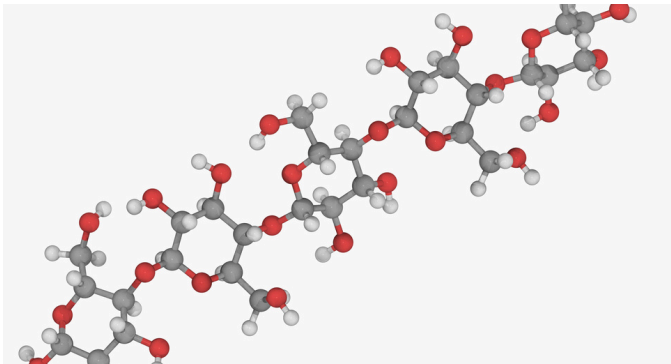


What are Plastics?

What are Plastics?

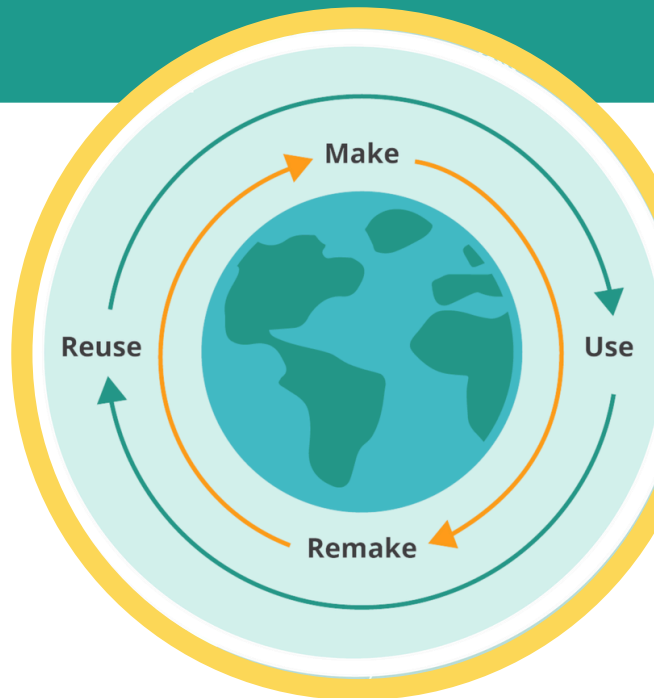
Synthetic or man-made plastics are light-weight, tough, flexible and durable materials created from fossil fuels. Most plastics are made from synthetic polymers – long chains of molecules made by bonding a series of smaller units called monomers, where monomers can be one, two or three atoms (Perkins, 2017).



Example of a polymer composed of the repeating smaller units (monomers)

Polymers occur in nature, such as cellulose which makes up the cell walls of plants or our DNA structure. Plastics today are mostly man-made, created from carbon atoms in fossil fuels. Using carbon atoms from fossil fuels allows for long chains of polymerization which makes plastics very durable as a product (Brown, 2021).

Plastics are designed to be tough and are hard to break down. Another strength of plastic is that it does not react chemically with most substances, therefore it doesn't decay when used for different applications. For this reason, it is important to keep plastics out of the environment (Freudenrich, 2021).





History of Plastics

The first synthetic polymer was invented in 1869 by John Wesley Hyatt in New York, by treating cellulose derived from cotton fiber to create a plastic that could be crafted into a variety of shapes. Hyatt was inspired by an offer of \$10,000 put forward by a firm in New York asking for anyone to provide a substitute for ivory, as its over consumption had put a strain on the natural supply. Hyatt's synthetic polymer from cotton could be shaped into natural substances such as tortoiseshell, horn, linen and ivory (Science History Institute, 2021).

In 1907 Leo Baekeland invented Bakelite, which is the first fully synthetic plastics as it contained no molecules found in nature. The need for inventing Bakelite came from the rapidly growing electricity industry as the United States was going through electrification. The industry was looking for a substitute for shellac (purified lac, which is a natural resin secreted by the lac insect (Britannica, 2013)) which was used as a natural electrical insulator. Bakelite served to be an excellent insulator, was durable, heat resistant and unlike celluloid, was feasible for mass production (Science History Institute, 2021). "Hyatt's and Baekeland's successes led major chemical companies to invest in the research and development of new polymers, and new plastics soon joined celluloid and Bakelite. While Hyatt and Baekeland had been searching for materials with specific properties, the new research programs sought new plastics for their own sake and worried about finding uses for them later" (Science History Institute, 2021).



Did you know?

Bakelite was used as a synthetic plastic for early home phones like this one!

Life Cycle of Plastics

The life cycle of plastic can be categorized into three main stages – the extraction of raw materials, the production of plastic products from raw materials, the consumption of plastic products and end of life post-use.



