PLASTICS

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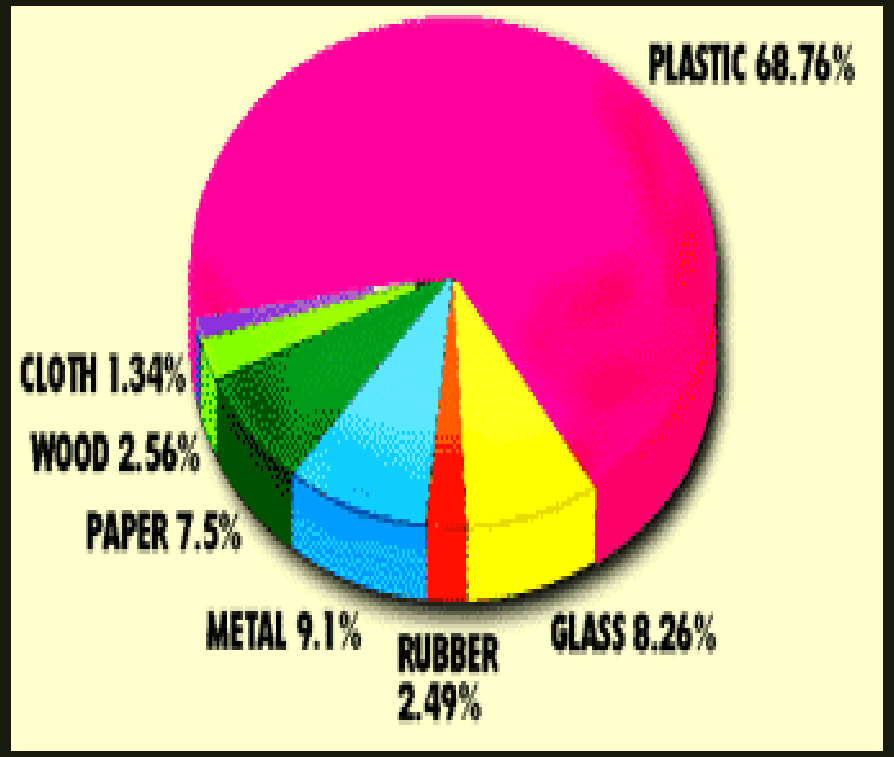
INTRODUCTION

PLASTICS, the biggest invention by mankind of the 21st century has become the most important ingredient of the lives of the people. The dependence of man on plastic is increasing with the passing time. But as we know nothing in this world is for free, this comfort has come at the cost of our **ENVIRONMENT**.

As pointed by the supreme court on April 3, 2013,

"We are sitting on a plastic time bomb''.



As most plastics are durable and degrade very slowly (the very chemical bonds that make them so durable tend to make them resistant to most natural processes of degradation). Plastics do not degrade in landfill and its pollution can unfavorably affect lands, waterways and oceans.
Living organisms, particularly marine animals, can also be affected through entanglement, direct ingestion of plastic waste, or through exposure to chemicals within plastics that cause interruptions in biological functions. Not much work has been done in the field of biodegradable plastics so need of the hour is to solve this problem.

Recycling of plastics is one such solution. Recycling of plastics not only saves money and energy used for making plastics from raw material but also reduces air and water pollution.

To further look at this issue we need to understand what exactly plastics are , their types and RESIN identification codes are.

RESIN IDENTIFICATION CODE

- The American Section of the International Association for Testing Materials (ASTM) **International Resin Identification Coding System** is a set of symbols appearing on plastic products that identify the plastic resin out of which the product is made.

PLASTIC RESIN CODES :-

1–POLYETHYLENE TEREPHTHALATE (PET, PETE OR POLYESTER)

Common Uses: Bottled water, carbonated beverages, medicine jars, peanut butter jars, salad dressing bottles, and mouth wash bottles

Health Concerns

- Though considered safe by the FDA, It contains **antimony.** In lab test on animals, long-term inhalation of antimony caused stomach pain, ulcers, diarrhea, pneumoconiosis (lung disease) and altered electrocardiograms (the heart's electrical activity).
- It is intended for **single use applications** i.e. repeated use increases the risk of leaching and bacterial growth. PET plastic is **difficult to decontaminate** and its proper cleaning requires harmful chemicals. Polyethylene terephthalates may leach **carcinogens.**

Products made of #1 (PET) plastic should be recycled but not reused.

