

Introduction

Within a specific ecological–economic system, each material is generally connected to and also dependent on others. Moreover, plastics contribute to the overall integrity of this life system. However, since all plastics contribute to the functional scheme of things in waste generation, it is undoubtedly a very important issue. In particular, plastics provide key applications that are also unique; without plastics, the underlying ecological–economic system would be very different.

The first synthetic plastics developed were celluloid (cellulose nitrate) in 1869 and phenol formaldehyde in 1909. Other plastics such as cellulose acetate and polyvinylchloride were made into semi-durable items, such as electrical equipment or insulation, motion picture film, billiard balls, etc., which are considered a nuisance when they become waste. Plastics production and consumption have increased considerably since the first industrial production of plastics in the 1940s [1]. The high-volume production of low-density polyethylene began in 1940, which is also when plastic waste started being recycled. Included in the rapidly growing plastics industry are all thermoset plastics and thermoplastics, with the consumption of plastic materials having grown to around one million tons per year as of 1962. Worldwide production and consumption of plastics has increased at an average rate of about 8 percent per annum [2]. However, it is now a billion tons of plastics waste. Plastics consumption has increased rapidly while the deposit of natural resources is decreasing. The decrease in crude oil and natural gas puts pressure on plastics production. Therefore, rapid, large changes in oil prices can cause significant long- and short-term economic consequences. Obtaining and using this oil also carries with it the enormous burden of adverse environmental consequences, social

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issues, and geopolitical risk, since plastics undergo little degradation and dispersion by natural processes.

Global post-consumer waste generation totals approximately 900–1,250 metric tons per year [3, 4]. In an underdeveloped country, the per capita solid waste generation rate is less than 0.1 tons per capita per year as opposed to developed countries where it is greater than 0.8 tons per capita per year in high-income industrialized countries [5–12].

Plastics waste is closely linked to population type and size, and the degree of urbanization and material comfort. It remains a major challenge for municipalities to collect, recycle, treat and dispose of increasing quantities of plastics waste in most developed and developing countries. Most technologies for plastics waste management are immature and have been difficult to implement in many countries.

Plastic waste has gone up both in absolute terms and as a percentage of solid waste. However, the volume may not be enough to warrant systems to separate different types of plastics from each other for recovery. Because of the amount of plastic waste disposed of in municipal solid waste, it needs to be managed.

Plastics waste can be used as a raw material for recycling operations or can be treated prior to disposal, resulting in the waste being transformed into material which can be safely disposed of or reused. The proper management of plastics waste starts at the production stage. Plastics waste has an economic advantage, in comparison with many other solid wastes, as it can be regularly recycled. Current processing technology enables the efficient conversion of waste into new recycled end products.

Plastics waste management does not exist in a vacuum; waste plastics are affected by and impact upon many different aspects of national life, i.e., there is a balance between the utilization of plastics waste and its production and processing. The majority of plastics waste generation is related to material comfort items; however, recycling/reuse initiatives for mixed plastics are limited [3].

In particular, it is crucial that plastics waste management is linked to the parallel development of production and processing, otherwise there is a risk that controls to limit the environmental

pollution of one operation will lead to an increased level of pollution in another, hence:

- Plastic processes and activities should be chosen which produce the lowest amount of waste.
- The production of hazardous waste from antimony and lead and so on from additives, should be kept to a minimum.
- All feasible and reasonable steps should be taken to recycle and reuse materials from plastics waste and convert this waste into useful marketable products.
- The waste disposal process should include arrangements for the disposal of plastics waste that cannot be reclaimed, such as degraded polyvinyl chloride. Disposal should reduce the level of risk to public health, water supplies and the environment to acceptable levels.
- All types of solid waste should only be disposed of at sites suitable for the disposal of that particular waste, which will not be reclaimed. The site can stipulate upon acceptance, any special requirements regarding the method of disposal which includes preparation to receive the waste, the methods involved in disposing of the waste and so on.
- Plastics waste treatment and the methods to be used for the disposal of the residues from the treatment should be included in the waste disposal process.
- Waste generators are responsible for their waste, which is a very important aspect for plastics waste. Generators of waste must be assumed to have adequate knowledge of its composition, form, and of the potential hazards to public health and the environment, to ensure disposal of the waste is not detrimental to the environment. The waste generator is responsible for ensuring that only appropriate disposal methods are used for their waste.
- Future planning needs to include the proper management of plastics waste.

Recycling of post-consumer plastics has not yet become a significant recovery option. Plastics pollution in most cases results in already stressed ecosystems. Humans fear that the dangers posed by plastics waste tend to create problems more often than not. An attempt is being made to treat plastics-waste-related environmental and natural resource problems as part of an important task to help the societies of the world. The world has an emerging interest in moving away from plastics waste towards material management due to their non-degradable nature. There are strong drivers at all levels towards a culture of more sustainable plastics waste management.

Industrialists should know the type and quantity of waste produced by their operations and processes, whereas a waste generator should know the composition, properties and environmental impact of the waste. Without this knowledge industrialists cannot properly manage their operations and cannot discharge their responsibilities to protect the health and safety of employees, i.e., the nature of the waste they are exposed to must be known, otherwise they are not in full control of their operation; in addition, if the quantity of waste is unknown the cost, material balance and efficiency cannot be determined [13].

When solid waste including plastics waste disappears from an ecological-economic system, the system changes dramatically. In fact, what is particularly significant is that the disappearance of plastics often triggers the loss of other applications, and when this happens, the complex connections among nexus components, such as packaging with other substitute material, begin to evolve. Minimizing solid waste through an ecological-economic system in effect addresses environmental problems.

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