

Impact of Plastics Wastes, Their Management Strategies and Role of Educational Institutions: An Overview

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Abstract: Due to the cost effective and plasticity nature, plastics and their derivatives were over utilized in the past few decades, particularly in packaging industries. Used plastics and plastic waste discarded unscientifically pose undesirable and negative impacts to the environment. Dumping of plastic garbage in the landfills, cause soil, water and air pollution and thereby it indirectly influences the vegetation and all living organisms. Plastic pollutants impart the health issues not only to the human but it affects the food web of the ecosystems. Management strategies of plastic waste adopting both the conventional methods and applying the recent technologies are highlighted to mitigate the ill-effects of plastic wastes. This article covers the role of educational institutions in order to protect the present-day environment without further degradation due to utilization of plastics.

Keywords: Plastic, Waste management, Role of educational institutions, Management strategies

1. INTRODUCTION

Enhanced economic developments and technological advancements contributed considerable changes in human life style. Both these factors influenced the environment directly or indirectly at varying levels. The priority challenge faced by the environmentalist, in particular, is to preserve the present-day environmental conditions from the ill-effects of blooming economic developments and anthropogenic activities which instigated environmental degradation with long-term irreversible consequences, particularly, solid waste management. Inadequate management strategies at grass root level pose the environmental degradation. Plastics as a synthetic polymer substituted the natural resources and invaded in every facet of human life due to its flexibility and allows them to be used continuously. Nations have witnessed a considerable intensification and production of plastics from early 1950's and its consumption enhanced rapidly. It has been estimated that about 359 million tonnes of plastic produced globally, of which ~40% were used for packaging purpose and discarded immediately¹. Having a prolonged half-life period, plastics end up in the environment, invariably associated with all ecosystems as a pollutant and implies with direct harmful effect to society². Even though most efficient waste management practices inducted in the nation, major proportion of the waste currently disposed as open dumping method besides incineration, landfilling and composting. The article summarizes the utilization of plastics, impact of plastic waste in the environment and their management besides the role of educational institutions with respect to plastic utility.

2. PLASTICS

The term plastic referred to a wide range of polymeric, semi-synthetic or synthetic organic compounds, most commonly derived from petrochemicals. Among these, the most important groups are silicones, acrylics, polyesters, polyurethanes and halogenated plastics. Plastics are also categorized according to key characteristics that area of relevance to manufacture, product design and end-use. Thermoplastics include polyethylene (PE), polyamides (PA), polypropylene (PP), polycarbonate (PC), polystyrene (PS) and expanded polystyrene (EPS), polyethylene terephthalate (PET) and polyvinyl chloride (PVC). Due to their ease low-cost manufacture, impermeability and their resistance to chemicals, temperature and

light, plastics are used in a wide range of products and have replaced and displaced many other natural materials³. In the modern society, wide range of plastics occupies as a component ranging from stationary to spaceships.

3. PLASTICS: BOOST OR CURSE?

While evaluating the “pros and cons” of utility of plastics, one should not ignore the role played by plastics in our daily routine. At present, plastics have played a significant role in each and every field of human activities viz., food and medical industries, agriculture, transportation, electrical goods, household appliances, irrigation pipes, packaging, furniture, etc. As a disposable syringes, blister packing of tablets/capsules, blood bags, medical devices, etc., significantly contributed and supported the human life. Plastic materials are significantly used for packaging purposes and in fact, about 40% share contributed by the plastics¹. Due to its flexible usage and economically cost-effective packing resource, it has been widely used hygienic packaging of almost all consumer products including, food grains, oil, milk and milk products, medicines besides cosmetics, toiletries⁴. Its usage spreads irrespective of the urban or rural areas and economically poor or well-settled societies. Javeriya Siddique and Govind Pandey⁴ highlighted significant attributes of plastic materials which includes a) hygienic, inert and chemical resistance, b) easy to handle/transportation and unbreakable nature, c) being an exceptional barrier property protects and improved the shelf-life of packed items, d) resistance to microbial contaminant and e) lower energy consumption during transportation. However, plastics are liable to induce a series of negative impact in the environment which will be elaborated separately.

