



Ministry of Housing & Urban Affairs
Govt. of India

CAPACITY BUILDING PROGRAMME ON IMPLEMENTATION OF WASTE MANAGEMENT RULES, 2016



Ministry of Environment, Forest &
Climate Change, Govt. of India

Tool Kit on Plastic Waste Management Rules 2016



Central Pollution Control Board



National Productivity Council

TOOLKIT PLASTIC WASTE MANAGEMENT RULES, 2016

**Environmental
Issues of
Plastic waste**

**Salient
Features of
the PWM
Rules, 2016**

**Responsibilities
of
stakeholders**

**Management
&
Disposal of
Plastic waste**

**Your Guide For
Safe & Scientific Management Of
Plastic Waste**

**1st Edition
June, 2019**

Preface

National Productivity Council (NPC) is pleased to present to you the 'Toolkit on Plastic Waste Management Rules 2016'. This toolkit has been crafted specially for all the stakeholders involved in the generation, collection, storage, transportation & treatment of plastic waste.

The toolkit has ten sections broadly classified under environmental issues of plastic waste, salient features of PWM rules, 2016, responsibilities of stakeholders, recycling of plastic waste, utilization of non-recyclable plastics and finally disposal of plastic waste. It provides useful tips, dos and don'ts, methods and practices that should be followed in the plastic waste management.

The toolkit has been brought together by a team of technocrats and environmentalists. It has been carefully reviewed by experts.

This toolkit is to guide safe and scientific management of plastic waste .

NPC would welcome any suggestions and feedback on this publication so that “The Toolkit” becomes a trusted companion and part of all stakeholders.

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Regional Director, Delhi

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National Productivity Council

Note: 1. All pictures used in the toolkit are from various sources, which have been duly referred to.
2. This publication is purely for education purpose and not for commercial purpose.

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1. INTRODUCTION

The rapid rate of urbanization and development has led to increase in consumption of plastic products leading to plastic waste generation. It is a fact that plastic waste constitutes a significant portion of the total municipal solid waste (MSW) generated in India. Plastics are non-biodegradable and remain on earth for thousands of years. The burning of plastics waste under uncontrolled conditions lead to generation of different hazardous air pollutants (HAPs), depending upon the type of polymers and additives used. However, the end-of-life plastics can be recycled into a second life application but after every thermal treatment/recycling deterioration in quality of recycled plastic product occurs. Thus plastic waste can be recycled only 3-4 times. The visibility of huge quantity of plastic waste has been perceived as a serious problem and made plastics a target in the management of solid waste. As per IS 14534: 1998 “Guidelines for Recycling of Plastics”, to identify the raw material of plastic products, the symbols defined by Society of the Plastics Industry (SPI, USA) shall be marked on each product. Different types of plastics and their uses are given in Table 1.

Table 1: Different Types of Plastics and its Uses

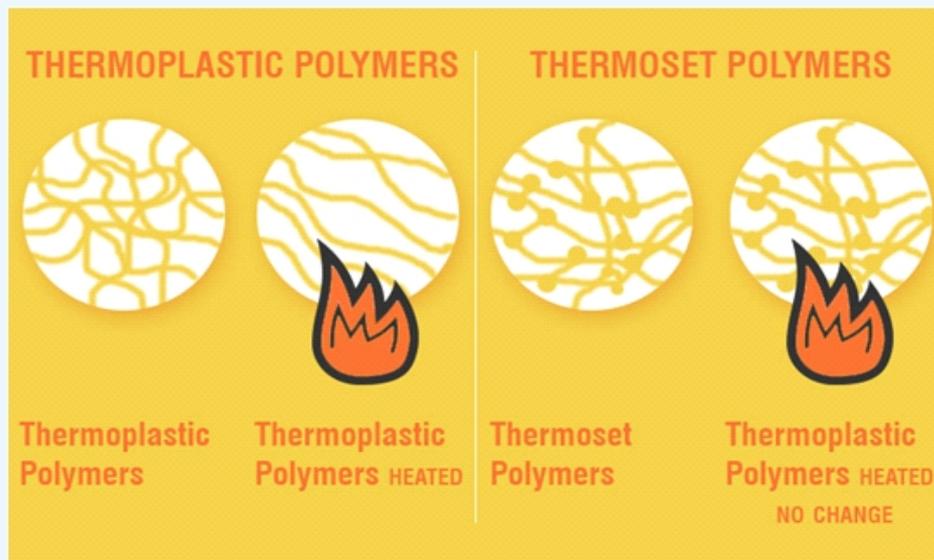
S. No.	Symbol	Short Name	Scientific Name	Uses
1		PET	Polyethylene terephthalate	Soft drink bottles, furniture, carpet, paneling etc.
2		HDPE	High-density polyethylene	Bottles, carry bags, milk pouches, recycling bins, agricultural pipe, base cups, playground equipment etc.
3		PVC	Polyvinyl chloride	Pipe, Window profile, fencing, flooring, shower curtains, lawn chairs, non-food bottles and children's toys etc.
4		LDPE	Low-density polyethylene	Plastic bags, various containers, dispensing bottles, wash bottles, tubing etc.
5		PP	Polypropylene	Auto parts, industrial fibers, food containers, dishware etc.
6		PS	Polystyrene	Cafeteria trays, plastic utensils, toys, video cassettes and cases, clamshell containers, insulation board etc.
7		O	Other	Thermoset Plastics, Multilayer and Laminates, Bakelite, Polycarbonate, Nylon SMC, FRP etc.

Plastics are generally categorized into two types:

- **Thermoplastics:**

§ Thermoplastics or Thermosoftening plastics are the plastics which soften on heating and can be molded into desired shape such as PET, HDPE, LDPE, PP, PVC, PS, etc.

- **Thermosets:** Thermoset or thermosetting plastics are developed on heating, but cannot be remolded or recycled such as Sheet Molding Compounds (SMC), Fiber Reinforced Plastic (FRP), Bakelite etc. which are the examples of the same.



For efficient management of plastic waste, the Government of India has superseded earlier Plastic Waste (Management & Handling) Rules, 2011, and notified **Plastic Waste Management (PWM) Rules, 2016** on **18th March, 2016**. These rules shall apply to every Waste Generator, Local Body, Gram Panchayat, Manufacturer, Importer, Producer and Brand Owner throughout India.

