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Plastic Waste Management Technologies

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Abstract:

Plastics use is considered as the crucial part of our daily life and used in large number of applications in worldwide. It is mostly used in Indian cities and villages, for the purpose of buying vegetable, drinking water bottle, plastic furniture in home, plastics objects in kitchen, plastic drum in packing, storage of different chemicals for industrial use and its utensils are used in home and in many more due to their natural properties such as inertness and low bulk densities and make them suitable mover material and contamination less. It will be a part of waste garbage, after the usage of plastic, due to which it creates pollution by the presence of toxic chemicals and it will contributes in spreading diseases. By plastic waste management policy, packaging revolt has not been backed but in a lot of countries in India, left littered part of plastic waste creates horrible visual troubles and other community health problems. In most development countries, increasing environmental awareness and decrease in available landfill capacity have encouraged plastic recycling programmes. Now a days, plastic waste is recycled only 5 to 25% and it contain limited methodologies for utilization of plastic waste again. This review paper, discusses about the existing methodologies of plastic waste management schemes.

Keywords: *Plastic waste management, Landfill, Recycle, Packaging Revolt*

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Introduction

In our everyday life, plastic items plays a significant contribution for greenhouse, coating and wiring, packaging, films, and covers, bags and containers. In medical products, plastics like disposable syringes, blister packing of tablets and capsules, joint replacement prostheses, inter venous (IV) fluid bottles, blood bags, catheters, heart valves, etc., that have significantly helped supporting the human life. It contains the lightweight (energy saving), low cost, exhibit unique and versatile properties. One of the most important application of plastics is packaging in which 40% plastic materials are used for packaging. Thermoplastic are used of the total plastic consumption roughly 80% and used for packaging that is application of plastics but non-plastic applications such as plastic fiber and coating.

Packaging has been possible due to following attributes of plastic materials:

- Safe and hygienic – inert and chemical resistance
- Light weight and non-breakability
- Excellent barrier properties - enhancing shelf-life
- Superior impact resistance
- Sterilizable and resistance to bacterial and other microbial growth
- Transparency as well as opacity
- Lower fuel consumption and product loss during transportation

Health, safety and environmental problems are created by the use of plastics. As the plastics and non-biodegradable, so this property cause waste management problem and choke the drain urban cities.

Effective mass awareness campaign is very important because solid waste management contain the solution that lies in segregation of dry and wet solid waste at the source. To increase the concept of resource management by occurring plastics can be recycled to produce articles. With the recycle of plastics, many useful products have been developed and in small, micro and informal sectors, large number of people is employed in these activities. The unwanted and discarded plastic waste does not remain in road side not it is carried to landfill that is providing through the recycling. By conventional process, many types of plastic waste like multilayer laminates, EPS etc. are not easily recyclable.

The total environmental impact of a product or activity on the earth is analysed by Life Cycle Impact Analysis (LCIA) that is an important and modern scientific tool. Life Cycle Analysis (LCA) proved that plastics have much less adverse impacts on the environment pollution as compared to their alternative that is conducted by credible academic institutions and independent professional organisations of reputation.

Plastic is produced from fossil oil which is distilled to fractions containing a mixture of hydrocarbon chains and subsequently cracked into repeating molecular units, ‘monomers’. The monomers are synthesized into polymers forming the base material, e.g. granulate or powder, that can be manufactured to different shapes and products by several mechanical means, as for example, extruding and molding.

Plastic can be divided into two main groups that is based on their thermal processing behavior: thermoplastics, which account for by far the largest amount of plastic produced (around 80%), and thermosets.

Type of plastics with their major applications are as follows:

Thermoplastics:

Thermoplastics have a structure with long chains of polymers and increase temperature and pressure in which doing the mechanically work. It can be stable at large temperature range that make them attractive for use and also for recycling.

