PLASTIC WASTE MANAGEMENT

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Abstract: *The abysmal state and problems in municipal solid waste management (MSWM) in urban India and lack of awareness in general population necessitates this study. This article aims to assess the impact of plastics on the environment, and analyse the prevalent methods of plastic waste management. Newer and more efficient methods of waste management are also studied and their adoption strategies are proposed. A genuine attempt needs to be made to improve the condition of management of this material, which has undoubtedly become the need of the hour.*

Keywords: **Solid Waste, Waste Management , Plastic Waste**

1. INTRODUCTION

Plastic is omnipresent, it's inarguably the backbone of globalisation. Due to fabrication of aspired shape and specification suited for potential customers, there is a growing demand in packaging, agriculture, automobiles and biomedical. They are essential to the modern age due to growth in information technology and smart packaging system. Rapid population growth, urbanization, combined with industrial growth has together led to critical waste management issues around the world. More often than once, concurrent development in economic prosperity and industrialization conflict with environmental concerns. According to US Environmental Protection Agency, since the 1960s use of plastic has grown substantially, and resultantly, the portion of plastic waste has also increased from 1% of the total municipal solid waste stream to approximately 13%. According to a report by the United Nations Environment Programme, approximately 400 million tonnes single-use plastic (SUP) waste is generated yearly (that accounts to 47 per cent of the aggregate plastic waste) and approximately fifty per cent of this quantity is for disposal purposes, purchases that are discarded within a year.

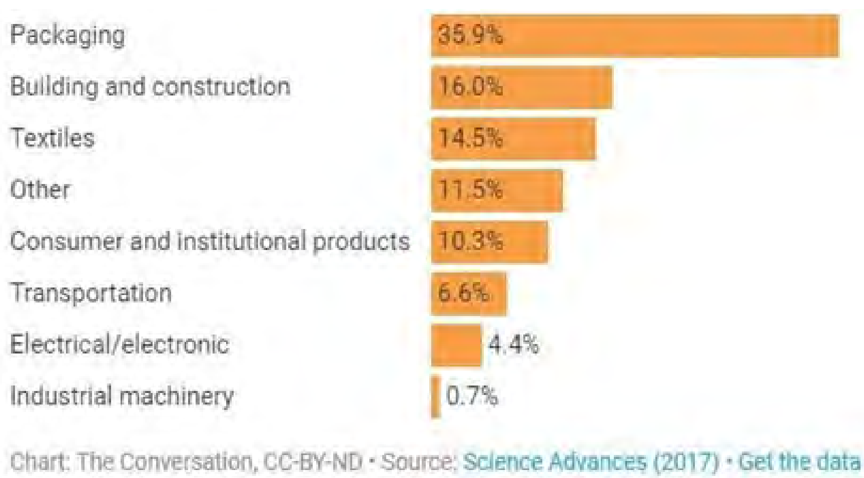

Figure 1. What are plastics used for?

The first synthetic plastic, Bakelite, was produced in 1907, chronicling the onset of the global plastics industry. Still, accelerated growth in global plastic production was not understood until the 1950s. Annual production of plastics dramatically increased by nearly 200-fold to 381 million tonnes in 2015. This is approximately comparable to the mass of two-thirds of the world population.[1]

