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STUDIES ON PLASTIC WASTE MANAGEMENT IN INDUSTRIES – CHALLENGES AND STRATEGICAL APPROACH

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Abstract:
Plastic is one of most widely used material on the planet. It's easily available, durable and can be moulded into anything from bottles to Rubik's cube. Plastic is a reign of among the variety of materials used in various sectors like automotive, construction, healthcare, packaging, agriculture, transportation, piping, manufacturing of household and electronic goods, textiles and other engineering applications. As the plastic is used in various sectors, so the consumption of plastic is more. This paper seeks to explore the all aspects related to plastic waste management and environmental sustainability by managing the usage of plastic. It also touches upon laws and policy implementation. The extended measures to recycle the maximum amount of plastic and proper usage steps are also advised for the better eco-friendly India.

1. Introduction

Plastics are lightweight, versatile and durable, and play critical role in many of our technological advancements from automobiles and computers to replacement heart valves. In spite of their ubiquitous presence, plastic is seen as a challenge to animals, marine life and future generations of humans. After food waste and paper waste, plastic waste is the major constitute of municipal and industrial waste. The quantum of plastic waste is ever increasing due to increasing of population, developmental activities, changes in life styles and socio-economic conditions. Plastic waste is a significant portion of the total municipal solid waste. The plastic waste constitutes two major category of plastic i.e. Thermoplastics and Thermosets plastics.

1.1 Plastic is dumped into seas and landfills or it burns in air

Many cities in India lack designing the landfills for the disposal of plastic waste. Single usage of plastic leads to large collection of plastic waste. It is dumped in the landfill sites and seas along the solid waste. In landfills plastic degrades into smaller components and leaches into soil and water, it pollutes the earth components. It affects the soil quality and there is direct impact on cultivation. Overtimes it enters into the soil and finally reaches the ground water. It leads to ground water contamination.

The problems of Ocean plastics are on the rise due to over flow effect of plastic which is dumped into the sea. Plastic waste can enter into marine environment from land by river, drainage or by sewage systems or by wind transport. The Figure 1(a) showed the possible top ocean polluters. In seas plastic pollution impacts turtles, whales, seabirds, fish, coral reefs and other marine species and habitats. So the Plastic in ocean can arise both land based and marine sources.

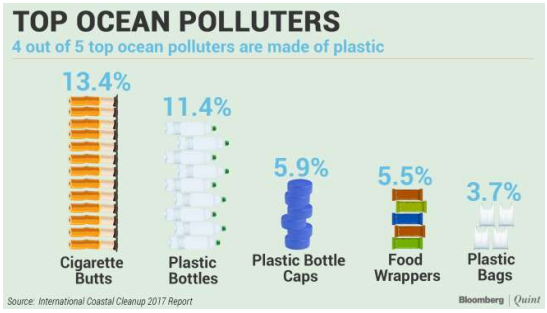

Fig.1(a) Top Ocean Polluters [1]

Waste burning of plastic, without taking the certain measures is biggest problem. As the plastic burns in the air, chemical reactions take place and air gets polluted. So in this way Natural environment gets polluted.

The industrial plants that create chemical products derived from petroleum, called petrochemical are essential for plastic production. Besides Plastic production, plastic engineering is an important part of the industrial sector. Petrochemical plants release chemicals into the atmosphere and produce massive amount of greenhouse gases, significantly contributing the climate change. Because the petrochemical industry is reliant on fossil fuels, it runs the risk of oil spills and other fossil fuel disasters. Communities living at the frontline of the petrochemicals plants face the added dangers of air and water pollution, especially in the wake of a natural disaster. The Figure 1(b) shows the effect of Plastic on Ecosystem .

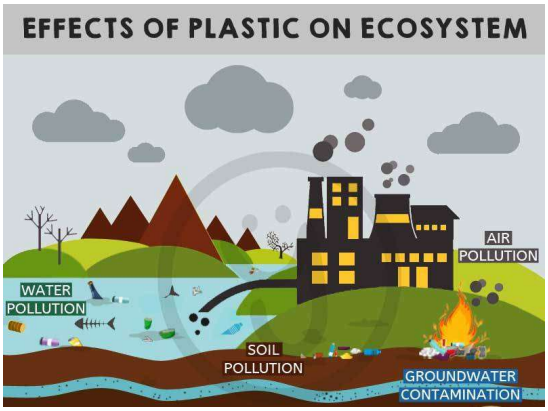

Fig.1(b). Effect of Plastic on Ecosystem [1]

Range of products and usages of petrochemicals is extremely wide and diverse. Petrochemicals are broadly categorized into building blocks, plastics, synthetic rubbers, synthetic fibers, fiber intermediates and basic chemicals. Petrochemicals are enablers for growth of other sectors of the economy. Sectors like agriculture, housing, textile, health-care, infrastructure, consumer goods use a variety of petrochemical products for their versatility, cost efficiency and affordability.

