

# Case Study on Plastic Pollution – Reuse, Reduce and Recycling Process and Methods

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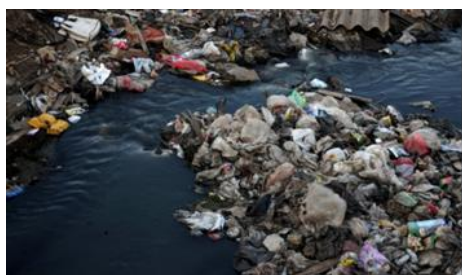
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**Abstract** - The problem of plastic pollution is increasing day to day. Research has shown that the use of plastic has increased quite rapidly in the last two Decades. The use of plastic has increased a lot with the changing life style, easy to use and economical. The increasing demand of plastic has also invited a number of companies to make plastic products rapidly. Plastic is a non- bio degradable material, it remains in its form for many years in soil as well as in water, this accumulation of plastic products in the atmosphere causes pollution known as Plastic pollution. Plastic pollution causes ill effects on human as well as on animal life. The plastic pollution is a very serious problem facing by the world in many areas, related with the soil, water or air. The toxicity of the plastic is very serious and to stop the spread, first of all it needs creating awareness in the society, working on effective and economical plastic waste management system and renewable process.

**Keywords:** Plastic pollution, Plastic recycling, waste, Recycle

## I. INTRODUCTION

Disposal of plastic and its production is equally serious. Many types of fossil fuels like oil and petroleum etc. are used in the manufacture of plastics. This fossil fuel is a non-renewable resource and it is also very difficult to obtain. Marine life: worst affected by plastic pollution. Plastic pollution is also spread by people who go for picnics and campaign, it all reaches rivers and seas. This creates a serious crisis for aquatic creatures these plastics are eaten by aquatic animal as their food. A serious crisis arises over the health of turtles and other sea creatures. Every year many marine organisms lose their lives due to the problem of plastic pollution and study claim that this number is going to increase further in the coming times. Plastic pollution: a danger to humans and animals.



The plastic scattered in the litter or in Municipal waste is also eaten by the street animals as food. Many times, these animals eat a lot of plastic which is trapped in their stomachs, that leads to their death. Plastic waste gets worse as time goes on.



When plastic waste reaches landfills or water sources, it becomes a serious problem, like wood and paper, we cannot eliminate it even by combustion. As it produces many harmful gases, which are harmful to the Earth's atmosphere and life. Because of this plastic spread three types of pollution air, Water and land. No matter how much we try, but we cannot stop the use of plastic products completely.

### There are two types of plastic-

1. *Thermoplastic*- It is a plastic made by linear molecules of chain that turns into various forms when heated (on heating becomes soft vice versa on cooling becomes hard). Types of thermoplastic are –

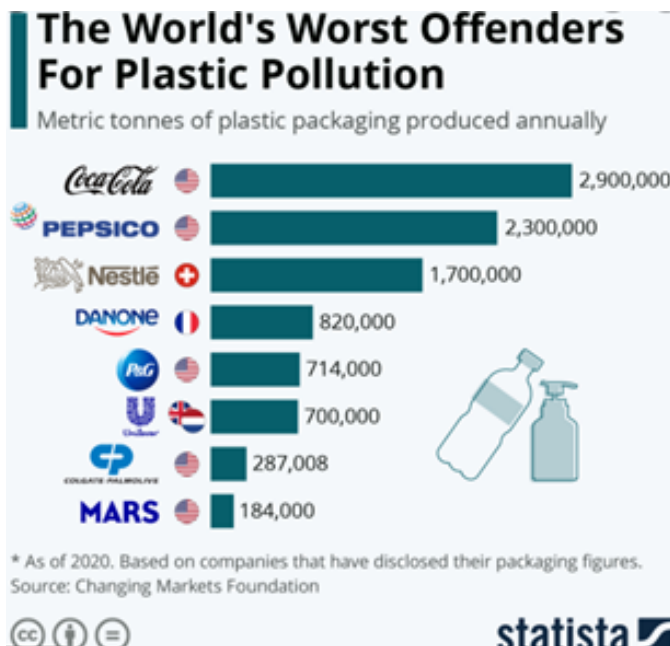
- a) Crystalline thermoplastic – examples PP, LDPE, HDPE
- b) Amorphous thermoplastic – example PVC, PMMA, PC, PS, ABS
- c) Semi-crystalline – example PBT, PAI

2. *Thermosetting* - This is the plastic that is set to heat and refers as irreversible polymerization, this type of polymer is cured by heating or chemical reactions and then they become insoluble & infusible. like urea, formaldehyde, poly urethane.