2. ENVIRONMENTAL ISSUES OF PLASTIC WASTE

Following are the major environmental issues related to plastic waste

- Littering of plastic waste is major environmental issues, it makes land infertile, chokes the drains, on ingestion by cattle cause death and give ugly look to a city or town.
- Lack of proper system for plastic waste collection and segregation in cities/towns, besides plastic waste is not easily available in segregated manner.
- Accumulation of non-recyclable plastic waste such as multilayered metalized laminated packaging and thermoset plastic like SMC, FRP etc.

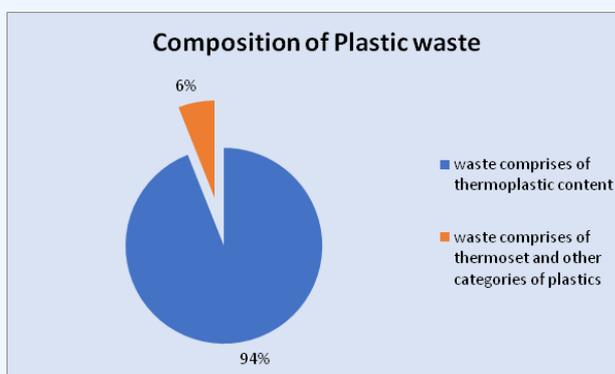
- Open burning of plastic waste; especially PVC and thermoset plastic waste is major health and environmental issue, as it emits toxic gases which may cause cancerous disease.
- Leaching impact on soil, underground water etc., due to improper dumping of plastic waste (contain metals & phthalates).
- Running of unregistered plastic manufacturing and recycling industries in residential areas.



3. PLASTIC WASTE GENERATION IN INDIA

The fraction of plastic waste in total Municipal Solid Waste (MSW) varies from 3.10% (Chandigarh) to 12.47% (Surat). Average plastic waste generation is approx. 7% of MSW. As per the study conducted by Central Pollution Control Board (CPCB) in 60 major cities of India, it has been observed that around 4059 T/day of plastic waste is generated from these cities. With extrapolation of the plastic waste generation data from 60 major cities, it is estimated that around 25,940 T/day of plastic waste is generated in India.

The fraction of plastic waste in total Municipal Solid Waste (MSW) varies from 3.10% (Chandigarh) to 12.47% (Surat). Average plastic waste generation is approx. 7% of MSW.



As per the results of the study, out of total plastic waste, around 94% waste comprises of thermoplastic content, which is recyclable such as PET, LDPE, HDPE, PVC etc. and remaining 6% belongs to the family of thermoset and other categories of plastics such as sheet moulding compound (SMC), fibre reinforced plastic (FRP), multi-layered, thermocol etc., which is non-recyclable.

4. PRESENT STATUS OF PLASTIC WASTE MANAGEMENT IN INDIA

As per the Annual Reports on Implementation of Plastic Waste Management Rules, 2016, the following key issues have emerged:

- The manufacturing, stock, sale & use of less than fifty micron (<50µm) plastic carry bags is continued in majority of States/UTs. Besides, carry bags/films are manufactured, stocked sold and used without proper label or marking.
- Widespread littering of plastic waste continue on road-side, railway tracks, open areas, open drains, river banks, sea-shores, beaches, public places like Bus-station/Bus-stops, open market etc.
- The estimated plastic waste (PW) generation is approx. 26000 metric tons/day (based on per capita PW generation)
- A number of unlicensed/unregistered plastic manufacturing & recycling units are running in residential or non-conforming areas.
- Accumulation of PW may lead to choking of drains, can cause land infertility, on ingestion by cattle's may lead to death etc.
- No proper system evolved by majority of Municipal Authorities for collection, segregation and disposal of PW.
- Many States/UTs have not constituted State Level Monitoring Committee (SLMC) Body for implementation of PW (M&H) Rules, 2011.
- Open burning of PW is continued & may contaminate ambient air quality resulting into diseases to human beings.



5. KEY DEFINITIONS AS PER PWM RULES, 2016

Some of the important keywords as per PWM Rules, 2016 are explained below:

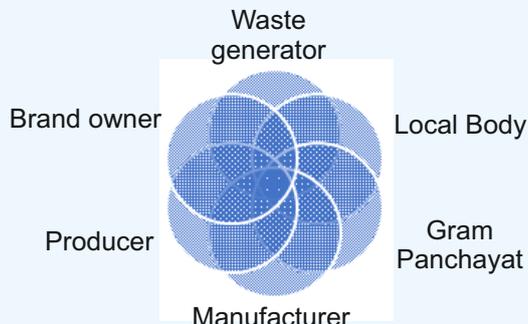
- i) **Brand Owner** : Brand Owner means a person or company who sells any commodity under a registered brand label.
- ii) **Carry bags** : Carry bags mean bags made from plastic material or compostable plastic material, used for the purpose of carrying or dispensing commodities which have a self-carrying feature but do not include bags that constitute or form an integral part of the packaging in which goods are sealed prior to use.
- iii) **Commodity** : means tangible item that may be bought or sold and includes all marketable goods or wares.
- iv) **Compostable Plastics** : Compostable Plastics mean plastic that undergoes degradation by biological processes during composting to yield CO₂, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and does not leave visible, distinguishable or toxic residue.
- vii) **Extended Producer's Responsibility (EPR)** : EPR means the responsibility of a producer for the environmentally sound management of the product until the end of its life.
- viii) **Importer** : Importer means a person who imports or intends to import and holds an Importer-Exporter Code number, unless otherwise specifically exempted.
- ix) **Manufacturer** : Manufacturer means and includes a person or unit or agency engaged in production of plastic raw material to be used as raw material by the producer.
- x) **Multilayered Packaging** : Multilayer Packaging means any material used or to be used for packaging and having at least one layer of plastic as the main ingredients in combination with one or more layers of materials such as paper, paper board, polymeric materials, metalized layers or aluminum foil, either in the form of a laminate or co-extruded structure.
- xi) **Plastic** : Plastic means material which contains as an essential ingredient a high polymer such as polyethylene terephthalate, high density polyethylene, Vinyl, low density polyethylene, polypropylene, polystyrene resins, multi-materials like acrylonitrile butadiene styrene, polyphenylene oxide, polycarbonate, Polybutylene terephthalate.
- xii) **Plastic Sheet** : Plastic Sheet means Plastic sheet is the sheet made of plastic.
- xiii) **Plastic Waste** : Plastic Waste means any plastic discarded after use or after their intended use is over.