2. Methodology

2.1 Environmental issues on disposal of Plastic Waste:

Indiscriminate littering of unskilled recycling / reprocessing and non-biodegradability of plastic waste raises the following environmental issues:

- During polymerization process fugitive emissions are released.
- During product manufacturing various types of gases are released.
- Indiscriminate dumping of plastic waste on land makes the land infertile due to its barrier properties.
- Burning of plastics generates toxic emissions such as Carbon Monoxide, Chlorine, Hydrochloric Acid, Dioxin, Furans, Amines, Nitrides, Styrene, Benzene, 1, 3-butadiene, CCl4, and Acetaldehyde.
- Lead and Cadmium pigments, commonly used in LDPE, HDPE and PP as additives are toxic and are known to leach out.
- Non-recyclable plastic wastes such as multilayer, metalized pouches and other thermo set plastic poses disposal problems.
- Sub-standard plastic carry bags, packaging films (<40μ) etc. pose problem in collection and recycling.
- Littered plastics give unaesthetic look in the city, choke the drain and may cause flood during monsoon.
- Garbage mixed with plastics interferes in waste processing facilities and also cause problems in landfill operations.
- Recycling industries operating in non-conforming areas are posing threat to environment to unsound recycling practices.[1]

2.2 Environment Ministry of Government rules regarding the Plastic waste management (2018)

1. The amended rules lay down that the phasing out the multi layered plastic (MLP) is applicable, which are non recyclable, or non energy recoverable or with no alternate use.
2. Explicitly pricing of carry bags are omitted (Rule no.15).
3. Increase minimum thickness of plastic carry bags from 40 to 50 micros and stipulate minimum thickness of 50 microns for plastic sheets also to facilitate collection and recycle of plastic waste.
4. Expand the jurisdiction of applicability from municipal areas to rural areas, because plastic has reached rural area also.
5. To bring in the responsibilities of producers and generators, both in plastic waste management system and to introduce collect back system of plastic waste by producers/ brand owners, as per extended producers responsibility.
6. To introduce collection of plastic waste management fee through pre-registration of the producers, importers of plastic carry bags/multilayered packaging and vendors selling the same for establishing the waste management system.
7. To promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc, for gainful utilization of waste and also address the waste disposal issue; to entrust more responsibility on waste generators, namely payment of

user charge as prescribed by local authority, collection and handling over of waste by institutional generator, even organizers.

8. An eco-friendly product, which is complete substitute of the plastic in all uses, has not been found till date. In absence of a suitable alternative, it is impractical and undesirable to impose a blanket ban on the use of plastic all over the country. The real challenge is to improve Plastic waste management systems [1].

The Figures 2(a) , (b) & (c) showed Rise of Plastic Consumption in India, Top 5 Plastic waste Producing States of India and Mismanaged Plastic Waste every year in world.

Fig.2(a) Rise of Plastic Consumption in India [2,3]

Fig.2(b). Top 5 Plastic waste Producing States of India [2]

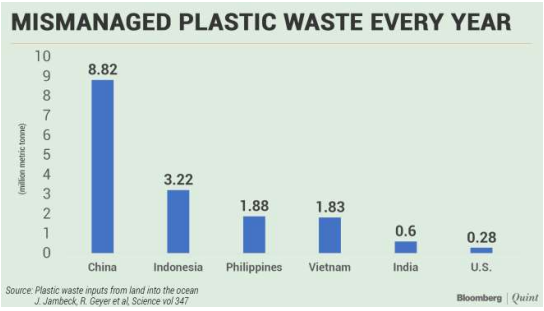

Fig.2(c) Mismanaged Plastic Waste every year in world [2,3]