**The plastic groups depending on the usage**

1. Low density -- They are used as covering material, carry bags are used as low-density plastics to lift low loads. Low density polyethylene (L. D. P. E.), High density polyethylene (H. D. P. E.), Poly vinyl chloroid (P. V. C.), Poly-propylene (P. P.), Poly styrene are all thermoplastic. They are re-cycled and used
2. High density -- Use high-density plastics for overloaded and beautiful bags or containers.

Plastic is formed by multiplication and condensation reaction. Multiplication is the action in which many molecules of the same substance or many molecules of different matter form polymers. The polymer's molecule is a multiplier of the molecule of substances. Generally this process represents unquenchable matter, condensation is the action in which two or more molecules of the same or different matter form polymers together. Water as well, Ammonia etc. form subgenre materials. Different materials form different types of plastics depending on their uses.



Recycling of plastic polymers requires excessive processing. The solubility in plastics is very low due to the high molecular weight of their large polymer chains. A large molecule (Macromolecule) establishes contact with the environment near you along its entire length. The thermal capacitance of plastic mixture is higher than that of an organic molecule of the same structure. Only heat is not enough to melt such a large molecule, plastic structure and often needs to be uniformly mixed. When plastics of different varieties

are melted together, they are phased out like oil and water. Structural weakness is found in the substance obtained as a result of phase limits, means that polymer mixtures are useful only in limited applications. Another barrier to recycling is colours in plastic, filler and other chemicals. Filers are usually difficult to remove at low cost due to the sticky nature of the polymer and they will be damaged by many processes that can easily remove excess colour.



**Recycling Process**

Basic step in recycling of the plastic waste is segregation / separation / sorting according to their resin identification code, according to colours, depending on the fillers. The segregated plastic waste to recycle are then cut into small pieces known as shredding. After this, these cut pieces go through many processes to eliminate impurities like paper, labels, sand, etc. This material is melted and converted in form of pellets to be used as raw material in industries for making different items of plastic, after which they are used in the manufacture of other usable plastic products and articles.

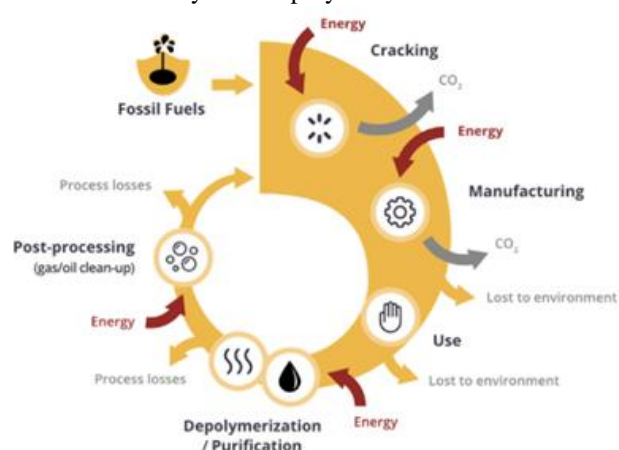


The method of categorizing polymer varieties, was founded in 1988 by the Plastic Industry Association (Society of the Plastics Industry).

