Plastic Waste in India- Management and Utilisation

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ABSTRACT

India being a developing country, consumption of plastic products and hence the generation of waste is increasing at an alarming rate. Around 60% of the plastic waste is recycled, mainly by the informal sector, under serious constraints due to the lack of fiscal incentives. Financial limitations are a constraint to the technical improvements needed to satisfy market demand. Non-recyclable plastic wastes are of major concern as they lead to serious environmental and health issues. They are either subjected to landfilling or incineration emitting toxic fumes of dioxins, furans, methane, carbon monoxide, chlorine, hydrochloric acid etc. The aim of the study is to provide an overview of the plastic waste management scenario in India and improving the same taking the aid of newer technologies. The study is divided into two parts: the first part comprises of general outlook towards the present status of plastic waste management and a brief interaction with few of the people dealing in the recycling process. This helped to gather information on the use of recycled products and their hub of recycling. The second part includes the examination of a South Korean model which can be replicated in India. It effectively converts plastic waste into fuel by the process of pelletization and can be used as a substitute for coal by the use of a waste plastic burner. Waste will prove to be a resource rather than a burden. In addition, this paper suggests certain strategies which when adapted can improve the plastic waste management process in India.

Keywords: lastic waste, recycling, pelletisation, incineration

1. INTRODUCTION

Almost all the major cities in India have experienced unprecedented population and industrial growth over the last few years. Continuous migration of the people from rural to urban centers in search of better employment opportunities has put a lot of pressure on the limited natural resources in the urban cities. Human activities and the rate of utilization of resources always generate waste, large concentration of which constitutes plastic waste.

Plastics are inherently unsustainable, derived from non-renewable petroleum sources. From cradle to grave, plastics are implicated in a variety of problems, including environmental pollution and

worker health hazards during manufacture, processing and disposal; toxic exposure to consumers during use; cattle and wildlife deaths due to ingestion of plastic wastes. Despite of this, plastics have become an integral part of our lives because of their low cost, high durability and low weight. They can be classified as given in Table 1.

India is a developing country with a present population of approx. 1020 million [1]. Plastic consumption has increased from 61,000 tonnes in 1996 to 135, 00,000 tonnes in 2011[1]. Per Capita Generation of plastic waste is 6 kg per annum and hence the Plastic Waste Generation comes out to be approx. 16,500 tonnes per day [1]. There are more than 20,000 plastic processing units that generate an average output of Rs 85,000 Crore per annum. Around 7,500 recycling units are responsible for the recycling of 60% of the plastic waste generated in the country[1]. The plastic industry as a whole also provides gainful employment to about 3.3 million people.[1] Hence, plastic industry is not just any other chemical industry in this country but it is one of the most promising and prominent source of income and livelihood for millions of people.

Table 1: Categorization of plastics [2]

Symbol	Short Name	Scientific Name	Uses
	PET	Polyethylene Terphthalate (PET)	Water bottles, PET Bottles, etc.
	HDPE	High Density Polythylene (HDPE)	Milk/detergent bags, Carry bags, containers
	PVC	Poly Vinyl Chloride (PVC)	Cable, pipes, Flooring
	LDPE	Low Density Polyethylene (LDPE)	Carry bags, films
	PP	Polypropylene (PP)	Medicines bottles, Packaging films, cereal Liners
	PS	Polystyrene (PS)	Foam packaging, Tea Cups, ice cream cups
	O	Others	Thermoset plastics, Multilayer and laminated Plastics, PUF, nylon etc.

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2. CURRENT SCENARIO OF PLASTIC WASTE MANAGEMENT (PWM) IN INDIA

Due to enormous amount of plastic waste generated per day, a series of steps are being implemented involving a chain of people comprising of the **Ragpickers** (Form the backbone of plastic waste management in India and clean about 12-15% of municipal solid waste generated), the **Khabariwala** (move house to house to collect the waste whereas **Raddiwala** remain stationery at their shop and carry out their business), the **Scrap dealer** (get their waste from mobile khabariwala and stationery raddiwala) and the **Bulk Buyer**s (traders that collect material until it is sufficient to be sent to the recycling plant . The current scenario of PWM in India is presented in Figure 1 in the flow chart form Generally, the major operations involved in waste management process includes the collection of plastic waste followed by their disposal in landfills or incineration to reduce their volume and obtain energy[3]. The negatives of plastic waste disposal in landfills and incineration of plastic waste are presented in the following paragraphs.[3]

Disposal of plastic waste in landfill: Disposal of plastic in landfills leads to slow degradation which reduces the quality of the material. Land filling plastic waste decreases the density of the wastes and thus a lot of area is taken up. Moreover, plastics interfere with the degradation of other organic wastes. If plastic cover other biodegradable wastes, air supply ceases and anaerobic decomposition produces methane that is a potent green house gas that contributes to climate change. It also leads to water pollution and contaminates the land.