- This type of plastic become soft
- When it is heated, they can be moulded or shaped with pressure
- When it is cooled, they are solidify and retain the shape or mould

Some common thermoplastics with their uses and properties which is as follows:

Table 1: Types of Thermoplastic and their Properties

Plastic type	Abbreviation	Thermosetting	Properties
Polyethylene terephthalate	PET	Bakelite	• Tough and clear, good strength and stiffness, chemical and heat resistance • Used in packaging, soft-drink and mineral water bottles, fibers for clothing, films, food containers, transport, building and appliance industry (as it is fire resistant), etc.
High density polyethylene	HDPE	Alkyd	• Good process ability • Excellent balance of rigidity and impact strength, • Excellent chemical resistance, crystalline, melting point (130-1350C), • Excellent water vapour barrier properties • Used for making blow moulded products (various types of containers, water bottles), pipes, injection moulded products (storage bins, caps, buckets, mugs), films (carrier bags), etc.
Polyvinyl chloride	PVC	Polyester	• Versatility and energy saving, • Adaptability to changing time and environment, • Durability and fire resistance • It is used in industries such as building and construction, packaging, medical, agriculture, transport. • Also used for making wires and cables, furniture, footwear, domestic appliances, films and sheets, bottles, etc.
Low density polyethylene	LDPE	Urea - Formaldehyde	• Versatility and energy saving • Adaptability to changing time and environment • Durability and fire resistance • It is used in industries such as building and construction, packaging, medical, agriculture, transport. • Also used for making wires and cables, furniture, footwear, domestic appliances, films and sheets, bottles, etc.

Polypropylene	PP	Epoxy	• Low density and excellent chemical resistance, • Environmental stress resistance and high melting point • Good process ability, dielectric properties and low cost, creep resistance • Used for making bottles, medical containers, pipes, sheets, straws, films, furniture, house wares, luggage, toys, hair dryer, fan, etc.
Polystyrene	PS	Polyurethane	• Glassy surface, clear to opaque, rigid, hard and high clarity • Affected by fats and solvents • Used for making electrical and communication equipment's such as plugs, sockets, switch plates, coil forms, circuit boards, spacers and housing • Also used for making containers, toys, wall tiles, baskets, cutlery, dishes, cups, tumblers, dairy containers, etc.
Polyvinyl Acetate	PVA	Melamine	• It is amorphous polymer, not a crystalline one. • It is good adhesion to most surfaces. • Used in engineering sector.

Source: (Siddiqui and Pandey, 2013; Gawande *et al.*, 2012)

Some common technologies for Plastic Waste Management that is as follows:

Recycling: It is carried out in such a manner that reduces the pollution level throughout the process and results in increasing the efficiency of the process and conserve the energy. This type of recycling have been divided into four types:

Primary: It is included in plant process of recycling of waste scrap into a material with features similar to the original product.

Secondary: In this recycling, the process of waste plastics into products with the characteristics dissimilar to the original plastics products.

Tertiary: In this recycling, plastics scrap is produce the basic chemicals and fuels that is as part of municipal waste stream or as a segregated waste.

Quaternary: By burning or incineration, reclaims the energy content of the scrap plastics and it is not use in India.

Landfilling: This process is purely temporary and to manage the plastic waste and buried the waste materials in specific area. It give result that harm to environment and create risk of contamination of soils and underground water by breakdown of water. This may result in:

- Affecting water recharge
- Reducing soil microbial activity
- Clogging the drainage
- Water line clogging

Such clogging may result in production of gases like methane that affects Green House effect.

Incineration: It can be used with recovery of some of energy part in plastic and vary energy that is depending on whether which is used for electricity generation, heat and power. It is carried out about 700°C and incineration of polymers like PE, PP, PS that produces gases like CO, CO_2 etc. and these gases cause global warming, air pollution, monsoon failure etc. but in case of PVC mixed with waste that produces of HCl, Cl_2 and dioxin, poisonous gas.

Co-processing of Plastic waste in Cement Kiln: Municipal Solid Waste (MSW) contains the part in which plastic waste generated from different cities and towns. Disposal of plastic waste is causing many problem such as leaching impact on land and ground water, choking of drains, making land infertile, indiscriminate burning causing environmental hazards etc. It is generated approximately 15,342 tonnes per day (TPD) in country. It is most effective methods of recycling of plastics waste for recovery of energy that is used as an alternative fuel in cement kilns. With the aim of plastic into new energy sources that is apart from recycling of plastic for making new products and saving energy. Plastic is made up from crude oil that is the same raw material from which fuel is made. It contain the goal that waste plastic back to crude oil which is reused for powering engines that is made by scientists. The high temperature used in the cement kilns gives a scope to some type of plastic waste contaminated with toxic chemicals such as pesticides and some other hazardous materials without creating any increase in amounts of emissions in the air or water.