- PET plastic is recyclable and about 25% of PET bottles in the US today are recycled. The plastic is crushed and then shredded into small flakes which are then reprocessed to make new PET bottles or spun into polyester fiber. This recycled fiber is used to make textiles such as fleece garments, carpets, stuffing for pillows and life jackets, and similar products.

2–HIGH-DENSITY POLYETHYLENE (HDPE)

Common Uses: Milk jugs, motor oil bottles, soap bottles, bleaches and detergent bottles, and shampoos and conditioner bottles.

Health Concerns

This type of plastic is BPA and phthalate-free, and doesn’t contain any other known harmful chemicals. HDPE is the most commonly recycled plastic and is considered one of the safest forms of plastic.

Products made of HDPE are reusable and recyclable.

- It is a relatively simple and cost-effective process to recycle HDPE plastic for secondary use.
- HDPE plastic is very hard-wearing and does not break down under exposure to sunlight or extremes of heating or freezing. For this reason, HDPE is used to make picnic tables, plastic lumber, waste bins, park benches, bed liners for trucks and other products which require durability and weather-resistance.

3 – POLYVINYL CHLORIDE (PVC).

Common Uses: Fruit juice bottles, clear food packaging, shower curtains, deli and meat wrap, plumbing parts, other beverage bottles (usually not bottled water).

Health Concerns

- The production of PVC requires harmful chemicals such as vinyl chloride monomer, ethylene dichloride and chlorine. The Center for Health, Environment & Justice refers to PVC as “The Poison Plastic”. The FDA considers PVC safe, even though it contains vinyl chloride, which is a known human carcinogen. In addition, the use of PVC is environmentally unfriendly, as it may emit phthalates, lead additives and toxic glues into homes and the environment. One study showed that PVC in shower curtains released phthalates which could cause damage to the liver and reproductive system.

Products made using PVC plastic are not recyclable. While some PCV products can be repurposed, PVC products should not be reused for applications with food or for children's use.

4–TYPE OF PLASTIC: LOW-DENSITY POLYETHYLENE (LDPE)

Common Uses: Frozen food packaging, squeezable bottles, garbage bags, plastic grocery bags, and the coating on milk cartons.

Health Concerns

No known health concerns

Products made using LDPE plastic are reusable, but not always recyclable.

LDPE is considered less toxic than other plastics, and relatively safe for use. When recycled, LDPE plastic is used for plastic lumber, landscaping boards, garbage can liners and floor tiles. Products made using recycled LDPE are not as hard or rigid as those made using recycled HDPE plastic.

5–TYPE OF PLASTIC: POLYPROPYLENE (PP)

Common Uses: Yogurt containers, baby bottles, microwaveable plastic containers, and plastic cups.

Health Concerns

- No known health concerns, however, it is advised to not warm up plastic containers in the microwave, because it is unknown whether this is a safe practice.

#5 plastic is today becoming more accepted by recyclers. PP is considered safe for reuse. To recycle products made from PP, check with your local curbside program to see if they are now accepting this material.

- Polypropylene plastic is tough and lightweight, and has excellent heat-resistance qualities. It serves as a barrier against moisture, grease and chemicals.
- Polypropylene is recyclable through some curbside recycling programs, but only about 3% of PP products are currently being recycled in the US. Recycled PP is used to make landscaping border stripping, battery cases, brooms, bins and trays.

POLYSTYRENE (PS)

Common Uses: Styrofoam, take-out containers, dairy containers, plastic cutlery, egg cartons, aspirin bottles, and meat trays.

Health Concerns

- The Foundation for Achievements in Science and Education show that small quantities of styrene found in polystyrene can have carcinogenic effects, fatigue, low platelet and hemoglobin values, and chromosomal and lymphatic abnormalities. There is evidence that exposure to styrene causes cancer in animals. Another study showed that women who were exposed to low concentrations of styrene vapors demonstrated menstrual disorders, metabolic disturbances during pregnancy and neurotoxic symptoms.

