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Plastic Pollution & Solution

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Abstract:
Nowadays, plastics are increasingly being used in our daily life activities, including the packaging in different food and brewing companies, cosmetics, pharmaceutical, and other production sectors need to pack their end products for efficient and safer product's delivery to the community. Plastics are produced through the biochemical process of polymerization or polycondensation. The post-use of generated plastic waste has many adverse impacts on the environment if not processed and managed in a proper way. This review aims to discuss the lifecycle of plastic products according to their different categories. There are various plastic waste management strategies; plastic waste dumping in landfills is still the most commonly employed strategy. Being nonbiodegradable, plastic waste dumping in landfills creates several environmental and human health problems. Numerous research studies have been conducted recently to determine safe and ecologically beneficial methods of plastic waste handling. This article performed an analysis of various plastic waste management strategies and their environmental benefits. It has been concluded that among the six plastic waste management techniques (landfills, recycling, pyrolysis to produce RDF and SRF, road construction and concrete production), road construction and concrete production are the two most effective strategies. This is due to significant benefits, such as ease of localization, decreased greenhouse gas emissions, and increased durability and sustainability of manufactured materials, structures, and roadways. Recycling has equal benefits and drawbacks. In comparison, pyrolysis is favorable due to the production of char and fuel, but high energy requirements limit their benefits.

Keywords: Plastic pollution, waste management, Refuse Derive Fuel, Solid Recovered Fuel.

Introduction: Plastic is defined as a material that contains an essential ingredient an organic substance of large molecular weight. It is also defined as polymers of long carbon chains. Carbon atoms are linked in chains and are produced in long-chain molecules**.** The word, plastic, was derived from the word 'Plastikos' meaning 'to mould' in Greek [1]. Fossil fuels have compounds containing hydrogen and carbon (hydrocarbon) which act as building blocks for long polymer molecules. These building blocks are known as monomers, they link together to form long carbon chains called polymers. Depending on physical properties, plastics are divided into two types: Thermoplastic and thermosetting [2].
Thermoplastic: Plastics that can be deformed easily upon heating and can be bent easily. Linear polymers and a combination of linear and cross-linked polymers come under thermoplastics. Example: PVC, nylon, polythene, etc.
Thermosetting: Plastics that cannot be softened again by heating once they are moulded. Heavily cross-linked polymers come under the category of thermosetting plastics. Example: Bakelite, melamine, etc. Bakelite is used for making electrical switches whereas melamine is used for floor tiles.

Product made from polymers are all around us: clothing made from synthetic fibers, polyethylene cups, fiberglass, nylon bearings, plastic bags, polymer-based paints, epoxy glue, polyurethane foam cushion, silicone heart valves, and Teflon-coated cookware. The list is almost endless. Plastics are used extensively in almost all human activities, including manufacturing, farming, furnishings, healthcare, electricity and thermal insulation, the manufacture of domestic and technological items, pipes, and so on [3]. Plastic's utility is predicted to rise even more as a result of its remarkable features such as low cost and maintenance, easy handling, high tensile strength, shock resistance, resistance to microbial growth, opacity as well as visibility, chemical resistance, and feather weight. In addition, plastic's flexible properties encourage technological innovations and—particularly in the fields of medicine, building technology, and aircraft and automobile manufacturing—lead to new solutions, improvements, and comfort [4]. Some familiar household synthetic polymers, their monomers and applications are given in table below:

Polymer	Monomer	Applications
Polyethylene	Ethene	Plastics bags, squeeze bottles, toys, pipes
Polystyrene	Styrene	Foamed plastics, lids, jars
Polyvinyl chloride	Vinyl chloride	Adhesives, industrial fiber, pipes
Teflon	Tetrafluoro ethylene	Coating for frying pans, valve sheets, insulations
Neoprene	Chloroprene	Rubber articles
Orlon	Acrylonitrile	Knitting fiber, carpets, blankets
Buna S (SBR)	Butadiene + Styrene	Rubber articles resistant to ozone
Decron	Terephthalic acid+ ethylene Glycol	Fiber for dresses, curtains, suitings
Nylon	Adipic acid + hexamethylene diamine	Hosiery fiber, ropes, belts, nets
Bakelite	Phenol + formaldehyde	Electric switches, plugs

Harmful Effects of Plastics:

Yet the tremendous consumption of plastic also presents numerous problems. A large part of the plastic quickly ends up in the garbage. As standard plastic is not biodegradable, plastic refuse improperly disposed of pollutes our environment for decades or even centuries. Today, mountains of plastic are piling up in garbage dumps and in the natural world. Plastic Pollution is affecting the whole earth, including mankind, wildlife, and aquatic life. It is spreading like a disease which has no cure. We all must realize the harmful impact it has on our lives so as to avert it as soon as possible. Plastic pollutes our water [5], each year tonnes of plastic are dumped into the ocean. As plastic does not dissolve, it remains in the water thereby hampering its purity. This means we won't be left with clean water in the coming years.

