapped by marine debris (2008 ICC Report, Ocean Conservancy).

Ecosystem Alteration

The direct impacts of marine debris are not limited to mobile animals. Plants, other immobile living organisms, and sensitive ecosystems can all be harmed by marine debris. Coral reefs can be damaged by derelict fishing gear that breaks or suffocates coral. Plants can be smothered by plastic bags and fishing nets. The ocean floor ecosystems can be damaged and altered by the movement of an abandoned vessel or other marine debris.

Indirect Environmental Impacts

Ecosystem Alteration

Efforts to remove marine debris can harm ecosystems. Mechanical beach raking uses a tractor or other mechanical device to remove marine debris from beaches and marine shorelines and can adversely impact shoreline habitats. This removal technique can be harmful to aquatic vegetation, nesting birds, sea turtles, and other types of aquatic life. Beach raking also can contribute to beach erosion and disturbance of natural vegetation when the raking is conducted too close to a dune.

Invasive Species

Marine debris can contribute to the transfer and movement of invasive species. Floating marine debris can carry invasive species from one location to another. Invasive species use the marine debris as a type of "raft" to move from one body of water to another. In a study performed by the British Antarctic Survey in 2002, it was estimated that man-made debris found in the oceans has approximately doubled the number of different species found in the subtropics (Barnes, D.K., 2002).

*Source: http://water.epa.gov/type/oceb/marinedebris/md_impacts.cfm

Mythbuster

The myth

Plastic just disappears when it gets thrown in the sea because it breaks down in the sun.

The truth

The most common types of plastic are made from fossil fuels and the main way in which they break down is due to photo-degradation. This cannot be confused with decomposition where a material or substance is broken down into completely different substances; photo-degradation in the case of plastics just leaves smaller and smaller pieces of plastic. The mechanical breakdown caused by the waves also adds to the amount of small pieces of plastic.

Although there is no true definition, researchers suggest that all plastic particles smaller than 1mm are considered to be microplastics. Along with the products of photo-degradation and mechanical breakdown, microbeads of plastic are used in many cosmetic products, causing microplastics to become more common and a greater concern.

Microplastics are free to enter the food chain, where they can release any chemicals or pollutants they have been able to absorb, or collect in digestive tracks inhibiting digestion and metabolism.

Further information can be found on the PlasticsEurope website **http://www.plasticseurope.org/**

More mythbusting waste and recycling facts can be found at:
www.wastebuster.co.uk/mythbuster

Social and Economic Impact

Around half of the world's population live close to the sea, a figure that is suggested to rise to three quarters by 2025, and approximately 60% of the population gets the majority of its protein from the sea. This means as well as environmental impacts, plastic waste pollution also has a considerable economic impact.

Tourism

Marine debris can have a negative effect on the aesthetics of the shoreline causing a lack of tourism for that area.

Industry

Marine debris greatly affects commercial fisheries. The high cost of replacing fishing gear and vessels, as well as loss of days at sea for fishing, can cause small fisheries to go out of business.

CC by 2.0 ; Paradise and Trash.(Fabi Fliervoet)/CC by 2.0

Recyclables (Wikimedia commons)

Did you know?

- The waste on the coastline is not always locally produced. In 1989, 29,000 bath toys were lost at sea in the Pacific Ocean; 15 years and 17,000 miles later these toys began arriving on beaches in the UK.[1]
- In 2010, in the Cinque Terre region of Italy, 2 million plastic bottles were left behind by tourists – this region later banned plastic bottles completely.[1]
- Plastic pollution alone could be costing developing and industrialised nations up to $1.27 billion annually as it threatens fishing, shipping and tourism (McIlgorm, et al. 2008).[1]
- Plastic pollution has been described as being highly detrimental to large marine mammals, described as posing the “single greatest threat” to them.[2]
- It has been estimated that over 400,000 marine mammals perish annually due to plastic pollution in oceans.[3]
- In 2004, it was estimated that seagulls in the North Sea had an average of thirty pieces of plastic in their stomachs.[4]
- Americans use some 14 billion plastic shopping bags, an average of 425 bags per person per year.[5]
- ....recycling 1 ton of PETE (one of the most common materials used to package soft drinks and mineral water) saves us: 800 kg of petrol, the amount of power used by 2 people in 1 year and the amount of water used by 1 person in 2 months.[5]

1 http://water.epa.gov/type/oceb/marinedebris/md_impacts.cfm
2 Karleskint, George; (et al.) (2009).Introduction to Marine Biology. Cengage Learning. p. 536. ISBN 0495561975
3 Daniel D. Chiras (2004). Environmental Science: Creating a Sustainable Future. Jones & Bartlett Learning. pp. 517-518. ISBN 0763735698
4 Hill, Marquita K. (1997). Understanding Environmental Pollution. Cambridge University Press. p. 257. ISBN 1139486403
5 UNEP

UNEP sources:

www.ace.mmu.ac.uk/
www.napcor.com
www.letri.com
www.ecoinicijativa.com

Plastic waste information pack

The effect of plastic waste on the MARINE environment

Environmental

- **Indirect:** Ingestion, entanglement, Ecosystem alteration
- **Direct:** Ecosystem alteration, invasive species