Co-processing of plastic waste as an Alternative Fuel and Raw Material (AFR): Co-processing is referred to as the utilization of waste materials in industry process such as cement, production of lime or steel and power stations or any other large combustion plants. By waste recovery industry and material from waste, co-processing shows replacement of primary fuel and raw material. In this, plastic waste are used for co-processing that are referred to as alternative fuels and raw materials (AFR). It advises the advantages for cement industry as well as for the Municipal Authorities responsible for waste management. Fossil fuel and raw material consumption are saved by cement producers and contributing the more eco-efficient production.

Pyrolysis Technology: Till the waste plastic material decompose into gases and oils, when plastic materials are heated in the absence of oxygen. Plastic polymers are broken down into small molecules during pyrolysis. At high temperature (greater than 600°C), produces the small gases molecules but at low temperature (less than 400°C), produces more viscous liquids during pyrolysis. This process is viable route for recycling of waste plastics and convert into gases and fuels and also solve the environmental problem because most of the plastic contains toxic and halogen flame retardants. For pyrolysis, fluidized reactor is a better equipment which contain advantages are obtaining more oil products, better temperature control mechanism. Pyrolysis or thermal cracking is a suitable technique and is used in process of petrochemicals. Pyrolysis helpful in conversion of post-consumer waste plastic for the production of valuable hydrocarbons and also unique approach for catalytic recycling of plastic waste.

Advantages of Pyrolysis process

- It reduces CO_2 emissions
- It reduces landfilling
- It helps to faster commercialization of products
- It helps to product could be used to produce electricity and heat

Review of Literature

Salem, Lettieri and Baeyens (2009), for plastic waste management recycling, treatment and recovery, have various technologies which contributed greatly to eco-image of waste management. Certain benefit of current situation is re-using and decreasing single-life polymeric materials. Plastic solid waste (PSW) is derived from oil and has recoverable energy that are comparable to the other energy sources. One or two stage combustion technologies occur direct incineration that reduce the volume of PSW as well as dependence on fossil fuels, which lead to result with better conservation of natural resources and integrated waste management schemes. Incineration is most important to consider recycling and energy recovery methodologies in plastic manufacturing and converting facilities.

Gawande (2012), in this review paper, find out the effective ways to reutilize of hard plastic waste particle. Use of recycled waste plastic in pavement asphalt represents a valuable outlet for such materials. The use of waste plastics in manufacturing of roads and laminated roofing also help to consume large quantity of waste plastics.

Sasane *et al.* (2015), dictated that increase of waste plastic in bitumen, increases the properties of aggregate and bitumen. Their shows good result when use of waste plastic in flexible pavements and compared with conventional flexible roadways. It is an eco-friendly technique which has more value in minimizing the disposal of plastic waste.

Sharma (2015), day by day, increasing the generation of waste plastics and have polymers such as polyethylene, polypropylene, polystyrene that is show adhesion property in their molten state. One of the best method is use of waste plastics for pavement, for easy disposal of waste plastics. It has increase the technologies for prevention of harmful from waste plastic products.

Joshi and Ahmed (2016), stated that Muncipal Solid Waste Management system are fail from many reason such as lack of awareness, inappropriate technical knowledge, inadequate funding, unaccountability, implementation of legislation and policies. In this review paper, enhanced capacity, improved procedures and training can decrease the issues such as proper site selection, adequate financial support, and improper human resource management. The development and adoption of appropriate technologies and lack of trained manpower will require at realistic time frame for solution of the problems. It is not only central government bodies but also state government have taken various actions for strengthening Muncipal Solid Waste Management in country.

Singh and Sharma (2016), concluded that reduce the pollution and waste is viable through the industries due to which produces the harmful effects. In this, reduce packing materials for products and make products that last longer and easier recycle, reuse and repair.

Conclusion

In present day, Plastic Waste Management has presumed great significance. In India, plastic waste management contains the various schemes that are implemented to mitigate the impacts of plastic waste. Recycling is one of most useful technique to manage the plastic solid waste. It increases the rate of recovery and recycling of plastic wastes in current trend and rising sense environmentally as well as economically. This trends are expected to continue but some significant challenges still exist from both technological factors and from economic or social behaviour issues relating to the collection of recyclable wastes, and substitution for exploited material. In this review paper, discuss about the technology for improving the environmental performance of polymer industry of recycling of waste plastics.

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