4. IMPACT OF PLASTICS ON ENVIRONMENT

Being a polymer and contains or generates toxins on degradation which imparts negative impact on environment, broadly, water, soil and air pollution which in turn create long term issues pertaining to plants, animals and human. In particular, ground water pollution, interruption in food chains, vanishing the animals and creatures, soil pollution which affects the growth and development of vegetation and their diversity^{5,6}. Increased dumping of plastics can lead to long term changes in soil properties viz., water holding capacity, diminishing microbial diversity and their activity, nutrient availability and impaired nutrient cycle and soil structure, simply, change in physic-chemical properties. Pollution due to plastics occurs where humans directly litter in the surroundings, however, it is obvious plastic pollution in and around landfills can be reduced with improved site management. It may be noted that plastic pollution resulted in poorly reversible when weathering process cause fragmentation as micro-particles. Further, there are known remote areas of global environment that are accumulating poorly reversible plastic pollutant and it is not feasible to govern by present management system².

Littering of plastics on open surrounds and an inadequate waste collection system besides scanty disposal methods led to soil pollution, irrespective of the urban or rural areas. Dumped plastic wastes interacted with available moisture forming hazardous chemicals which seep into underground and degrade the available water resources. Plastic pollution on land poses a great threat to the plants and all other living organisms who inhabit the land⁷. Food chain is a linear action of energy transfer from producer to consumer and so on in a defined ecosystem. Plastic debris entered into most of the organisms in the food web and create obstruction in the food chain of the ecosystem. Irrespective of urban or rural areas, plastics are accumulated in the terrestrial soils through plastic litter, runoff and atmospheric deposition of micro/nanoplastic particles⁸. Plastic is also purposefully incorporated in to agricultural lands through plastic mulch as polyethylene films and biodegradable plastic films, compost and sludge-derived biosolids that comprised of plastic residues besides by the application of polymeric stabilizers against soil erosion⁹. It has been reported on the basis of the estimates of sewage sludge inputs alone in the agricultural fields, the quantum of plastic is comparatively higher than that of the plastic pollutants present in the ocean’s surface¹⁰.

Plastic contaminates the water bodies and oceans by storm water runoff, flowing into water courses or directly discharged into coastal waters. Mishandling of plastic mulches are a source of pollutant to the surrounding virgin land which can escape and spread along with stream water and pollute the nearby water bodies. Plastic waste on surrounding places enters into drainage lines and chokes it resulting in floods. Harmful chemicals are released by seepage in the ground water and in the ecosystem especially in the soil from the plastics. Harmful pollutants entered the food chain, even in the food grains, thereby causing hazardous long term carcinogenic effect to fishes, animals and finally human beings¹¹. Oceans

are generally polluted from micro plastic particles which floats on the water surface. Certain bacteria associated with polymers/nylon and release the methane gas in to environment which acts as a catalyst for global warming¹².

Ground water, the natural resource, relatively free from pollutants in most of the areas and used as source of drinking purpose besides the stream water. On rain fall, garbage dumps, landfills and plastic wastes tend to leach into the stream- and ground- water supplies. Ground water and reservoirs are susceptible to the leaching of pollutants from the plastic wastes thereby resulted water contamination⁷. It may be noted that besides ground water and stream/reservoirs polluted by plastic littering, the oceans were also contaminated due to plastics. This has caused devastating consequences on many marine species ultimately the people affected due to consuming marine food for their food source/nutrients.

As stated earlier, plastic pollutants not only influence the environmental degradation, it also affects the living organism of various ecological systems. For example, sea turtles are affected by plastic pollution besides whales where plastics cause oesophageal obstructions and accumulate in the stomach, respectively¹³. Marine plastic pollutants can affect the birds due to their food habits. It has been reported that millions of mammals, birds, reptiles and fish are reported to be killed every year by ingestion of plastic bags.