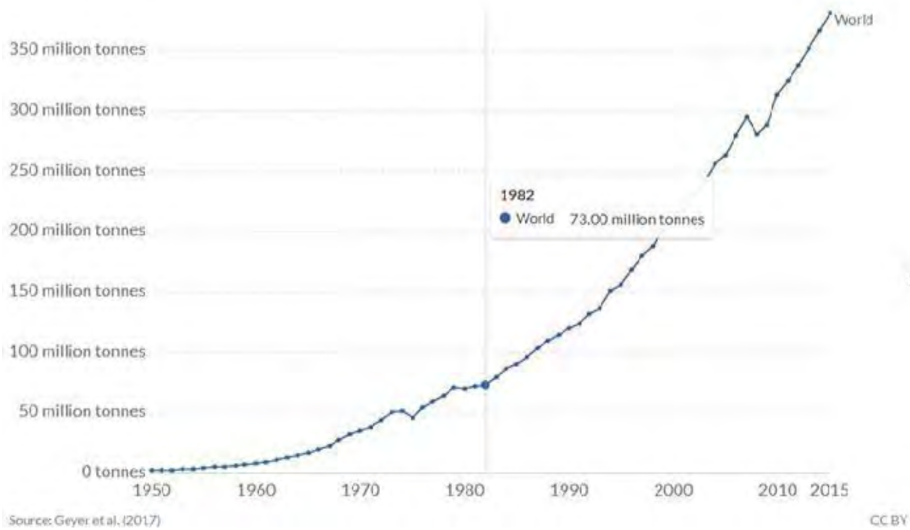

Figure 2. Global Plastic Production

Global Trend

While the use and consumption of plastic are increasingly high, reservations about viable possibilities for reuse, recycling and disposal are also on the rise. Developments such as the rising number of additives used to remodel the strength, texture, flexibility, colour, resistance to microbes, and other features of plastics, make plastics less recyclable. Moreover, there is very limited market value in certain plastics, leading municipalities to landfill or incinerate plastics as waste. Based on numbers from the EPA (2011 data), only 8% of plastic supplies are recovered through recycling.

A pressing concern about plastics chucked in the waste stream is their longevity and the uncertainty around their biodegradation. It is approximated that most plastics would take around a span of 500-1000 years to completely decompose into organic components. A majority of our plastic waste ends up in landfills or as litter as a result of the longevity and the low rate of recycling. Inarguably, plastic waste does affect living organisms throughout the ecosystem either in a direct or an indirect manner, including an alarmingly high impact on aquatic life at a macro and micro scale. In fact, according to the United Nations, roughly 80% of marine debris is nothing butplastic.[2]

2.Plastic Pollution

Mismanaged plastic waste

Insufficiently disposed waste is that which initially had the plan of being managed through a waste pile or dumpsites, but is ultimately amply managed. This includes disposal in landfills or open, uncontrolled dumpsites; this implies the material is not fully enclosed and can be lost to the encompassing atmosphere. This puts it at a dangerous risk of leakage and transport to the natural atmosphere and oceans via waterways, breezes and waves.

Developed nations within most parts of Europe, North America, Australia, New Zealand, Japan and South Korea have very efficient waste management support and systems; this implies dumped plastic waste (including unrecycled or unincinerated) is stored in secure, contained landfills. Across such nations, almost no plastic waste is regarded as partially managed. [3]

Across many low-to-middle-income income nations, insufficiently managed waste can be substantially high; in fact, across many countries in South Asia and Sub-Saharan Africa, a staggering 80-90 per cent of plastic waste is insufficiently managed, and consequently, holds a dangerous prospect of polluting streams and oceans.

3. Current Plastic Waste Management Scenario

3.1 Landfilling

Though all plastics can be disposed of in landfills, it is viewed highly reckless as it needs an enormous quantity of space and the chemical components and energy carried in plastic is dissipated (wasted) in this disposal route. In 2008, a staggering amount of 29.2 million tons of plastic was disposed of in landfills in the United States. In nations where landfills are inadequately managed, plastic wastes can be simply blown into waterways or carried out to sea by floodwater. Also, when plastics disintegrate in landfills, they may leak pollutants (phthalates and bisphenol A) into the soil and encompassing environment.[4]

3.2 Incineration

The simplest way to lessen the amount of solid waste is to burn it in a process called 'incineration'. The fundamental benefits of a municipal waste incinerator are that they need less land and can also be efficiently used for power generation. Nevertheless, incineration of plastics in MSW also generates toxic gas emissions that carry heavy metals, dioxins, and other volatile organic compounds (VOCs). Heavy metals such as lead, zinc, arsenic, cadmium and mercury are parts of the waste stream and consequently, when incinerated, they eventually reach the atmosphere and further persist with soot particles and generated ash. [5]