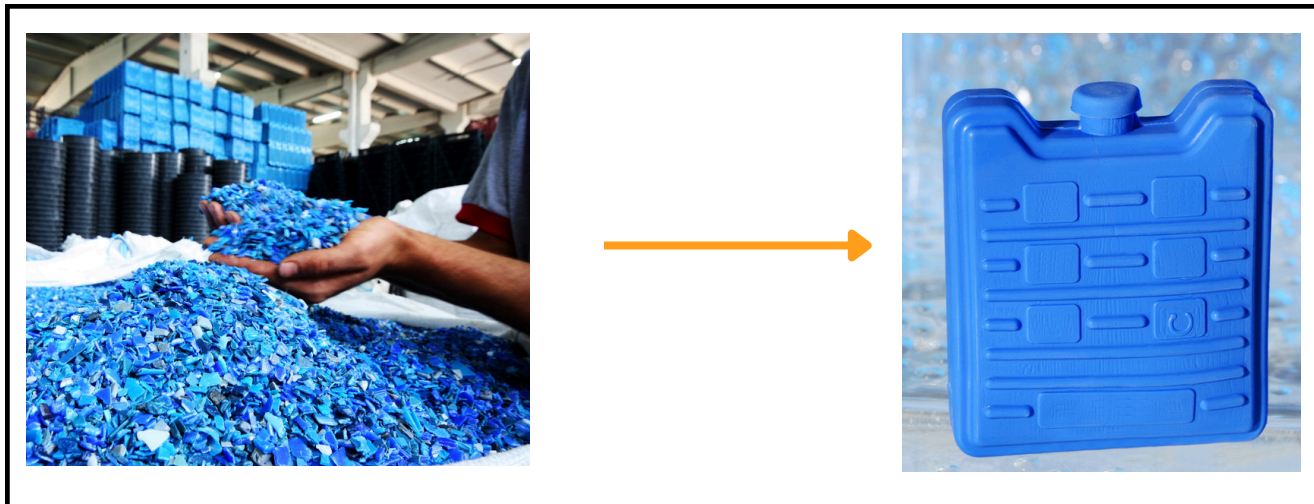
Extraction of Raw Materials

As plastics are made from synthetic polymers derived from fossil fuels, the life cycle of plastics starts at the extraction of fossil fuels. Therefore, the production of plastics is directly linked to the fossil fuel industry and as such, the life cycle assessment of plastic should consider the environmental impacts associated with the extraction of fossil fuels. About 99% of the feedstock to produce plastic comes from fossil fuels, and this accounts for roughly 8-9% of global oil and gas consumption (D. Nielsen, Hasselbalch, Holmberg, & Stripple, 2019).



Production of Plastic

From the raw fossil fuels extracted, such as natural gas and oil, they are then refined into ethane and propane to prepare for creating plastic. Ethane and propane are then treated with high heat to be converted into monomers such as ethylene and propylene. These monomers are then combined with catalysts to create polymers. The polymers then go through further processes to create plastic tubes, which are then cut into small plastic pellets. Plastic pellets are then shipped to various plastic factories to be melted and molded into various products, such as water bottles, food packaging, and so on. (Plastics Industry Association, 2021).



Example of blue plastic pellets being molded into an ice pack.

Watch this video for additional information on the life cycle of plastics:

 <https://www.youtube.com/watch?v=6xINyWPpB8> (4:06 minutes)

Consumption and End of Life

Once the plastic products are created and distributed for various end-use, they enter the consumer markets. According to Our World in Data, the production of plastic increased nearly 230-fold (figure below) in 2019 compared to 1907, when the first synthetic plastic – Bakelite – was produced (Ritchie & Roser, 2018).

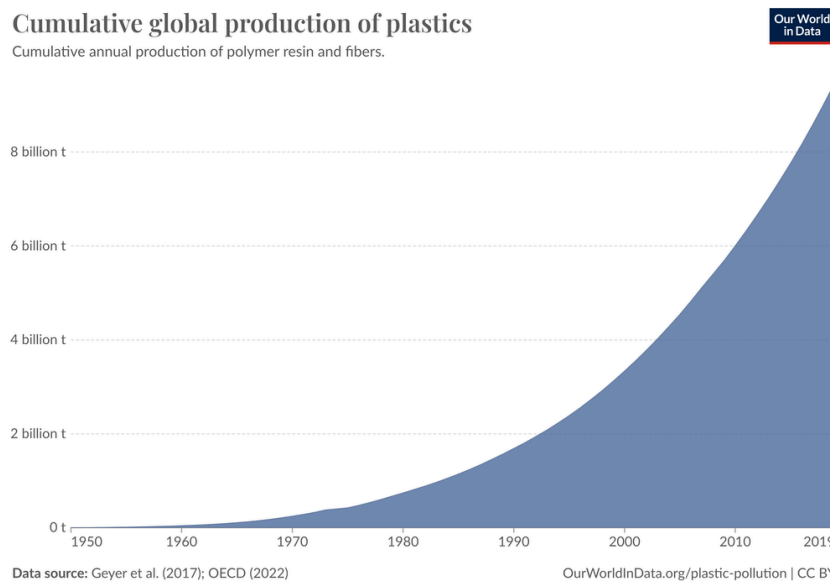


Figure 1. Cumulative global plastic production. Source: (Ritchie & Roser, 2024).

It is estimated that the annual global production of plastic is approximately 380 million tons, out of which about 40% - 50% is single-use plastic. Single-use plastics are utilized for one-time use after which they are discarded (Plastic Oceans, 2021).

In contrast to the enormous amount of plastic consumption, **less than 9% of all plastic gets recycled globally** (Plastic Oceans, 2021; National Geographic Society, 2019). The rest of the plastic either ends up in landfills or unfortunately, mismanaged and left in the environment, causing harm at unprecedented rates.

Here are some additional resources on circular economy:

- <https://debrisfreeoceans.org/the-life-cycle-of-plastics>
- <https://science.howstuffworks.com/plastic.htm>
- <https://angelwater.com/blog/life-cycle-plastic-water-bottle/>
- <https://plasticpollutionblogsite.wordpress.com/2016/09/21/the-life-cycle-of-a-plastic-product-part-2-reworking-the-cycle/>
- <https://www.nationalgeographic.org/article/whopping-91-percent-plastic-isnt-recycled/>
- <https://plasticactioncentre.ca/directory/plastic-by-the-numbers/>

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