Ingestion of plastic particles by diverse biota and humans has been demonstrated earlier where the small plastic particles can be taken up from gastrointestinal tract into tissues and can penetrate biological membrane^{14,15}. These studies illustrated that internal tissues/organs of humans and other biota could be alternate location of accumulating plastic pollutants. Biological cycles play an important role in incorporation of plastics to remain suspended in the water source/bodies. Biofilms that form on the surface of plastic excrete sticky polymeric substances that expedite the formation of aggregates of plastic particles with natural organic matter¹⁶.

Air pollution is the “talk of the town”, today, though it is merely not only due to plastics. However, mismanagement of plastics also contributes significantly to the air pollution. Areas far from the polluting sources may be adversely affected as the atmospheric free air circulation/movements along with the pollutants⁷. When the plastics are burnt in the open places, landfills and/or using incinerators, poisonous toxic substances are released into the atmosphere which in turn adversely affects all living organisms when they respire. In addition, toxic gases released in the atmosphere is also one among the reasons for escalation in concentrations of greenhouse gases which subsequently trigger rise in atmospheric temperature and climate change.

Pollution due to plastic wastes can influence the carbon cycle directly/indirectly. Carbon emission is due to direct burning of fossil fuels is negligible when considering the fossil carbon converted into plastics and its derivatives that degrades in the process of incineration and/or landfills which in turn emit carbon dioxide and other greenhouse gases. Threatening aspect of using plastic relies on its prolonged half-life period where emissions of greenhouse gases from plastic degradation and mishandling of plastic wastes continues for several decades. Significant quantum of plastic wastes circulated or being stasis nature in global oceans potentially affect the carbon cycles which is comparatively larger than that of direct impact of greenhouse gases emissions. Linear accumulation of plastic wastes in the marine water bodies also affect the nutrient cycle in diversified methods particularly nitrogen and phosphorus cycles^{17,18}. In view of socio-economics concern and the ease to handling of plastics state that its prevalence is a boon to the humanity. However, having a prolonged half-life nature and its poisoning, negative impact on the environment besides unwarranted utility of plastics is considered to be a curse according to the environmentalists.

5. MANAGEMENT STRATEGIES

Overwhelming exploitation of plastics is due to its abundant production, cheap cost and durability. These phenomena enable the people in the society use the plastic materials/items unwarrantedly. Improper disposal of plastics creates unpleasant environment with particular reference to environmental degradation which necessitated to explore possible plastic waste management methodologies. Productive use of waste represents a means of mitigating certain associated problems of solid waste management. Wastes should be treated appropriately and value-added products should be recovered for further utilization. As stated earlier, non-systematic littering of plastic wastes triggers environmental

degradation due to their prolonged biodegradation period, therefore, reasonable methods for reduction of their negative effects should be adoption of integrated solid waste management concept for its effective management with optimum resource recovery. While considering the plastic waste management, the decision should be flexible in terms of method selection from various waste management options and that too incur limited energy consumption, environmentally healthier and utilize feasible landfill space at affordable cost to the society³. Though the objectives can be achieved through various ways including segregating wastes by type, recycling of specific wastes and reuse of industrial by-products, the concepts adopted should be easily adoptable at community levels. However, whatever method is adopted for waste management, one should concentrate on the basics i.e., characterization of waste and source of identification, following scientific way of waste collection, reduction of waste volume/reducing its toxicity by adopting adequate treatments followed by selection of appropriate technologies which will enable cost effective, environmentally sound processing.

6. CONVENTIONAL METHODS OF PLASTIC WASTE MANAGEMENT

Conventional technology in relation to plastic waste management revolves around recycling, landfilling and incineration. Recycling of plastics through environmentally sound methods should be carried out to minimize the environmental pollution. Process of recycling of plastics include the production of products that are identical to the original plastic items or with dissimilar form. Basic chemicals and fuels can be extracted from the plastic waste otherwise it can be burnt or incinerated which is not advisable. Here again the recycling process tedious which includes various steps like, collection of plastic wastes, segregation and recycling. Landfilling is one of the traditional approaches in waste management strategies. For this process, it requires space for establishing landfills. A well-established landfill could restrict instantaneous negative environmental impacts than that of collection, transportation and recycling process. On the other hand, incineration is yet another process to reduce the volume of plastic waste, however, there are possibilities of release of hazardous gases into the atmosphere during incineration besides the higher cost involved in this treatment. In this context, modern incineration techniques tackle the liberation of pollutants which is highly undesirable.