Furthermore, plastic pollutes our land as well. When humans dump Plastic waste into landfills, the soil gets damaged. It ruins the fertility of the soil. In addition to this, various disease-carrying insects collect in that area, causing deadly illnesses [6,7].

Improper disposal of plastics poses a number of problems. Some of them are mentioned below:

- The littering of plastics in open spaces creates unhygienic conditions, as it acts as a breeding ground for insects and mosquitoes that cause diseases like malaria and dengue.

- Plastics do not undergo degradation, thus, stay in the soil for many years, which affects soil fertility and degrades the soil quality.
- When plastic artifacts enter the drainage and sewerage system, they block the pipes and the drains causing waterlogging.
- The improperly disposed of food bags, when eaten by animals, cause stomach and intestine related diseases which even lead to suffocation and death.
- Plastic items find their way to the river and other water bodies, which are then swallowed by fish, seabirds, and other marine species, thus leading to suffocation and death.
- The waste from the plastic manufacturing industry is thrown directly into the water bodies, thus affecting the chemical property of water, causing hazards on a very large scale.
- Proper disposal and usage of plastic discards can reduce these problems. A set of regulations should necessarily be followed to stop these problems [8].

Plastic waste and environment:- It is estimated that approx. 70% plastic packaging products are converted into wastes in a short span. Plastic waste is one of the major pollutants of the solid waste throughout the world as it is a non biodegradable product. The slow degradation rate of plastic waste results in death of billions of living organisms in marine and terrestrial environments. Six decades ago, mass production of plastics bags accelerating so rapidly that it has created 8.3 billion tonnes of plastic and over 90% of it isn't recycled. As of 2021, approximately 392 million tons of plastic is produced worldwide each year. Our planet can't cope with this amount of plastic polluting the environment, and calls to reduce plastic pollution and consumption have increased in urgency in recent years [9].

Management of plastic garbage:- Plastic waste management strategies are required for the proper management of plastic trash in an environmentally friendly manner, which may aid in the proper use of plastic material. The solution to this problem rests in the three R's: reduce, reuse, and recycle [10].
Mismanagement of plastic trash may pose environmental concerns, such as destroying the beauty of the city and clogging drains if littered, causing air pollution when burned, and interfering with waste production plants when garbage is coupled with plastic materials. Recycling, landfilling, and incineration are the most common traditional methods for managing plastic garbage. Apart from the traditional methods of Recycling plastic, RDF and SRF methods are used to manage plastic garbage.

1. 3Rs: Reduce, Reuse and Recycle

Reduce

- This refers to the reduction or decreased consumption of plastic artifacts.
- We can reduce the use of plastic bags and carry jute bags and paper bags to carry items from the market.
- We can reduce the use of plastic containers for storing food and other items and use more durable materials like metal.
- We can avoid using takeaway food containers.

Reuse

- We can use discarded bottles and jars to store food items and water.
- We can reuse plastic bags whenever possible, keeping safety and hygiene in mind.

- We can use broken artifact's and create something new with our own creativity, e.g. discarded water bottles can be used as containers as shown in the figure below.
- Plastic - Discarded PET bottles being used as containers
- Discarded PET bottles being used as containers

Recycling of plastics-

Recycling plastics entails repurposing the plastic product in its original or modified form by depositing the waste streams in plastic recycling facilities (PRF). There are four categories of plastic recycling technologies: primary, secondary, tertiary, and quaternary. In primary recycling, the waste stream is converted into a product with qualities similar to the original product. Secondary recycling involves the processing of garbage to produce goods with qualities that differ from those of the original product. Plastic trash is treated in tertiary recycling to produce basic fuels and chemicals. The energy content of waste plastics is retrieved in quaternary recycling by combustion or incineration. Selection of recyclable materials followed by the segregation of plastic waste are effective methods of the recycling process. The segregated waste is then processed. After that, the used plastic trash is cleaned, shredded, aggregated, extruded, and powdered [11]. Apart from these techniques, we can make changes in our daily lifestyle to make a huge difference towards

2. Using proper disposal techniques. For e.g. separating the biodegradable items and non-biodegradable items and disposing of them accordingly. Biodegradable items can be used for composting and vermicomposting whereas non-biodegradable items can be disposed of in the dustbin, for recycling or incineration [12].