- xiv) **Producer** : Producer means persons engaged in manufacture or import of carry bags or multilayered packaging or plastic sheets or like, and includes industries or individuals using plastic sheets or like or covers made of plastic sheets or multilayered packaging for packaging or wrapping the commodity.
- xiii) **Waste Generator** : Waste Generator means and includes every person or group of persons or institution, residential and commercial establishments including Indian Railways, Airport, Port and Harbor and Defense establishments which generate plastic waste.
- xvi) **Waste Management** : Waste Management means the collection, storage, transportation reduction, re-use, recovery, recycling, composting or disposal of plastic waste in an environmentally safe manner.

6. SALIENT FEATURES OF PWM RULES, 2016

6.1 The salient features of the PWM Rules, 2016 are given below:

- PWM Rules, 2016 shall apply to every Waste Generator, Local Body, Gram Panchayat, Manufacturer, Importer, Producer and Brand Owner.



- Carry bag made of virgin or recycled plastic shall not be less than fifty microns in thickness. The provision of thickness shall not be applicable to carry bags made up of compostable plastic, complying IS/ISO: 17088.
- Waste Generators including institutional generators, event organizers shall not litter the plastic waste. They shall segregate waste and handover it to authorized agency and shall pay user fee as prescribed by ULB for waste management or spot fine in case of violation.
- Within a period of six months from publication of PWM Rules, 2016 as amended 2018 in official Gazette, Producer,



Brand Owner shall work out modalities for waste collection system for collecting back the plastic waste generated due to their products, in consultation with local authority/State Urban Development Department and implement it within two years thereafter.

- Promote use of plastic waste for road construction or energy recovery or waste to oil or co-processing in cement kilns etc.
- SPCB/PCC shall be the authority for enforcement of the provisions of PWM Rules, 2016 as amended 2018, relating to registration, manufacture of plastic products and multi-layered packaging, processing and disposal of plastic wastes.



- Concerned Secretary-in-charge of Urban Development of the State or a Union Territory and concerned Gram Panchayat in the rural area of the State or a Union Territory shall be the authority for enforcement of the provisions of PWM Rules, relating to waste management by waste generator, use of plastic carry bags, plastic sheets or like, covers made of plastic sheets and multi-layered packaging.



- Stakeholders & Responsible Authorities shall use Forms I to VI of the PWM Rules, 2016 for providing information to respective authorities on implementation of PWM Rules, 2016
 - ✓ **Form I** : Application for registration for Producers or Brand owners
 - ✓ **Form II** : Application form for registration of units engaged in processing or recycling of plastic waste
 - ✓ **Form III** : Application for registration for manufacturers of plastic raw materials
 - ✓ **Form IV** : Format of Annual Report by Operator of plastic waste processing or recycling Facility to the Local Body by 30th June each year.
 - ✓ **Form V** : Format for annual report on plastic waste management to be submitted by the local body by 31st July each year.
 - ✓ **Form VI** : State-wise status of implementation of plastic waste management rules, 2016 for the year annual report format by 31st August each year.
- Brand owners are required to register in SPCB/PCC, if operating in one or two

state/UT, however, if operating in more than 2 states/UTs, it shall report with CPCB along with EPR plan.

6.2 Responsibilities of Local Authorities

- Ensure setting up an infrastructure for segregation, collection, storage, transportation, processing and disposal of plastic waste. Such system should be developed along with the infrastructure developed for collection, segregation, processing and disposal of Solid Waste as per the provisions under Solid Waste Management Rules, 2016.
- Coordinate with State Urban Development and the producers/ importers/brand owners to facilitate a mechanism for collection and channelization of plastic waste with the infrastructure developed for collection, segregation, processing and disposal of Solid Waste as per the provisions under Solid Waste Management Rules, 2016.
- Engaging with civil societies or groups working with waste pickers in collection segregation and channelization of Plastic Waste.
- Ensure setting up an infrastructure for segregation, collection, storage, transportation, processing and disposal of plastic waste. Such system should be developed along with the infrastructure developed for collection, segregation, processing and disposal of Solid Waste as per the provisions under Solid Waste Management Rules, 2016.
- Enforce a mechanism to stop open burning of plastic waste
- Frame by- laws on management of plastic waste which may include the rates for imposition of fine/ penalty on littering/ open burning of plastic waste.

6.3 Responsibilities of Producers/ Importers / Brand owners

- The producers, within a period of six months from the date of publication of these rules, shall work out modalities for waste collection system based on Extended Producers Responsibility and involving State Urban Development Departments, either individually or collectively, through their own distribution channel or through the local body concerned.
- Primary responsibility for collection of used multi-layered plastic sachet or pouches or packaging is of Producers, Importers and Brand Owners who introduce the products in the market. They need to establish a system for collecting back the plastic waste

generated due to their products. This plan of collection to be submitted to the State Pollution Control Boards while applying for Consent to Establish or Operate or Renewal. The Brand Owners whose consent has been renewed before the notification of these rules shall submit such plan within one year from the date of notification of these rules and implement with two years thereafter.

- Manufacture and use of non- recyclable multilayered plastic if any should be phased out in Two years time.
- The producer, within a period of three months from the date of final publication of these rules in the Official Gazette shall apply to the Pollution Control Board or the Pollution Control Committee, as the case may be, of the States or the Union Territories administration concerned, for grant of registration.
- No producer shall on and after the expiry of a period of Six Months from the date of final publication of these rules in the Official Gazette manufacture or use any plastic or multilayered packaging for packaging of commodities without registration from the concerned State Pollution Control Board or the Pollution Control Committees.
- Every producer shall maintain a record of details of the person engaged in supply of plastic used as raw material to manufacture carry bags or plastic sheet or like or cover made of plastic sheet or multilayered packaging.