Incineration of plastic wastes: The heat content of plastic waste can be recovered by incineration. Plastic wastes are a good source of fuel in addition to reduction in the volume of garbage by about 90-95%. [4]Through incineration, plastic proves to be an alternate source of energy but it leads to a lot of resistance by the public due to the emission of toxic gases like Carbon Monoxide, Chlorine, Hydrochloric Acid, Dioxins, Furans, Amines, Nitrides, Styrene, Benzene, 1,3- butadiene, CCl_4 and Acetaldehyde . [4] These can pose a serious threat to human health by causing damage to the reproductive system, immune system and cancer.[4]

A brief interaction was also carried out with few of the persons involved in recycling of plastic waste. Results obtained of the same are presented in Table 2.

3. PROPOSED TECHNOLOGIES FOR PWM IN INDIA

Waste Plastic has been a burden to mankind and is known for exhausting the resources on the planet earth. However, tremendous advancement in science and technology has led to the miraculous transformation of the non-hazardous and combustible plastic waste into potential energy generating fuel.[6] The vital factors which are solemnly responsible for the quality of the

plastic fuel are the smooth feeding to conversion equipment, effective conversion into fuel products, well-controlled combustion and clean flue gas in fuel user facilities[6]. Two of these technologies that can be implemented in India are presented in the following paragraphs:

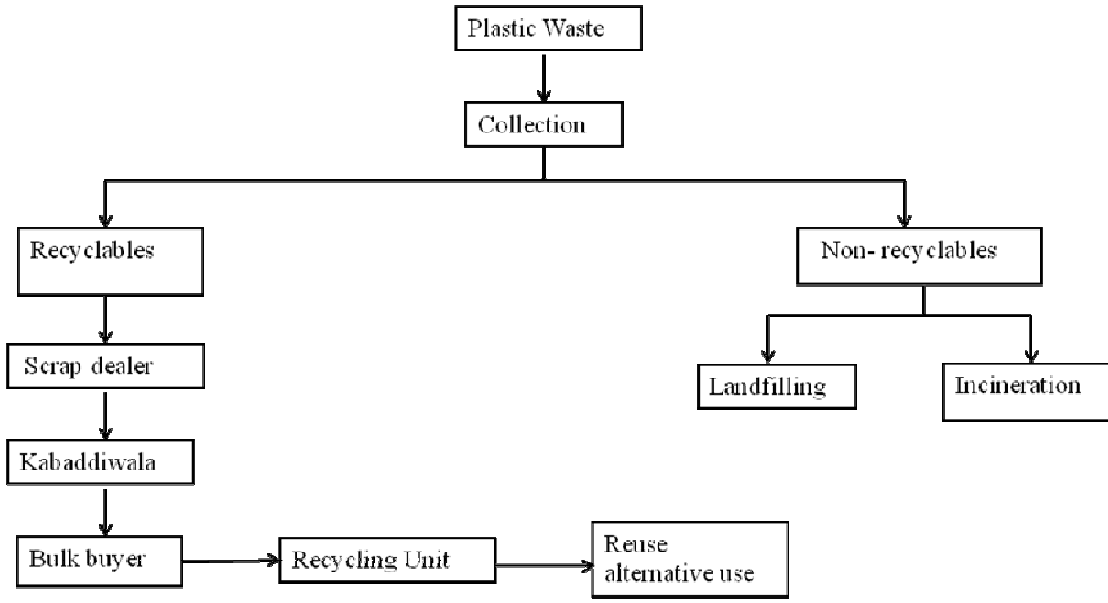

Figure 1: Current scenario of Plastic Waste Management in India

Table 2: Results of the survey

Plastic Waste	Hub of plastic recycling	Use of the recycled product
Plastic pet bottles (juice, cold drinks, liquor bottles)	Surat	Variety use of material
Vegetable bags thrown in drains and on roads	Jaipur	High strength underground wiring for telephone and electricity purpose in West Bengal.
Used tyres of vehicles	Punjab	Rubber gives a)Furnace oil - a substitute for diesel b)Carbon -in the form of black powder can be sold

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		c)Iron -can be recycled again
Side waste of polyester films (10mm from each side)	Bhavnagar, Gujarat	Ropes that serve as a substitute for jute and have high strength, durability, long life and are cheap. These are used in villages as well as in developed areas
Waste from polyester films/ X-ray films	Surat	It is washed and the silver water obtained is cleared which is used to make collar bone and fibre
Milk bags	Delhi, Punjab	Vegetable bags
Plastic Bags	Surat, parts of Punjab	PVC chappals, paper on plastic bottles and local suitcases

1. Pelletisation and Eco-Clean Burner [5,6]

Pelletising is the process of compressing or moulding a material into the shape of a pellet. For the pellets to be formed, pretreatment is required to be given to the waste plastic. Pre-treatment includes fine and coarse shredding and removal of non-combustible materials. Here vegetables, cartons and papers are disintegrated into fine particles of size 4-5 mm which serve as a binder to form pellets or briquettes by melting and adhering to other non-melting substances such as paper, wood and thermosetting plastics. Lime is then added to prevent continuing decay of organic matter. The mixture is then fed to the horizontal rotary dryer at 300°C which serves the purpose of proper mixing of fine and coarse garbage and ensures its homogeneity with lime. Secondly, it leads to the reduction in moisture of waste to 12% as it is a pre-requisite for pelletization. The mixture is then transferred to the pelletizing machine through the conveyor belt. The machine effectively works at a pressure of 1200 psi, with a capacity of 4 tonnes per hour and moisture content of 10-12%. This results in the production of compressed pellets. The pelletization of the waste plastic produces pellets of three forms:

a) Solid Fuel Pellet: Solid fuel is prepared from both municipal and industrial non-hazardous waste. Solid waste plastic pellet overtakes coal and their derived fuels as well as solid bio fuels like firewood and dried manure. They are further classified into two categories:

   - A. Refuse Derived Fuel = Waste Plastics are generally containing moisture and obtained from kitchen and other municipal wastes and require heating as pretreatment process.