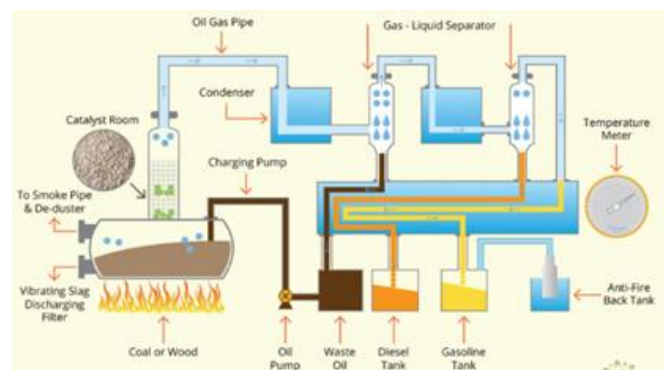
Recycling number	Image	Alternate image #1	Alternate image #2	Abbreviation	Polymer name	Uses	Recycling
1				PETE or PET	Polyethylene terephthalate	Polyester fibres (Polar Fleece), thermoformed sheet, strapping, soft drink bottles, tote bags, furniture, carpet, paneling and (occasionally) new containers. (See also: <a href="#">Recycling of PET bottles.</a> )	Picked up through most curbside recycling programs.
2				HDPE or PE-HD	High-density polyethylene	Bottles, grocery bags, milk jugs, recycling bins, agricultural pipe, base cups, car stops, playground equipment, and plastic lumber	Picked up through most curbside recycling programs, although some allow only those containers with necks.
3				PVC or V	Polyvinyl chloride	Pipe, window profile, siding, fencing, flooring, shower curtains, lawn chairs, non-food bottles, and children's toys.	740,000 tonnes in 2018 through Vinyl 2010 and VinylPlus initiatives. <sup>[6]</sup>
4				LDPE or PE-LD	Low-density polyethylene, Linear low-density polyethylene	Plastic bags, six pack rings, various containers, dispensing bottles, wash bottles, tubing, and various molded laboratory equipment	LDPE is not often recycled through curbside programs, but some communities will accept it. Plastic shopping and clothes dry cleaning bags can be returned to many stores for recycling.
5				PP	Polypropylene	Auto parts, industrial fibres, food containers, and dishware	Number 5 plastics can be recycled through some curbside programs.
6				PS	Polystyrene	Desk accessories, cafeteria trays, plastic utensils, coffee cup lids, toys, video cassettes and cases, clamshell containers, packaging peanuts, and insulation board and other expanded polystyrene products (e.g., Styrofoam)	Number 6 plastics can be recycled through some curbside programs.
7				OTHER or O	Other plastics, such as acrylic, nylon, polycarbonate, and polyactic acid (a bioplastic also known as PLA), and multilayer combinations of different plastics	Bottles, plastic lumber applications, headlight lenses, and safety shields/glasses.	Number 7 plastics have traditionally not been recycled, though some curbside programs now take them.

**Methods used in recycling of plastic**

1. *Monomer Recycling Process* – also known as *Chemical Recycling* – the process involves condensing the polymer in the plastic waste, so that it can undergo reverse polymerization. In simpler words *decomposition of polymer into smaller molecules or monomers*. Many challenges can be solved by the use of a more elaborate monomer recycling process. The condensation polymer essentially undergoes the inversion of the polymerization process that forms it. This gives a mixture of chemicals from which the original polymer was made, which can be purified and used to connect a similar variety of new polymer chains.



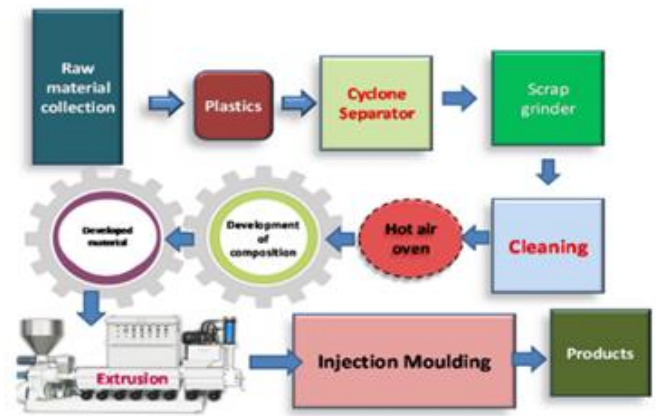
2. *Thermal Depolarization* -- A process in which the conversion of various polymers into petroleum is done by a less accurate thermal depolymerization process. Such a process is capable of accepting almost any type of polymer or mixture of polymers, which includes thermostat substances such as *vulcanized rubber tires* and biopolymers found in feathers and other agricultural waste products (biomass). Just like natural petroleum, Polymers can also be made with fuel from the chemicals produced. Gasification is also a similar process. But technically it is not recycling, because it is unlikely to become a polymer as end result.



3. *Heat compression* -- Heat compression is another process that some of the recycling companies are using (in Australia, United States and Japan) and is becoming popular. In this process different or unsegregated plastic waste is added in a single large heated which rotates and



mixes all type of plastic and breaking down of the polymer and creating a liquid form which can be extruded into pallets form to be used by different product manufacturers. As this process of recycling does not involve any segregation depending on the characteristic of polymers. Without depending on the types of plastic or segregating in different varieties of plastic. Clear plastic can used of all varieties, includes soft plastic bags to hard industrial waste. The biggest advantage of this method is that plastics of all varieties are recyclable rather than selective varieties. This mechanism is commonly used to recycle the municipal waste and also the plastic recovered from the process of bio mining / bio remediation. Although, this process is criticized for the energy spent rotating the drums and heating.



4. *Other processes* – process has also been developed in which plastics of many varieties can be used as a carbon source in recycling of scrap steel.