- Recycling is not widely available for polystyrene products. Most curbside collection services will not accept polystyrene, which is why this material accounts for about 35% of US landfill material. While the technology for recycling polystyrene is available, the market for recycling is small. Awareness among consumers has grown, however, and polystyrene is being reused more often. While it is difficult to find a recycler for PS, some businesses like Mailboxes Etc. which provide shipping services are happy to receive foam packing chips for reuse. Polystyrene should be avoided where possible.

- Polystyrene is an inexpensive, lightweight and easily-formed plastic with a wide variety of uses.
- Because polystyrene is structurally weak and ultra-lightweight, it breaks up easily and is dispersed readily throughout the natural environment.

- Beaches all over the world have bits of polystyrene lapping at the shores, and an untold number of marine species have ingested this plastic with immeasurable consequences to their health.

- Polystyrene may leach styrene, a possible human carcinogen, into food products (especially when heated in a microwave).

EVERYTHING ELSE

Common Uses: Some baby bottles, electrical wiring, 5-gallon water cooler bottles, and to-go coffee mugs.

Health concerns

- You cannot distinguish what type of plastic is being used, since it's a catch-all for the rest of the plastics. Plastics may or may not contain BPA, which is known to leach into food products, and is an endocrine disruptor.

- #7 plastics are not for reuse, unless they have the PLA compostable coding. When possible it is best to avoid #7 plastics, especially for children's food.

- The #7 category was designed as a catch-all for polycarbonate (PC) and “other” plastics, so reuse and recycling protocols are not standardized within this category. Of primary concern with #7 plastics, however, is the potential for chemical leaching into food or drink products packaged in polycarbonate containers made using BPA (Bisphenol A). BPA is a xenoestrogen, a known endocrine disruptor.

- A new generation of compostable plastics, made from bio-based polymers like corn starch, is being developed to replace polycarbonates. These are also included in category #7, which can be confusing to the consumer. These compostable plastics have the initials “PLA” on the bottom near the recycling symbol. Some may also say “Compostable.”

Types of Plastics You're Using
(And which ones you shouldn't)

Safest Choice Use with Caution Avoid

‘IGNORANCE IS A BLISS’

- **When not recognized as a valuable resource, plastic is often mistreated, with significant impacts:**

- Roughly **33%** of plastic is for single use, and then thrown away.
- Approximately **85%** of total global plastic used is not recycled.
- Plastic has the potential to stay in the environment for **hundreds of years**.
- Plastic **negatively impacts over 700 species** of animals and birds.

- Plastic pollution is a global problem with long-lasting environmental impact.

- To avoid plastic pollution, and plastic waste, plastic items need to be reimagined at the end of their useful life -- that is, treated as a **resource to be captured and used, instead of a waste to be disposed.**

DEFUSING THE PLASTIC TIME BOMB

Methods to utilize plastic waste

Plastic Recycling

- Separating the plastic products from the garbage and at home and handling over this plastic for recycling can reduce the impact of **environmental pollution due to plastic waste**. **Plastic recycling** industry is now a billion dollar industry in developed economies.
- **Recycled plastic** is usually used for laying down roads in place of bitumen, bottles, benches etc. Buying recycled plastic also helps with plastic management.
- The results indicates that the production of **1 kg of flakes of recycled PET requires a total amount of gross energy that is in the range of between 42 and 55 MJ**, depending on whether the process wastes (mainly coming from sorting and reprocessing activities) were sent or not to the energy recovery. **The same quantity of virgin PET requires more than 77 MJ**. The energetic (and then environmental) saving is so remarkable, **even for PE, being 40–49 MJ for the recycled polymer and about 80 MJ that for the virgin polyolefin**. The calculations were made with the reasonable assumption that the final utilization can use the virgin or the recycled polymer without any difference.

Using Incinerators

- Plastic waste is being burned in incinerator centers located outside the city limits in developed economies and this practice is now being followed by developing economies as well. This technique eliminates huge volumes of plastic material but there are some concerns related with air pollution due to such burning but efforts are being made to improve technology to reduce such air pollution in future.

Prohibition on manufacturing/ selling of certain plastic material/bags

- Some governments in the developed and developing countries has prohibited the manufacture and selling of plastic bags or material that contains more than the standard prescribed microns of plastic. By this way, the excessive dependence on plastic has been controlled to some extent.