3. Landfilling- Waste is left in earth pits to decompose in this practice, although sanitary landfill space is becoming increasingly scarce. A properly managed landfill site has the advantage of limiting damage to the ecosystem rather than the consequences of collecting and disposing, but the long-term concerns of water and soil pollution must be overlooked [13].

4. Incineration- Plastic waste is burned in this process, however, this may release harmful elements into the sky. Incomplete combustion of PVC, for example, produces harmful compounds such as dioxins; burning plastics emits CO2, which is a major cause of global warming. As a result, this approach of plastic waste disposal is typically abandoned because the cost of treatment of the gases is frequently greater than the energy recovered. However, incinerators can help to alleviate this issue to some extent.

5. Use of plastic waste in road and building constructions: One possible solution that has made its mark in following years is using plastic for road construction. In 2015, the Union Government issued guidelines for use of plastic waste in roads of National Highways on pilot basis. Besides improving environment sustainability, roads made by Plastics are found more durable and cost-effective. Plastic and bitumen bond well together because both are petroleum products. This combination enhances the road's ability to carry weight, as well as its life. The roads also show greater resistance to damages caused by heavy rains. As of July 2021, 703 km length of National Highways have been constructed using waste plastic in wearing coat of flexible pavement [14].

The utilization of recycled plastic in concrete is an effective solution to enhance sound and thermal insulation. The aggregate comprises the largest and heaviest portion of concrete, which accounts for

85% of its weight. Besides, the plastic has a low density compared to the aggregate. As a result, the use of plastic waste as a partial replacement (50% to 75%) for the total aggregate significantly boosts the efficiency of thermal and sound lightweight concrete insulation. In addition, the cost of its manufacturing is drastically diminishing in comparison to that of ordinary concrete, and plastic can be installed and utilized quickly with less labor due to its lightweight nature. Plastic waste may be considered a typical material for the production of lightweight green concrete that can be used as a non-structural component in building construction[15].

6. Use of plastic waste in textile industry: Today, many textile companies are using recycled plastics as synthetic fiber raw materials in order to reduce their costs and support nature and sustainable economy. Ganesha Ecosphere is a leading PET-recycled Recycled Polyester Staple Fibre (RPSF) manufacturer in India. The company collects PET waste through more than 20 collection centres across India and turns it into apparel textiles, functional nonwoven fabrics, geo textiles, carpets, car upholstery, as well as fillings[16].

7. Refuse derived fuel (RDF):- It is a type of fuel created from different forms of waste such as commercial waste, industrial waste or municipal solid waste (MSW).The waste used for RDF are often by-products that have a certain calorific value. In some instances, RDF that meets strict specifications can be put to use in applications that normally use fossil fuels such as coal.Non-recyclable plastic is often used for RDF. It undergoes significant pre-processing involving steps such as screening, ballistic separation, air classification and separation of glass/metallic materials. This results in producing fuels of grain size that's pelletized. This is then transformed into homogenous material that can serve as a substitute for fossil fuels in lime plants, cement plants and coal plants. RDF can also be used as a reduction agent in furnaces. . Refuse-derived fuel is being used to generate power at recovery plants, many of which are located in Europe, and generate power and water heating for municipal heating systems [17,18].

8. Solid recovered fuel (SRF):- It is a superior alternative to fossil fuel produced from commercial waste such as plastic, paper, wood, card and textiles. SRF goes through multiple processing stages to boost its quality and value. It boasts of a stronger calorific value than RDF and is used in cement kilns and boilers. Depending on the quality and process used, SRF can replace up to 100% of fossil fuels used to create electricity or heat. However, current processes and equipment can produce in the range of 30 to 60% of fossil fuels [19,20].

Bioplastics:- Bioplastics are plastic materials produced from renewable biomass sources, such as vegetable fats and oils, corn starch, straw, woodchips, sawdust, recycled food waste, etc. Biobased plastics reduce dependence on fossil resources which improving a product's carbon footprint. Biodegradable plastics allow enhanced end-of-life scenarios for disposal and recycling [21]. This may lessen the burden on our existing waste systems and also the environment.

Conclusion: As we all know, we use plastic in some form or another in our daily lives, such as kitchen utensils, stationery goods, debit/credit cards, bags, electronic and electrical equipment, and so on. As a result, plastic waste management has become a major worry and priority in today's world. Many advances in recycling plastic wastes have been made to facilitate this management, as indicated above;

nevertheless, we must not contaminate the environment when recycling and using recycled items. We can also consider biodegradable plastics, which can be manufactured from agricultural/animal resources such as cornstarch, soy protein polyester blends, cellulose, triglycerides, collagen, and casein, to help alleviate this problem of sustainable waste management.

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