6.4 Responsibilities of Prescribed Authorities

As per the provisions under Rule 12 of Plastic Waste Management Rules, 2016, the responsibility of various authorities is given as below:

Table 2: Responsibilities of Prescribed Authorities

S. No	Prescribed Authority	Responsibilities
1	State Pollution Control Board (SPCB)/ Pollution Control Committee	Enforcement of the provisions of PWM Rules , 2016, relating to registration, manufacture of plastic products and multilayered packaging, processing and disposal of plastic wastes.
2	Secretary-in-Charge, Urban Development Department	Enforcement of the provisions of PWM Rules, 2016, relating to waste management by waste generator , use of plastic carry bags, plastic sheets or like, covers made of plastic sheets and multilayered packaging.
3	Gram Panchayat	Enforcement of the provisions of PWM Rules, 2016, rules relating to waste management by the waste generator, use of plastic carry bags, plastic sheets or like, covers made of plastic sheets and multilayered packaging in the rural area of the State or a Union Territory .
4	District Magistrate or Deputy Commissioner	Shall provide the assistance to SPCBs/PCCs, Secretary -in-Charge, Urban Development Department and Gram Panchayat under his jurisdiction, whenever required for enforcement of provisions of PWM Rules, 2016.

6.5 Responsibilities of Central Pollution Control Board (CPCB)

As per Plastic Waste Management Rules, 2016, the responsibility of Central Pollution Control Board (CPCB) is given as below:

Table 3: Responsibilities of Central Pollution Control Board (CPCB)

S. No.	Rule No. (as per PWM Rules, 2016 as amended 2018)	Description
1	4(h)	The manufacturers or seller of compostable plastic carry bags shall obtain a certificate from the Central Pollution Control Board before marketing or selling their products.
2	5(c)	Thermoset plastic waste shall be processed and disposed of as per the guidelines issued from time to time by the Central Pollution Control Board.
3	6(2)(d)	The Local Bodies shall ensure processing and disposal of non-recyclable fraction of plastic waste in accordance with the guidelines issued by the Central Pollution Control Board.
4	17(d)	The CPCB shall prepare a consolidated Annual Report on the use and management of plastic waste and forward it to the Central Government along with its recommendations before the 31st August of every year.
5	13(2)	Producer/Brand owners who are working in one or two states/UTs shall register in SPCBs/PCCs, However, if working in more than 2 states/UTs then register to CPCB

6.6 Responsibilities of State Pollution Control Board (SPCB)

- SPCBs/PCCs are required to interact with Concerned Municipalities and to provide technical support to municipalities in setting-up of proper plastic waste management system for segregation, collection, transportation, disposal of PW as per PWM Rules, 2016.
- SPCBs/PCCS can ask State Urban Development Department to constitute State Level Advisory Body for implementation of PWM Rules, 2016.
- SPCBs/PCCS should constitute vigilance squad in collaboration with Concerned Municipalities to undertake surprise checks for thickness of carry bags (both manufacturing & stocking), for not allowing <50 µm thickness carry bags.
- SPCBs/PCCs can organize Mass-Awareness programme in various districts involving Municipalities & Stake-holders for not using less than fifty micron carry bags.

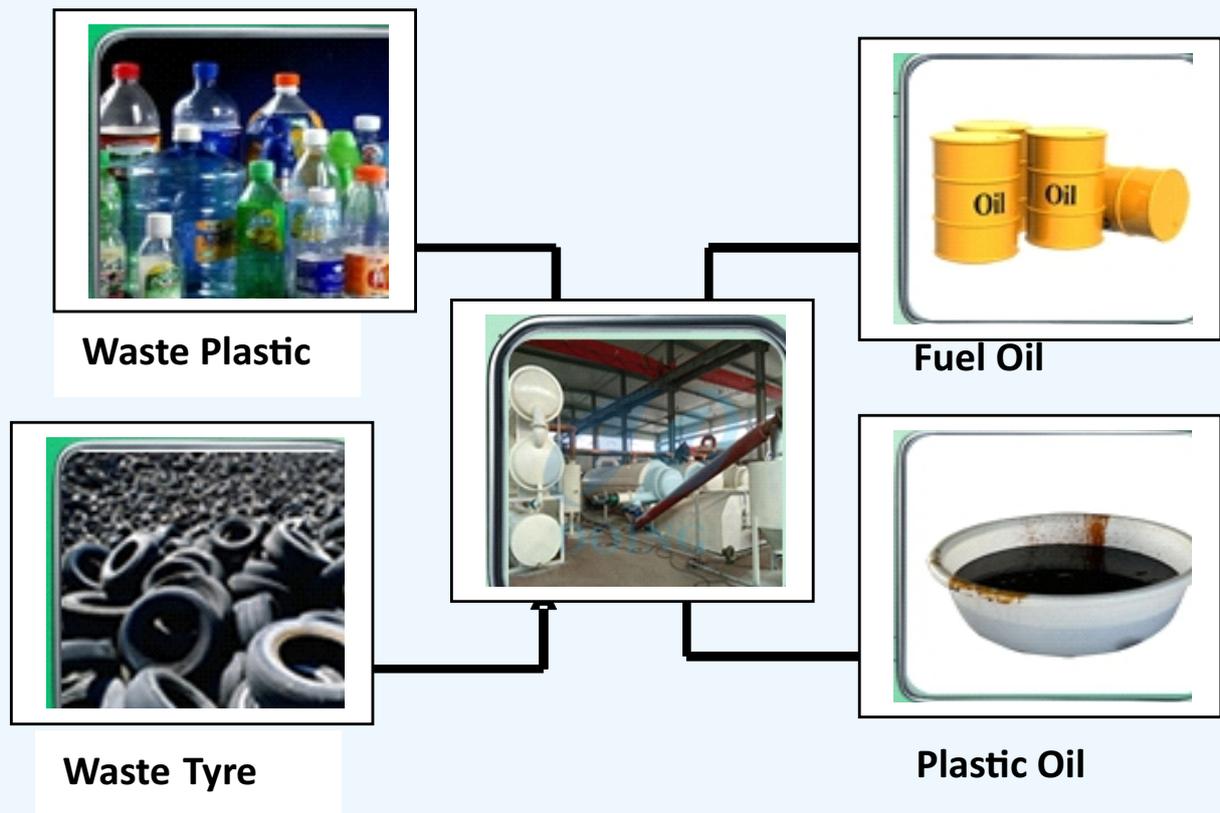
7. ACTION RECOMMENDED FOR MANAGEMENT OF PLASTIC WASTE

The concerned Local Bodies and Gram Panchayats are responsible for collection, storage, segregation, transportation and disposal of waste in their jurisdiction. The recommended process for collection, segregation, utilization and disposal of plastic waste is depicted in Figure 1. For effective management of plastic waste generated from different activities, the recommended action plan for implementation by local authorities is given below:



The following options should be envisaged for utilization or recycling of plastic:

- ✓ Use of shredded plastic waste in construction of bituminous road through hot mix plant (IRC Code SP 98:2013).
- ✓ Conversion of plastic waste into liquid fuel (As per document available at CPCB website).
- ✓ Transporting stored plastic waste to nearest cement kilns for co-processing (as per CPCB guideline).
- ✓ Transfer to plastic waste recycler for recycling into other plastic products.



The following options should be envisaged for utilization of non-recyclable plastic and the rejects / residues (having calorific value) generated from recycling units

- ✓ Send for co-processing in nearest cement kilns
- ✓ May remain in combustible fraction of solid waste for production of RDF
- ✓ May remain in combustible fraction of solid waste as feed to waste to energy plant

The following options should be envisaged for disposal of plastic waste where the option of recycling and utilization are not feasible:

- ✓ Destruction by plasma pyrolysis plant
- ✓ Disposal by incineration unit complying with emission standards stipulated under Solid Waste Management Rules, 2016 as amended 2018 (part C of schedule II)
- ✓ The residues/ rejects generated during recycling/ processing of plastic waste should be disposed in sanitary landfills as per the provisions under Solid Waste Management rules, 2016

STRATEGY FOR PLASTIC WASTE MANAGEMENT

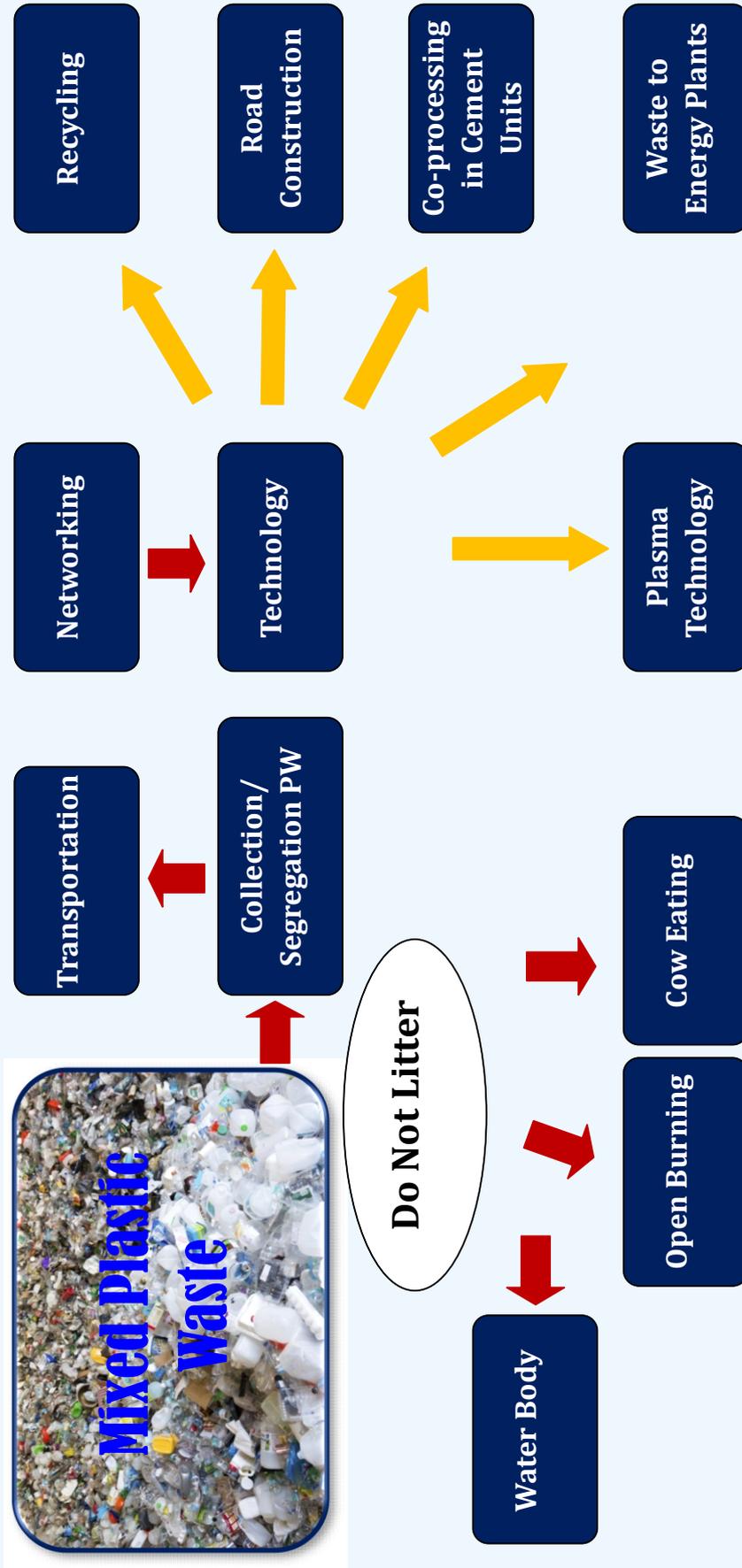


Figure 1: Strategy for Plastic Waste Management

7.1 Recycling of Plastic Waste

Plastic recycling refers to the process of recovering waste or scrap plastic and reprocessing the materials into functional and useful products, sometimes in entirely different from their previous state. Segregated Plastic wastes can be recycled to produce secondary plastic material. The process broadly involves sorting of plastic waste into different polymers and then shredding followed by melting. The molten material is cooled to produce plastic pellets. Before any plastic waste is recycled, it needs to go through five different stages so that it can be further used for making various types of products.