2.3 Focused Issues on Plastic Waste Management in Petrochemical Industry

Petrochemicals are derived from various chemical compounds, mainly hydrocarbons. These hydrocarbons are derived from crude oil and natural gas. Among the various fractions produced by distillation of crude oil, petroleum gases, naphtha, kerosene and gas oil are the main feed stocks for petrochemical industry. Ethane, propane and natural gas liquids obtained from natural gas are the other important feed stock used in the petrochemical industry. Petrochemical industry plays a vital role in economic growth and development of manufacturing sector. The value addition in the petrochemicals industry is higher than most of the other industry sectors. The Petrochemical industry, which entered in the Indian industrial scene in 1970s, registered a rapid growth in the 1980s and 1990s. Petrochemical industry mainly comprise of synthetic fiber / yarn, polymers, Synthetic Rubber (elastomers), Synthetic detergent intermediate, performance plastics and plastic processing industry. Today petrochemical products permeate the entire spectrum of daily use items and cover almost every sphere of life like clothing, housing, construction, furniture, automobiles, household items, agriculture, horticulture, irrigation, packaging medical appliances, electronics etc.

Presently there are eleven naphtha and dual feed cracker complexes in operation with combined ethylene capacity of about 7.05 million tonnes per annum. The Table-1 showed the Production performance of major petrochemicals during 2012-13 to 2016-17. In addition, there are six aromatic complexes in operation with a combined Xylene capacity of about 5.5 million tons.

Table - 1.The Production Performance of Major Petrochemicals during 2012-13 to 2016-17.

Sub Group	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Synthetic Fiber	3124	3144	3527	3554	3595
Polymers	7509	7876	7558	8839	9163
Elastomers	96	105	172	242	285
Synthetic Detergent Intermediate	627	597	596	566	664
Performance Plastics	1691	1685	1591	1700	1799
Total	13047	13406	13443	14900	15506

The annual consumption of virgin grade polymers for the year 2017-2018 was 15.9 Million Tonnes. Demand for Plastics in India is currently growing at an average rate of 8.9% for the past 4 years (2013-14 to 2017-18). It is expected to reach24 Million Ton by 2022-23 and 35 Million Ton by 2027-28.

3. Results and Discussion

Plastic waste management can be divided into (1).Conventional technology: (a) Recycling (b) Incineration (c) Land filling and (2). New technology: (a) Plasma Pyrolysis technology (b) Polymer blended bitumen roads (c) Liquid fuel (d) Co processing in cement kiln**.**

Recycling- Plastic recycling refers to the process of recovering waste or scrap plastic and reprocessing it into useful product. Waste from our homes is generally collected by our local authorities through regular waste collection or by special collections for recycling (plastic collecting business as a source of income).

Sink Float Systems- Sink float separation systems are very common and simple methods of separating materials of different densities. Some plastics, like PVC and PET, have very similar densities and cannot be separated by normal sink float system. There are specially designed machines that help in sorting of the plastics according to their resin content. Then the recycling mill sorts the scrap plastic by symbols at the bottom of the plastics.

Cleaning- After a complete separation, the flakes or chunks are then washed with detergents to remove the remaining contamination. Once the cleaning process is complete, the clean flakes are passed through specialized equipment that further separates the plastic resin types. The plastic flakes are then subjected to moderate heat to dry.

Sorting- The actual plastic recycling process starts with sorting of the different plastic items by their resin content. Companies that buy recycled resins want those recycle resins to have the same characteristics as virgin resins. Otherwise, it is not efficient to use recycled materials. Example: Recycling is the case of PET and PVC. These two resins are contaminants to each other combinations of PVC and PET resins can result in the release of hydrochloric gases. The PET resin will be ruined even with only a few parts per million of PVC resin.

Manual sorting; Most of the current plastic sorting is done by hand. It is a simple process and needs very little technology. But it leaves much room for improvement and is costly. It is inefficient method for sorting and it is difficult to differentiate between the resin types used in packages through the visual means employed by-manual sorting.

Macro sorting- Micro sorting deals with plastic after it has been chopped up into pieces. This type of sorting is the only one currently available commercially. It has the advantage of needing very little or no preparation before sorting. It has lower shipping costs and facilitates larger volume processing.

Shredding -After sorting the plastics, the next step is to cut the plastics into tiny chunks or pieces. The heavier and lighter plastic flakes are separated using a specially designed machine. The separation process helps in ensuring that the different plastics are not put together or mixed up in the final product

Making of Pellets- After the melting process, the plastic pieces are then compressed into tiny pellets and become ready for reuse or be redesigned into new useful plastic products.

Melting- The dry flakes are melted down. They can be melted down and molded into a new shape or they are melted down and processed into granules. The melting process is done under

regulated temperatures. There is specialized equipment designed to melt down plastic without destroying them.