3.3 Recycling

Most plastic can be recycled and the elements recovered can be given a second-life. Yet, this design is not fully utilized, due to complications with the accumulation and sorting of plastic waste. Several developing (and certain developed countries) have inadequate waste management provisions which frequently result in plastics (and other waste) being carelessly disposed into rivers and water bodies. Although recycling is the most efficient way to deal with plastic waste, its effectiveness is profoundly depended on public awareness, economic viability, and the implementation of public infrastructures. [6]

4. Plastic waste recycling technologies

4.1 Liquid refuse-derived fuelconversion

Conversion of plastic waste into molten refuse-derived fuel (RDF) oil by catalytic pyrolysis whereby it is segregated mechanically from solid waste and treated - this division method is not fool-proof, other fragmentary waste material is also separated along with the plastic waste. Then the segregated waste is sent through a conveyor belt fixed with optical segregation device for 100% source separation of plastic waste. This miscellaneous plastic waste is transformed into a useful fuel, i.e. liquid RDF oil through catalytic pyrolysis. The complete feed material is converted into Liquid RDF, gases and some sludge. There is no effluent generated in the process and the remaining gases from the reactor are released throughvents.

Plasma Pyrolysis is a recent advancement in the world of technology that couples the thermo-chemical features of plasma along with the pyrolysis technique. Plasma pyrolysis is the thermic disintegration of any carbonaceous material in an oxygen-starved environment. While optimization is carried, the most likely compounds produced are methane, carbon monoxide, hydrogen, carbon dioxide and water vapor. The method requirements are maintained such that it completely reduces any likelihood of formation of toxic dioxins and furans (in case of chlorinated waste). The transformation of organic waste into non-toxic gases is more than 99%. The severe conditions of plasma kill stable bacteria and the pyrolysis method aids in reducing carbon dioxide emissions and landfills.

4.2 Gasification of wasteplastic

This is another way to lessen landfill space and incineration expenses of waste plastic. The gasification process' principal benefit is that it uses inert air bearing nitrogen instead of oxygen, thus making it a much simpler process while also reducing the cost. This is a vertical fixed bed gasification system, where a thermo-chemical process turns carbon-based material into gases such as carbon dioxide, carbon monoxide, and hydrogen and methane gas, which can be utilised for heat or power production.

Gasification procedure using air as a gasifying agent has been determined to be an eco-friendly means of transforming biomass and plastic waste refuse into fuel gases. Immediate gasification has benefits of a simple method and cost-effective procedure, but the unavoidable presence of nitrogen in the inert air could decrease the calorific value of resulting fuel gases because of dilution. Waste plastic includes polyethylene, polypropylene and polystyrene, which are softened by heating up to 100-150 degrees C.

Innovations in plastic recycling incorporate increasingly stable chemical detectors and refined software that collectively enhance the precision and productivity of automatic sorting. The recycling method utilises minimal water to reclaim the plastic, where water is used only as a coolant. The water-less approach renders in recycled plastic pellets that are more useful than others, which can be helpful in the construction ofroads.

4.3 Microbial Degradation of Plastics

The principal approaches used to treat plastic waste are landfill, incineration and recycling. Each of these techniques has its shortcomings. The plastics in the landfill will persist for a great deal of time without decomposing. The plastics buried in the soil makes it useless since the land underneath becomes too delicate to hold any structure. The incineration of plastics discharges toxic gases, which are a pollutant to the atmosphere. And it is generally costly to recycle plastics. Save for these methods, biodegradation by microbes has been determined to be an environment-friendly means for degradation of plastic waste. Although recycling is still the most favoured approach, biodegradation is fit for plastics with particular applications, such as agricultural mulch films. [7] Following are the various steps of plastic degradation by microorganisms:

- Bio-deterioration is the action of microbial constructs and additional decomposer bodies which are responsible for the physical and chemical degeneration that transforms the mechanical, physical and chemical characteristics of plastic.
- Bio-fragmentation points to the catalytic actions that divide polymeric plastics into oligomers, dimers or monomers by ecto-enzymes or free-radicals discharged frommicroorganisms.
- Assimilation distinguishes to the combination of molecules carried in the cytoplasm in the microbialmetabolism.
- Mineralisation attributes to the whole degeneration of molecules that resulted in the excretion of completely oxidized metabolites (CO_2, N_2, CH_4, H_2O).[8]

5. Measures for Government

- Target the most problematic single-use plastics by carrying out a baseline assessment to recognise the most problematic ones, as well as the prevailing causes, scope and consequences of their mismanagement.
- Consider the most suitable procedures to tackle the problem (e.g. through regulatory, economic, awareness, voluntary actions), given the country's socio- economic status and considering their suitability in addressing the specific issues recognised.
- Assess the likely social, economic and environmental impacts of the favoured short-listed instruments/actions, by recognising how will the poor be affected, or what impact will the preferred course of action have on various sectors andindustries.
- Recognize and involve key stakeholder organisations – retailers, consumers, industry representatives, local government, manufacturers, civil society, environmental groups, and tourism associations – to guarantee extendedbuy-in.
- Support alternatives. Before the ban or levy comes into play, the availability of options requires to be evaluated, thereby the governmentmay:
    - Assure that the preconditions for their uptake in the market are inplace.
    - Present economic incentives to stimulate the uptake of eco-friendly and fit-for-purpose options that do not cause moreharm.
    - Assistance can include tax rebates, research and development funds, technology incubation, public-private partnerships, and help to projects that recycle single-use items and convert waste into a resource that can bereused.
    - Lessen or eliminate taxes on the import of materials used to make alternatives. [9]

Recommendations to Improve the Existing Waste Management Practices

- Community involvement is the answer to maintain a project related to the management of solid waste. A waste generator fee is the most suitable wayforward
- It is imperative to realise near-source waste segregation as biodegradables and recyclable matter for proper wastemanagement
- Viable decentralized composting plants to be established to lessen the load on garbage collectors. For large cities, zone-wise decentralized composting units should beestablished
- Support educational institutions to exercise waste management in their curriculum and organise student projects for wasterecycling
- Waste to be treated as a resource and a formal recycling sector to be developed from the waste hence providing employment to rag-pickers and employ them in the mainstream.
- Manufacture of non-recyclable single-use polyethylene bags should be forbidden or research initiated to develop biodegradablebags.
- Use of innovative and established technologies like plastic-to-fuel and waste-to-energy must be supported with proper provisions for abuyback.
- Practices of fluid biodegradable waste recirculation in landfills should be promoted to enhance waste stabilization and gas recovery as followed in developedcountries.
- Protection of groundwater contamination from leachate percolation from the open dump/landfill site should be made mandatory.[10]

6. Conclusion

Plastic is undeniably one of the most used materials in the world. However, the current condition of handling plastic waste is causing irreversible harm to the environment, and this impact has caused environmentalists to hastily call off the use of plastics altogether. Shifting to alternatives, when plastic has penetrated so deep into our daily lives is not a viable solution. The study carried out for this article show that various methods of plastic waste management have been adopted, but there are still prominent flaws in majority of them which can only be avoided through exhaustive restructuring of the entire methodology. The awareness of the Government about the waste management scenario, and their strict intervention is required to improve prevalent conditions. This article has listed various measures that can be taken by the government to better manage and dispose off plastic used by industries as well as households. Also, improvements can be made in the current procedures for plastic waste management by increasing awareness from an elementary level with the cooperation of educational institutions, establishing city waste disposal units at a larger scale, and also study ways to manufacture biodegradable plastics in order to eliminate the problems at a manufacturing levelitself.

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