Using paper bags

- It is suggested to use paper bags and bags made with cloth material such as jute, cotton etcetera while going for shopping or for purchasing grocery items. In this way, we as individuals can rely less on the plastic bags while going on a shopping spree.

Implementing the best civic practices

- As the citizens of a community or country the **best tip for proper disposal of plastic** is follow the below mentioned practices:
  - ***Using garbage bins/dust bins*** *at public places for disposing of the plastic water bottles, food containers and other plastic material.*
  - ***Avoid throwing plastic garbage*** *in open spaces, public places, water channels, rivers, sea beaches and other fragile natural resources or environment.*
  - ***Follow the government regulations*** *relating to plastic management and help the government agencies in dealing with plastic waste.*
  - ***Create awareness among the people*** *about safe practices of plastic waste management and run a campaign if possible with the help of other agencies who are involved in* ***plastic waste management programs****.*

HOW PLASTICS ARE MADE

- **Significant amounts of fossil fuels are required** to make plastics, both as a raw material and as energy for manufacture. **About 4 percent of the world's annual oil production is used for as raw material and another 3-4 percent for manufacture.**

A NEW APPROACH TO DEALING WITH THE MENACE – THE REAL EXPERIENCE

Winter Project
(December-2016)
At NPL, Delhi

- Six students and three teachers did a project under Dr. S. K. Dhawan in his laboratory at NPL.
- We got exposure to the process of Recycling of plastics and how plastic which is considered a pure waste can be recycled and then reused.
- We got the opportunity to see the technique of converting Plastic waste into tiles invented in NPL and have also obtained patent for this technology.

PROCESS OF PLASTIC RECYCLING

Recycling Process involves following steps:

1. Segregation
2. Shredding
3. Extrusion
4. Compression moulding

SEGREGATION

- As discussed earlier **International Resin Identification Coding System** is a set of symbols appearing on plastic products that identify the plastic resin out of which the product is made.
- These codes are used to segregate different types of plastics from one another.
- This process is called **SEGREGATION** and is an important step in the subsequent recycling steps.

SHREDDING

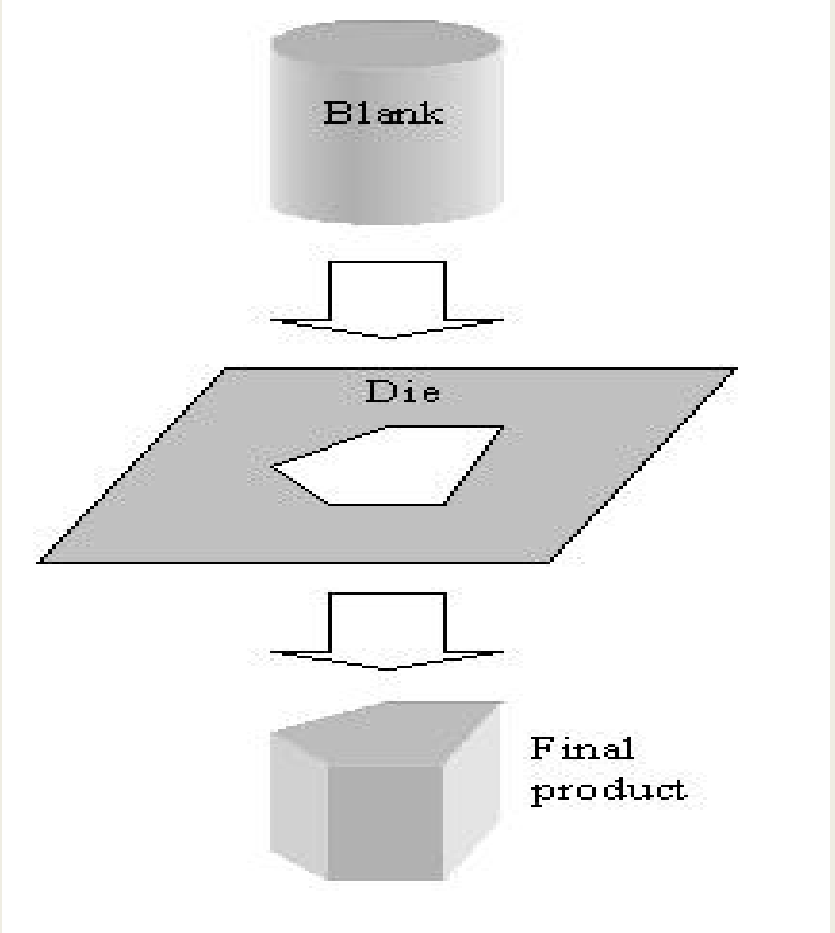
- For plastic to be converted into subsequent forms initially **SHREDDING** is done.
  It crushes the plastic into small pieces and make it easy to convert big bottles, bags into small pieces so that it can be used further.
  The main requirement of the shredder is that different kinds of plastic materials are required to be segregated first in accordance with the **RESIN CODE** inscribed on them. Only similar grade plastic could be used at a time for shredding i.e. materials made with low density polythene should be segregated and then used. Randomly mixing different type of plastic and then shredding won't lead us to the desirable output.