7. RECENT TECHNOLOGIES IN MANAGEMENT OF PLASTIC WASTES

Recent technologies in plastic waste management include polymer blended bitumen road where the plastic waste is used for laying roads and is being successfully adopted in India. Besides being recycling of plastics for making new products, certain projects aim to turn plastic waste into energy sources. One of the most effective methods of recycling of plastic waste for recovery of energy is its use as an alternative fuel in cement kilns. Low-end plastic waste which creates a waste management problem, may provide the vital energy to the cement industry. Co-processing illustrate the replacement of primary fuel/energy by waste recovering and referred to as alternative energy sources. Other than cement factories, in the production of lime, steel and power stations and/or large combustion plants plastic wastes can be utilized as an alternative energy where the process provide efficient eco-friendly production. Plasma pyrolysis technology and conversion of plastic wastes into liquid fuel are alternative methods for plastic waste management where these processes eradicate the emission of toxic gases⁴.

8. ROLE OF GOVERNMENTAL AGENCIES

Legislators of all National Governments need to involve in the campaign to prevent plastic pollution, in order to safe guard the present-day environmental condition by enacting stringent rules and regulations besides strictly adhering the rules. Apart from the Governments, corporate sectors can realize their participatory role in the prevention of plastic wastes and accordingly design their vision and mission and observe the same for the benefit of each and every individual. Though awareness is being created among the societies on ill-effects of plastic utilization, it has to be geared-up further and each and every individual should participate to upkeep the environment clean and tidy. Most of the initiatives, however, are carried out with little attention or with no coordination. In this context, extensive coordination is expected from the legislators, corporate sectors, governmental agencies and public. All the regulatory instrument (international, national, regional or local) should address the plastic pollution by following a) preventive, b) removal, c) mitigation and d) educational measures.

9. ROLE OF EDUCATIONAL INSTITUTIONS

Being an educational institution, the management should undergo environment audit as an integral part of their regular academic activities and recognition. The waste management audit in the educational institutions sought to examine whether all kinds of waste had been covered under legislation for safe disposal and monitor the allocated responsibilities and accountability of waste management system. In this concern, the organization should maintain an inventory which will be served a record pertaining to resource use, waste generation, reuse, recycling, production of by-products, and landfill or disposal details. Following the waste management audit, the organization definitely realize positive impacts and follow to sustain environmental sound campus.

In addition to the above, awareness will be created on usage of personal protected materials, undertake MoU with waste disposal agencies as per Central and State Government Pollution Control Board regulations and regulates the concept of plastic waste/toxic materials management within the campus. It has been noted that MAHSA University had taken impressive steps to ban the plastics within their campus following a) not to use one time use plastics, distribution of reusable bags, utility of alternative materials for plastic cups, etc., and conducting frequent awareness programs for the benefit of stake holders¹⁹.

As an integral part of the society, educational institutions are also responsible to tackle the plastic pollution issues, at least with in the campus by educating the scholars on environmental issues. By announcing the campus as “Plastic free zone”, the authorities can advocate the campaign against extensive utility of plastics and its derivatives. Since plastic items invaded everywhere in our daily routine, as a preventive measure its utility can be reduced at sources or reused and/or recycled. Disposal of plastic wastes should be strictly disposed in compliance with Central Pollution Control Board instructions. Conducting awareness programs and campaigns will create responsiveness among them and the public,

10. CONCLUSION

In present day context, plastic waste management has assumed greater significance among the global issues. Though, preventive measure are taken to mitigate the ill-effect of plastic pollution in the context of every component of the environment, its utility is not under manageable. Reduce, reuse and recycling the plastics should be advocated to minimize its negative impacts. Conventional methods of plastic waste disposal should be adopted precisely with advantage of scientific knowledge. As the technology advancement, recycling and recovery of plastic wastes opened a new avenue to mitigate the issue to an extent. In this connection, concentrated efforts should be focused on the plastic pollution issues with coordination among the legislators, environmentalists, educationalists, students and peoples from the society.

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