1. Advantages of Recycling Plastics

Plastics should be recycled because of a number of reasons as can be seen below:

1. Provision Of A Sustainable Source Of Raw Materials- Recycling plastics provides a sustainable source of raw materials to the manufacturing industry.
2. Reduces Environmental Problems-Since plastics are non-biodegradable, they pose a high risk to the people and the environment as a whole.
3. Reduces Landfill Problems-Recycling plastics minimize the amount of plastic being taken to diminishing landfill sites. Little plastic garbage (can be used for agriculture or for human settlement).
4. Consumes Less Energy-Recycling of materials including plastics requires less energy as compared to making the plastic from scratch. Energy can be diverted to other important things in the economy. It will save the economy billions of money. The process of manufacturing plastic using natural raw materials is expensive and time consuming compared to the recycling process.

2. Co-processing in cement kilns

Co-processing of plastic waste as an alternative Fuel and Raw Material (AFR). Co-processing indicate substitution of primary fuel and raw material by waste. Waste material such as plastic waste used for co processing are referred to as alternative fuels and raw material (AFR). One of the advantage of recovery method used in existing facility is eliminating the need to invest on other plastic waste practices and to secure land filling.

3. Construction of polymer (plastics) coated bitumen road

It involves the following steps: Plastic waste collection, segregation and storage. Cleaning and drying of plastic waste. Shredding plastic waste into required size (2 to 4 mm). Stone aggregate (granite ceramic) is heated to around 160 to 170^0C. Shredded polymer (5 to 10%) is added to heated stone aggregate for 30 to 40 sec and mixed for uniform coating at surface of aggregate. The coated aggregate is mixed with hot bitumen at temperature ranges from 155 to 163^0C. The mix composite aggregate known as waste plastic aggregate bitumen mix (130 to 140^0C). This composite is used for road laying at temperature between 110 to 130^0C.

4.Liquid fuel

Conversion of Plastics Waste into liquid fuel. The entire process is undertaken in closed reactor vessel followed by condensation, if required. Waste plastics while heating up to 2700 to 3000^0C convert into liquid-vapor state, which is collected in condensation chamber in the form of liquid fuel. The tarry liquid waste is topped-down from the heating reactor vessel. The organic gas is generated which can be used in dual fuel diesel generator set for generation of electricity.

5. Plasma Pyrolysis technology

Pyrolysis is the thermal disintegration of carbonaceous material in oxygen-starved atmosphere. The Figure 3 showed the complete processed structural Usage of Pyrolysis Process to extract the different industrial waste recovery products and by-products. The intense and versatile heat generation capabilities of Plasma Pyrolysis technology enable to dispose of all type of plastic waste including polymeric, biomedical and hazardous waste in a safe and reliable manner.

When optimized, the most likely compounds formed are methane, carbon monoxide, hydrogen, carbon dioxide and water molecules.

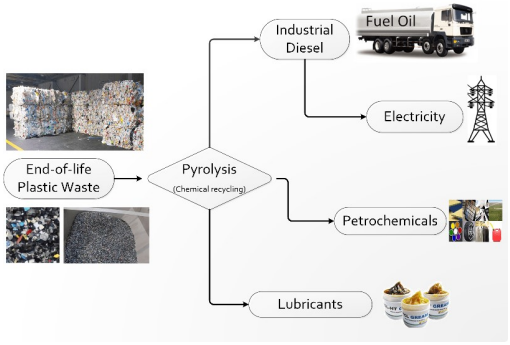

Fig.3. Use of Pyrolysis Process [4,5]

4. Conclusions:

- The government should immediately make a mandatory clause for maintaining a PLASTIC DISPOSABLE UNIT in every micro, macro, small, medium and large scale industries.
- Households are the biggest collections of plastic waste. So the segregation of plastic waste from homes and offices should sell all these dry waste –paper, milk sachets, etc, where as domestically waste reduction can be achieved.
- Municipalities can setup MATERIAL RECOVERY FACILITIES (Dry Waste Collection Centers), where recyclable plastic can be sold at pre-decided rates as industrial waste reduction can be achieved.
- Companies can work with municipalities to collect back the packaging waste generated from their products itself.
- Governments can levy a high fee on plastic bags instead of banning plastic. This will tends to behavioral change in the human kind for their better future endeavors.
- The government should focus on funding towards research activities to develop Eco-Friendly plastic materials such as BIO-PLASTICS in the usage.

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