- B. Refuse-derived Paper and Plastic Densified Fuel = Waste Plastics are prepared from used paper and other dry feedstock and are widely used.

Output

i. Pellets of dimension between 6 to 60 mm in diameter and 10 to 100 mm in length.

ii. Pellets having calorific value of 18,000-20,000 kJ/kg. Every 1 tonne of pellets can produce 1MW power in the gasification plant.

iii. Plastic burns cleanly giving high energy levels and less dioxin emissions.

b) Liquid Fuel Pellet: They are plastic derived liquid hydrocarbons at normal temperature and pressure. Poly Styrene (PS), Poly Ethylene (PE), Poly propylene (PP), Acrylonitile butadiene styrene (ABS) etc are widely used and they are likely subjected to the contamination by amines, alcohols, waxy hydrocarbons, some inorganic substances, nitrogen, sulphur and halogens gives flu gas pollution. They generally require certain fuel like Gasoline and kerosene for the advanced process. However, they are likely to have more moisture.

c) Gas Fuel Pellet: They are heavily subjected to the polluted contaminants and have not met their utilization on the large scale.

Once the pellets are formed, they are burned in a burner commonly called **Eco Clean Burner** which derives energy out of the plastic pellets. This waste plastic burner is the mechanical and electrical framework which is responsible for the conversion of the waste plastic pellet into the energy. They use the pellet type of Polyethylene, Polypropylene, ABS Pellets and have an efficiency of 75% which could reach to 89% at 150 F of water but produces dioxin emission of 0.119 ng-TEQ/sm^3 at 12 % of O_2. The fuel from this burner has a variety of applications in greenhouses, agricultural structures, commercial applications and light industrial applications.

4. CONSTRUCTION AND WORKING OF ECO CLEAN BURNER

The present invention relates generally to burners that use solid fuels, especially waste plastic fuels. Burner size is minimized by having multiple combustion chambers arranged concentrically around a rotating screw conveyor. Heat efficiency is improved by having an air chamber disposed around the combustion chambers, because the air for the combustion is preheated prior to being delivered to the combustion chambers, while the air chamber at the same time thermally insulates the combustion chambers against the environment. Waste plastic is transported from a fuel hopper to

the combustion chambers by a rotating screw conveyor having spiral auger blades. Speed of the screw conveyor rotation controls the consumption of waste plastic and, hence, the amount of thermal energy generated in the burner. Parts of the combustion chambers can also rotate to auger waste plastic for better oxidation, therefore enhancing the combustion process.

1.5 litres of kerosene is preheated for 20 minutes and then it is mixed thoroughly with the pellet and the mixture is fed in the chamber.

Output:

The output is 100,000 kcal/hr with use of 11,500 kcal/kg of Plastic fuel pellets with boiling water heat of 1 ton water requiring 45 heating minutes and power needed is 4KW @ 110 – 208 Vac of vacuum fuel supply with operating temperature in the chamber of 900-1100 C.Average fuel Gas Temperature is 151 degree Celsius and average fuel gas flow rate is 5.1 m/s. Boiling heat Time is 5 hours where 2 hours for heating and 5 hours for Circulation.

There are several models yet getting proposed in order to reduce waste plastic and result into a better living environment.

2. Incineration

An eco-friendly incineration unit should be designed which can capture all the unwanted toxic gaseous emissions mainly dioxins and furans so that they cannot directly pollute the atmosphere. These trapped gases can be used in a productive way and at the same time the volume of the garbage can be reduced up to 90%. Bottom ash produced from incineration as a result of combustion process and is the largest residue from incineration. It consists mainly of aggregate (80%), organics (5%), and other trace amounts can be used in infrastructure processes or as road fillers.[7]

5. CONCLUSION

Source separation of solid waste is one option that can be effectively carried out by involving the waste generating agents and integrating the formal and informal authorities. It is necessary to bring a change in attitudes, which views waste management as a responsibility of the municipal body and treats waste picking as an illegal activity. Therefore, it is worth considering the integration of the informal practices with the existing formal system and look into options of decentralizing waste management with the involvement of the waste pickers. The recycling industry has to be promoted as it presents a source of livelihood to millions of people in the country. Technology as mentioned above will help people to see value of plastic waste. Our Government should encourage

government companies to adopt such technologies. The newer technologies and efforts of every individual will go a long way in making the Earth a better place to live in.

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