**Table 1.** The properties of various polymers [32].

Properties	Limits	Type of Polymer					
		PP	LDPE	HDPE	PC	PBT	PAI
$\rho$ (g/cm <sup>3</sup> )	Upper	0.920	0.925	1.000	1.24	1.35	1.45
	Lower	0.899	0.910	0.941	1.19	1.23	1.38
T <sub>g</sub>	Upper	-10	-125	-100	150	45	290
	Lower	-23	-	-133	140.5	20	244
$\sigma_{max}$ (MPa)	Upper	41.4	78.6	38	72	55.9	192
	Lower	26	4	14.5	53	51.8	90
E (GPa)	Upper	1.776	0.38	1.490	3	2.37	4.4
	Lower	0.95	0.055	0.413	2.3	-	2.8

**Common and easily adopted Recycling plastic**

The above study tells us about the plastic and its polymer, about some of the technicality of plastic, their processing method. In this study we will also discuss some of the small-scale methods of recycling plastic waste which will not only help the environment and the nation to decrease the plastic pollution as well as it will also provide the economic boost to the small-scale industries. As we have discussed earlier in our previous study that treating of any waste at the source or in the industry set up at small distance will be economical viable and will be acceptable practically.

The methods used commonly in small-scale industries is *Heat compression process*. This process can be easily adopted by small recyclers in recycling the plastic waste or making articles out of plastic waste in low cost. The investment of setting of such units is small as it requires a small land, low investment on the machine and electricity connection. The process of recycling or manufacturing of the articles from the plastic waste is

- a) Segregating the waste or precuring the segregated waste from the plastic waste generators / street pickers
- b) Washing and drying of the plastic waste to remove the dirt, paper and other foreign materials.
- c) Shredding the plastic waste or getting the shredded plastic waste, as transportation is easy and easily melted by small industries.
- d) Making the plastic in the liquid form by heating it at a particular temperature with help of melting units / heaters.
- e) The melted plastic is then injected in the mould of desired shape of an article / product.
- f) The mould is cooled, after cooling the mould is opened and the article / product is removed, again the same mould. This process continues to get the Product

Depending on the articles manufactured by using the plastic waste we have categorized them in 3 different categories—

1. *Article and product manufactured by using same colour and same type of plastic* – in this type of manufacturing

the same type of plastic waste is used, in this process of manufacturing the plastic waste from the big manufacturing industry (already involved in plastic products manufacturing units, i.e. the plastic waste of a big industry is the raw material for a small industry) is directly used by recycler to make different products like plastic furniture, plastic articles. The colour pigment is used to give the products same colour and uniformity.

2. *Article or product manufactured by using same colour but different category of plastic* – in this type of manufacturing the plastic waste is having different colour but have similar nature of polymer the plastic waste is collected from the big manufacturer units as well from the used plastic collected by the waste pickers. The process is same as discussed above only the use of the raw material i.e the plastic waste used by the processing unit is changed. At last adding of the colour pigment is done to give or provide the product a similar colour for example electric conduit pipes, sanitary plastic pipes, etc.

Study on Pipe manufacturing unit -

- a) Feeding of raw material pellets / powder into the twin screw extruder.
- b) Melting and heating in multiple extruder zones.
- c) Extruding through a die to shape into a pipe.
- d) Cooling of the shaped pipe.
- e) Cutting of pipes to the desired length.

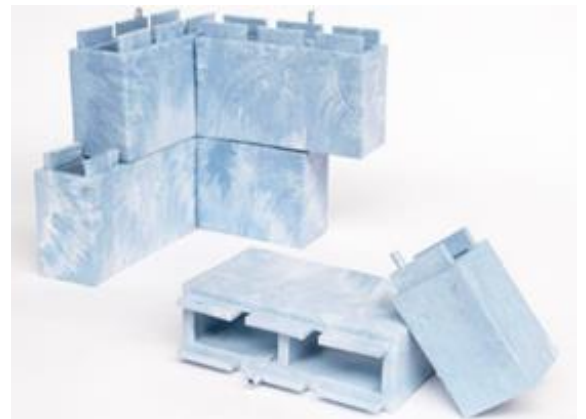


3. *Article or products manufactured with random colour and mixed category of plastic* – in this process the plastic waste collected from the municipal waste i.e. used carry bags, the unsorted plastic waste or the waste that cannot be sorted easily is used for recycling or make different articles, can be made out of it that can be easily used in the construction world and the public areas. As the articles made from this plastic waste does not have uniform colour, uneven surface (due to voids), variation in density, and many other factors. The plastic waste used in this process is municipal waste that contains a large amount of impurities, that cannot be completely

separated from the plastic waste, thus the articles or product made from this waste contains dust or foreign particles making the surface slightly rough. The use of this process will be very helpful in the processing of plastic waste (management) recovered from the process of Bio mining or Bio remediation.