Economic

- **Tourism:** Dirty beaches scare people away from visiting
- **Fishing:** damages ships and fishing equipment

Social

- **Microplastics:** smaller particles can enter the food chain
- **Health:** the long-term effects of micro-plastic ingestion are unknown. Studies into the marine animal called the "Lugworm" indicate a negative

Mythbuster

Compostable plastics

The myth

Compostable plastics are better for the environment than recyclable plastics

The truth

There are many new “compostable” products emerging onto the market. These meet the EN13432 European Standard for commercial composting. There is a difference, however, between what is commercially compostable and what is likely to compost in the average person’s back garden bin. Most commercially compostable products are made from PLA. PLA is a plant-based plastic, which is generally derived from cornstarch. Growing this crop also has other issues attached to it, such as the use of herbicides and pesticides, and the fact that it uses a lot of land – which can result in the destruction of natural habitats and environmental problems such as landslides. PLA can eventually degrade in a garden compost bin, but can take a very long time. These new “compostable” products can easily be confused with ordinary recyclables, but if they’re put in that waste stream they can contaminate it. There have been many discussions in the industry recently about how these new compostable products increase the risk of contaminating traditional recycling streams, and how to educate the public about these issues.

Further information can be found on the WRAP website **www.wrap.org.uk**

More mythbusting waste and recycling facts can be found at:
www.wastebuster.co.uk/mythbuster

Plastic facts:

- Recycling 1 plastic bottle would save enough energy to power a 60-watt light bulb for 3 hours. Recycling guide **(http://recycling-guide.org.uk/facts.html**)
- 275,000 tonnes of plastic are used each year in the UK; that's about 15 million bottles per day. Recycling guide (**http://recycling-guide.org.uk/facts.html**)
- Most families throw away about 40kg of plastic per year that could otherwise be recycled. Recycling guide (**http://recycling-guide.org.uk/facts.html**)
- There are approximately 46,000 pieces of plastic floating in each square mile of the world's ocean. UNEP (**http://www.unep.org/regionalseas/marinelitter/publications/docs/plastic_ocean_report.pdf**)
- Studies on 600 fulmar bodies that had washed up on beaches revealed 95% had plastic litter in their stomachs, with an average of 40 pieces per bird. Save the North Sea project (**http://www.kimointernational.org/Save-the-North-Sea.aspx**)
- 50 billion drinks bottles were recycled in the UK between 2003 and 2013. WRAP (**http://www.wrap.org.uk/content/weve-come-long-way-recycle-week-celebrates-10th-anniversary**)
- European plastic production accounts for 20.4% of the world's total production. Plastics Europe (**http://www.plasticseurope.org/Document/plastics-the-facts-2013.aspx?Page=DOCUMENT&FolID=2**)
- More than 1 million birds and 100,000 marine mammals die each year from becoming entangled in or ingesting marine litter. Local Authorities International Environmental Organisation (**http://www.kimointernational.org/MarineLitter.aspx**)
- Over 220 million tons of plastic are produced each year. UNESCO (**http://www.unesco.org/new/en/natural-sciences/ioc-oceans/priority-areas/rio-20-ocean/blueprint-for-the-future-we-want/marine-pollution/facts-and-figures-on-marine-pollution/**)
- PET plastic (commonly used to make bottles) can take hundreds of years to degrade in a landfill as it depends on a lot of different factors like acidity. Even as a material PET is sold with a 100+ year guarantee for geotextile use, where it is buried to strengthen the ground around big building projects like roads! PlasticsEurope (**http://www.plasticseurope.org**)

Plastic waste information pack

Glossary

- **Cracking:** the process of breaking down long-chain hydrocarbons into smaller, more useful molecules; usually using high temperature and pressure, and a catalyst.
- **Crude oil:** raw material extracted from under the ground by drilling and other processes. Composed of the remains of plants and animals buried for millions of years.
- **Feedstock:** the basic material from which finished products are made.
- **Hydrocarbon:** a substance made from hydrogen and carbon atoms, e.g. methane gas, octane fuel.
- **Microplastic:** plastics that have been broken down into very small particles. Can be ingested by animals and find their way into the food chain.
- **Naphtha:** a flammable mixture of hydrocarbons produced in the refining of crude oil.
- **Plastic:** a substance made from long-chain hydrocarbons. Versatile in their use, plastics generally take a long time to break down and their use must be carefully managed.
- **Polymer:** technical term for plastics. Polymers are made from long chains of monomers – simpler molecules that are joined together.
- **Refinery:** an industrial facility for separating crude oil into its different components, and processing them into useful materials.
- **Sustainability:** ensuring that the world's ecosystems remain diverse and productive. Human activity can influence the sustainability of natural systems, disrupting them and causing irreversible harm.
- **Thermoplastic:** a polymer that can be remoulded when heated. Easier to recycle than thermosets.
- **Thermoset:** a polymer that does not soften when heated. Harder to recycle than thermoplastics.