- § **Sorting:** It is necessary that every plastic item is separated according to its make and type so that it can be processed accordingly in the shredding machine.
- § **Washing:** Once the sorting has been done, the plastic waste needs to be washed properly to remove impurities such as labels and adhesives. This enhances the quality of the finished product.
- § **Shredding:** After washing, the plastic waste is loaded into different conveyer belts that run the waste through the different shredders. These shredders tear up the plastic into small pellets, preparing them for recycling into other products.
- § **Identification and Classification of Plastic:** After shredding, a proper testing of the plastic pellets is conducted in order to ascertain their quality and class.
- § **Extruding:** This involves melting the shredded plastic so that it can be extruded into pellets, which are then used for making different types of plastic products.

Currently, only PET, HDPE, and PVC plastic products are recycled. PS, PP, and LDPE are not recycled because these plastic materials get stuck in the sorting equipment in recycling facilities causing it to break or stop. Lids and bottle tops cannot be recycled as well.

A wide range of goods can be fabricated with recycled plastics. These include plastic bottles, carry bags, and polyethylene bin liners. Other examples include fiber filling for sleeping bags and duvets, a variety of office accessories, ducting and flooring, drainage pipes, damp proof membrane, fleeces, seed trays, water butts, garden sheds, compost bins, fencing, garden furniture and decking. The industry involved in recycling of plastic waste should obtain registration from State Pollution Control Board.

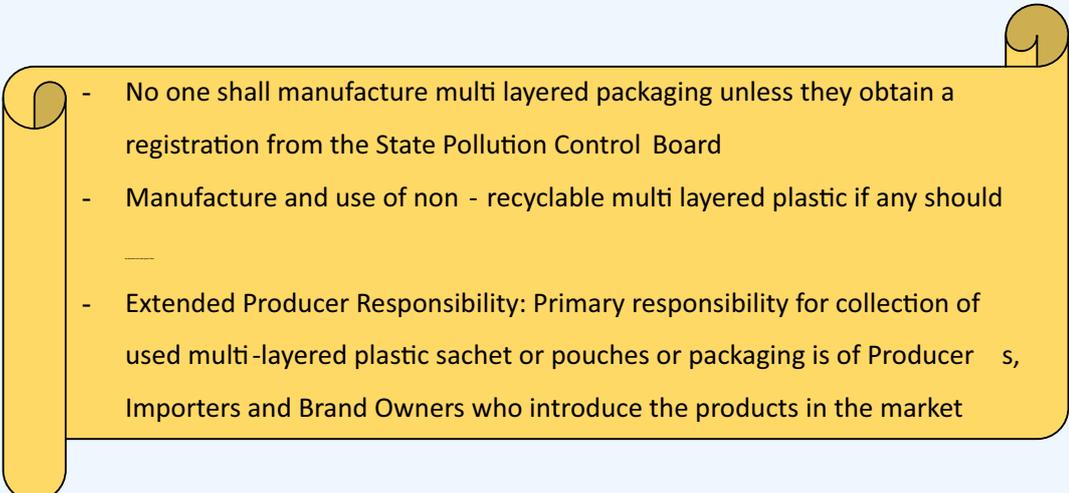
7.2 Recycling of multilayered plastic

Some of the most common household packages – including potato chip bags, biscuit & chocolate wrappers and toothpaste tubes often comprise of multi layered and metalized packaging that aren't typically recycled and generally find their way to landfills or illegal dumpsites.

Multi layered packaging (MLP) comprises a thin foil of aluminium, which is sandwiched, or laminated in a matrix of paper and/or plastic layers. As per the CPCB, “multi layered packaging” means any material used or to be used for packaging and having at least one layer of plastic as the main ingredients in combination with one or more layers of materials such as paper, paper board, polymeric materials, metalized layers or aluminium foil, either in the form of a laminate or co-extruded structure. Fruit juices and wines can be kept for extended periods of time at room temperature in containers made from paper, aluminium foil and polyethylene film. Laminated foil with paper stuck on the inside is used for packaging tea and sweets. This kind of foil is three times as waterproof as standard foil even in hot climates: the paper absorbs moisture while the foil itself protects the contents against other negative elements.

Most companies prefer multi layered packaging because its light reduces shipping volume, doesn't take up much space on a shelf, and is graphics friendly.

Multi layered packaging waste has found mention in the Plastic Waste Management Rules, 2016 as amended 2018 and its earlier versions. Some salient features of the new rules include:

- 
- No one shall manufacture multi layered packaging unless they obtain a registration from the State Pollution Control Board
 - Manufacture and use of non - recyclable multi layered plastic if any should
 - Extended Producer Responsibility: Primary responsibility for collection of used multi-layered plastic sachet or pouches or packaging is of Producers, Importers and Brand Owners who introduce the products in the market

Tertiary recycling most preferred option till the industry finds an alternative to ML packaging. Recycling/treatment options of plastic waste are generally classified into three categories:

- a. Primary recycling to the same or similar product
- b. Secondary recycling to a different product (material recovery)
- c. Tertiary recycling to a chemical or fuel.

Tertiary recycling is the most preferred method for multi layered packaging since separating the individual layers is difficult and costly. Pyrolysis and gasification are two key technologies currently used for tertiary recycling of multi-layered packaging waste.

7.3 Utilization of Plastic Waste

The provision '5(b)' of PWM Rules, 2016, encourages use of the plastic (preferably the plastic waste which cannot be further recycled) for road construction or energy recovery or waste to oil etc. Some of the technologies for such utilization are given below:

§ Utilization in Road Construction:-

Plastic waste is collected and segregated (except chlorinated/brominated plastic waste) from mixed MSW. The segregated plastic waste is stored and should be transported to the location working site for drying. The dried plastic waste is shredded to 2-4 mm size and added to heated stone aggregate followed by mixing. Further, the coated aggregate is mixed with hot bitumen, which is used for laying and compaction. The use of plastic waste in road construction shall follow the IRC: SP: 98-2013, titled as “Guidelines for the use of waste plastic in hot bituminous mix (dry mixing) in wearing courses”. Presently, several roads have been constructed by using plastic waste with bitumen in many of the States/UTs, such as: Tamil Nadu, Himachal Pradesh, Nagaland, West Bengal, Pondicherry etc. A process flow diagram for construction of polymer-bitumen road is shown at **Figure-2**.