SHREDDER

SHREDDED PLASTIC

EXTRUSION

Extrusion is a process used to create objects of a fixed cross-sectional profile.
Shredded plastic is pushed through a die of the desired cross-section.



This process starts by feeding **shredded plastic** material from a hopper into the barrel of the extruder(sometimes even fillers are added).

The plastic is gradually melted by the mechanical energy generated by turning screws and by heaters arranged along the barrel which converts it into molten form and mixes all the pieces with the help of heater (temperature approximately being 180 degree Celsius).

The **molten polymer** is then forced into a **die**, which shapes the polymer into various shapes depending on the shape of the die (in this case pipe like shape)

Now this **pipe** like shape of molten plastic is cooled by making it pass through water as shown in the figure which **hardens because of cooling process due to water** and results in continuous solid pipe like plastic wires**.**

CUTTING

These solid pipe like plastic are then passed through a **cutter** which cut them to give small pieces , now the resulting pieces are **homogeneous** in **composition** and could further be used as a starting material for further steps.

INJECTION MOULDING

These pieces are then again **melted** and passed through a machine where it is **molded** into the **desirable product.** For making grids injection molding is used. The type of molding used depends upon the type of plastic as if the plastic is highly compressible then compression molding is used.

Compression molding is a forming process in which a plastic material is placed directly into a **heated metal mold**, then is softened by the heat, and forced to conform to the **shape of the mold** as the mold closes. Materials are usually preheated before molding.

After all of these steps i.e. SEGREGATION, SHREDDING. CUTTING and INJECTION MOLDING we can get tiles of various **colors** and the tiles made are of different **sizes** and **shapes** and is a blend of colors. They can be further used for making **pavements**, **housing partitions**, etc.

The advantage of using plastic tiles is that plastics as, we know, have a large shelf life. Moreover, it is **not affected by heat, water, moisture, etc. only fire safety needs to be taken into account** as plastic crimples when it comes in contact with fire. This can be reduced by adding certain fillers that reduced the burned length/min. the laboratory has successfully made washrooms having plastic tiles. Similarly, pavements can also be made out of them.

The advantage of this innovation is the utilization of waste plastic bags and bottles in the form of tiles which can be used for designing the structure for making a smart toilet or any other structure for societal usage. One of such waterless toilet structures made at CSIR-NPL is shown in the figure above.

CONCLUSION

- Every problem has a solution and every problem if seen in a logical and pragmatic manner then it can change the dynamics of the situation altogether.
- Our root problem is that plastics take millions of years to degrade and the rate at which we are generating it immensely hazardous.
- We cannot get rid of the huge levels of plastic at present our planet has by burning it as it gives rise to another issue of Air pollution and Global warming.
- So the best option that we have at present is to first limit our use of plastics and at the same time utilizing the presently available plastic judiciously by converting them into materials of use after recycling it or using it again as plastic after Recycling virgin plastic.
- The plastic which at present was a bane to our society will thus become boon by making various useful material from it , this way plastic which was earlier perceived as a burden on our society would become a material which could be recycled ,reused and useful materials could be extracted from it .
- This way we could curb the ongoing generation of plastics utilize presently available plastics by recycling and in the meanwhile finding alternative to plastics altogether.

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