In this study we have taken some of the products can be easily made –

- a) Making of the hollow blocks for construction. – this is example of the Eco bricks, The hollow block made of the plastic waste has dual advantage, one as it is using the plastic waste and second it will also provide the thermal effect of the room. The light weight of the brick also makes it fit for the seismic forces. The interlocking of the block make it easy in the installation or the making of the wall is much easier and faster.



- b) Making of the construction bricks – the bricks made out of the plastic waste are lighter as compared with the concrete / fly ash bricks. The pasting of the plastic bricks can be done by glue. The interlocking of the bricks makes their strength. The walls made of these bricks can be given architectural look by pasting wallpaper on them.



- c) Making of the pavement blocks / plastic pavement blocks can be used on the shoulder of the city roads – the waste of plastic can be used from making of the paver blocks.

The city in India, Hyderabad has placed a good example and tells us the story how to use the plastic waste to make the paver blocks. These paver blocks are used in Shilparama area in Hyderabad. The paver tiles are placed on the walk way on the road site in the centre of the main city. This execution will encouraging others and showing them the way of treating the plastic waste. The paver tiles are made out of 30000 nos. of carry bags.

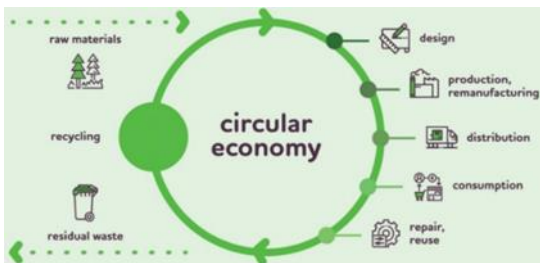
- d) Making of the pots.
- e) Making of the dust bins for municipal use.
- f) Making of the Table top
- g) Making of the Furniture for garden use (chairs, tables, etc)



**Circular Economy of Plastic waste**

The circular economy is an economic system in which materials are designed to be used, not used up. From the outset, products and the systems they sit within should be designed to ensure no materials are lost, no toxins are leaked, and the maximum use is achieved from every process, material, and component. If applied correctly, the circular economy benefits society, the environment, and the economy. The processing of the plastic waste can be designed to form a circular economy as:

- 1. The collection of the plastic waste from the plastic waste generating units or from the house hold waste collected by the waste pickers / street prickers, will provide a source of income to the local persons involved in this collection.



- 2. The sorting and cleaning of the waste and waste collector are educated how to collect the plastic waste in a

segregated manner or segregating and storage of the plastic waste.



- 3. The recycling of the plastic waste and converting them in the desired shape or article to sell in the market.

The above processing will make a close loop, for the treatment of the plastic waste and saving the environment by polluting it. Also creating the earning source for the local people.

**Suggestion**

This is some important steps that must be followed

- 1. Due to the increasing demand for plastic goods, plastic production continues to grow worldwide. The government should make the rules stopping the plastic production or production in a controlled manner or by enforcing of the laws and restrictions to be properly implemented.
- 2. Ban on the single use plastic by Government and other private companies and offices as the practise.
- 3. Spreading awareness in public about the effect of plastic waste on the environment. These awareness programs will be done by governments, NGO's and environment consultants done through television and radio advertisements, hoardings and social media.
- 4. Encouraging public not use carry bags of plastic, to carry the commodities of their house hold needs.
- 5. Encouraging public to collect the recyclable plastic bottles, food wrappers, instead of throwing them, we should give these things to these recycle vibrations.
- 6. Organising training programs for the industrial units to train them on the plastic pollution and the ways they can give their waste to the recycler.
- 7. Moving towards the use of bio degradable plastic only.



## II. CONCLUSION

Disposal of plastic waste and increasing amount of its use is becoming a challenge, due to which the problem like plastic pollution has taken such a frightening look. With some of the above suggested methods and measures, we can play an admirable role in reducing the level of plastic pollution. This dreadful problem can be overcome only by stopping the increasing use of plastic from us. Every person has to come forward to resolve this problem and has to contribute in preventing it. This study will also help in recycling process and it is the best technique to treat waste polymer products in comparison with the wrong practice of combustion of waste polymers or burying it in ground and thus this study will help in removal of the negative impact of the plastic on the environment.

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