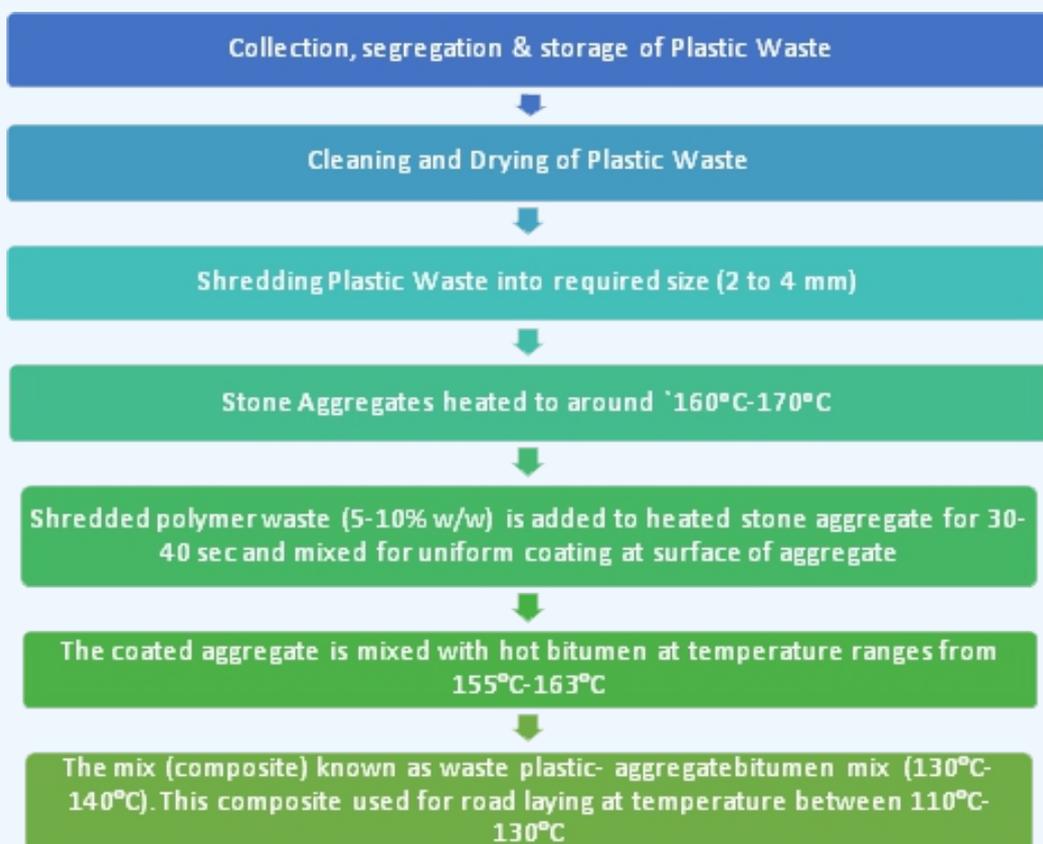


Figure 2: Process Flow Diagram for Construction of Polymer-bitumen Road

Salient Features of Polymer-Bitumen Road:-

- ✓ Stronger road with increased Marshal Stability Value.
- ✓ Better resistance towards rain water and water stagnation.
- ✓ No stripping and no potholes.
- ✓ Increased binding and better bonding of the mix.
- ✓ Reduction in pores in aggregate and hence less rutting and raveling.
- ✓ For 1km x 3.75m road, 1 ton of plastic is used, which leads to saving of 1 ton of bitumen.
- ✓ Cost of road construction is decreased due to saving of bitumen.
- ✓ Value addition to the waste plastics.

§ Co-processing of Plastic Waste in Cement Kilns:-

Co-processing refers to the use of waste materials in industrial processes as alternative fuels and raw material (AFR) to recover energy and material from them. Due to the high temperature and long residence time in cement kiln, all types of wastes can be effectively disposed without any harmful emissions. As per the Basal Convention, variety of wastes including hazardous wastes, get disposed in an environmentally safe and sound manner through the technology of co-processing in cement kiln. In cement plants, plastic waste is used as Alternate Fuel and Raw-material (AFR), subjected to higher temperature around 1400°C-1500°C. During the process, energy is recovered while burning of plastic waste and its inorganic content get fixed with clinker. It requires an automatic feeding mechanism for feeding plastic waste to cement kilns. This technology is used successfully in some of the States where, cement plants (have facility for co-processing of waste) are present, such as: Gujarat, Tamil Nadu, Karnataka, Chhattisgarh, Himachal Pradesh, Madhya Pradesh, Orissa etc. Flow diagram for co-processing of plastic waste in cement kilns is shown at **Figure 3**.

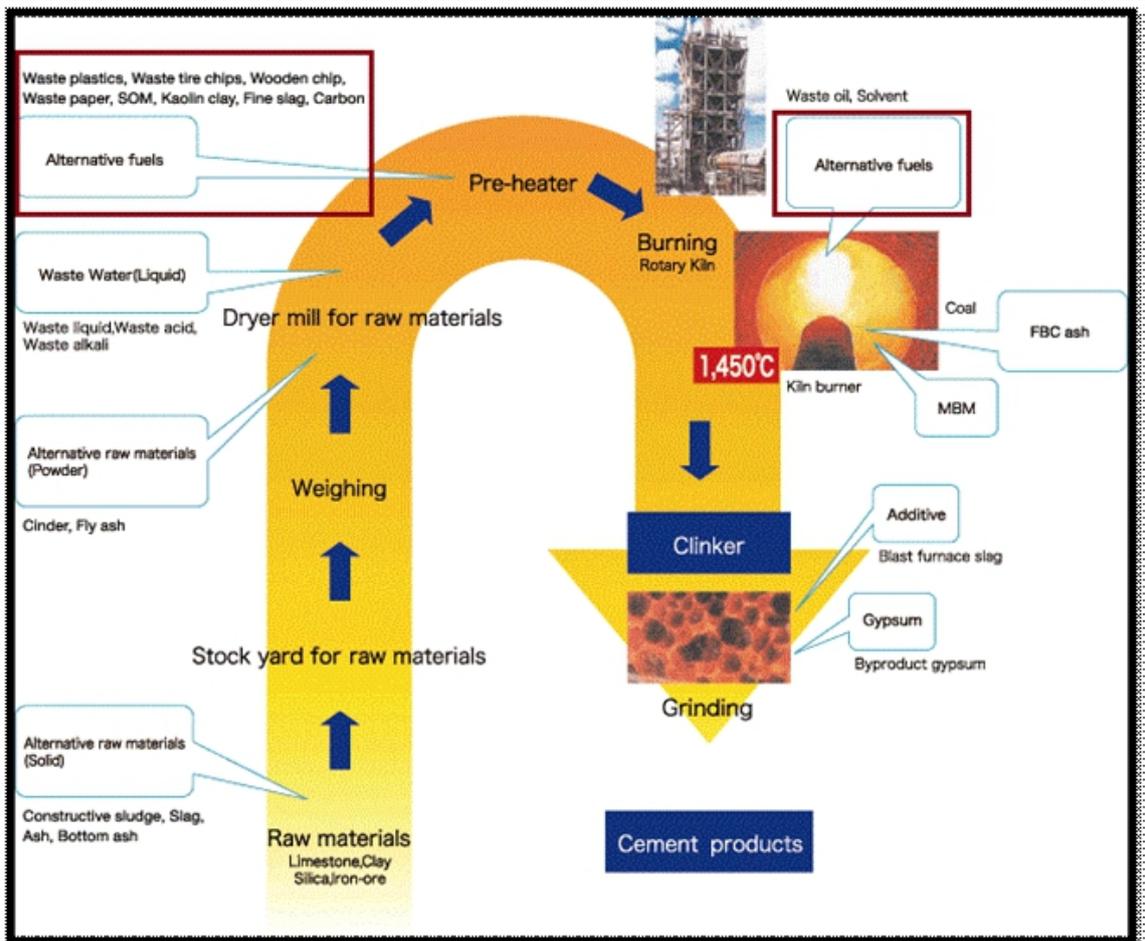


Figure 3: Flow Diagram for Co-processing of Plastic Waste in Cement Kilns

§ Conversion of Plastic Waste into Fuel-oil:-

For converting plastic waste into fuel-oil, the segregated plastic waste is fed into multifractionalization unit where the unwanted material is rejected for better handling & processing. The segregated plastic waste (only the HDPE, LDPE, PP and multilayer packaging except PVC) is fed into in-vessel forde-polymerisation using a catalyst. The reactor operates at high temperature and in absence of air, during which the polymers are converted into to small chain hydrocarbons. The vapors produced are condensed in the condensers and collected as plastic fuel oil of different grades.. The recovery of fuel oil is generally at 40% to 50% of input depending on the input quality of plastics and contaminations. The non-condensable remains are then passed through scrubber for removal of gases like Chlorine, Gas-Fuel etc. This Gas-Fuel is used in process for heating.

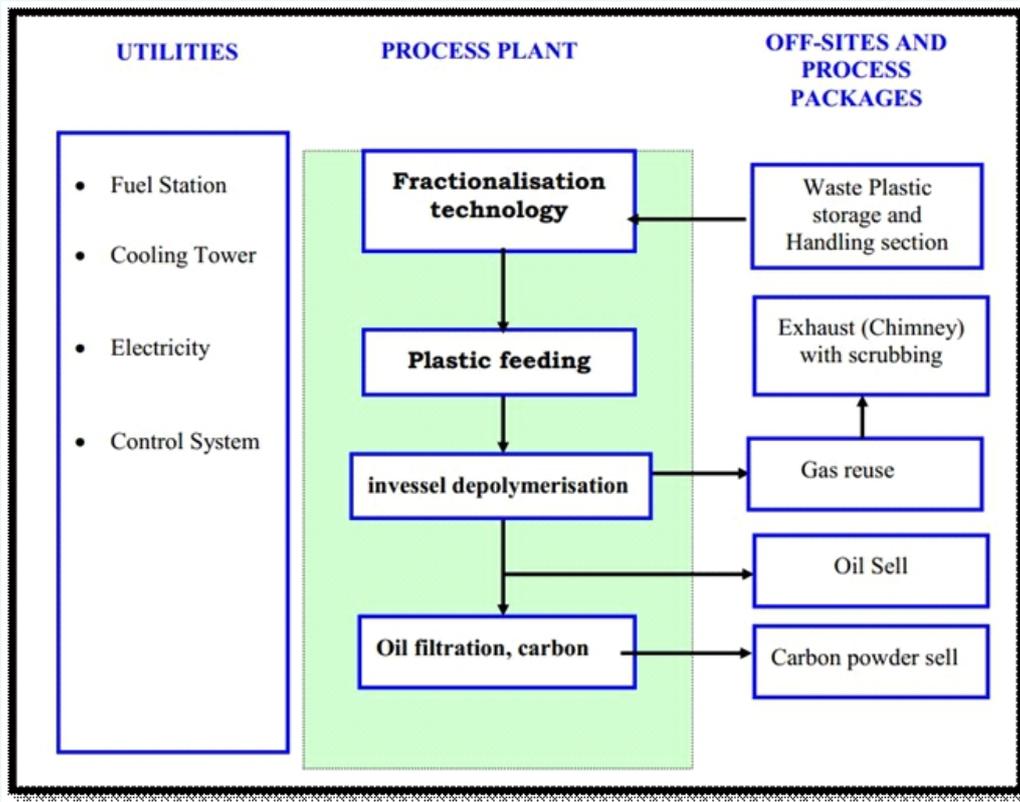


Figure 4: Process block diagram for Conversion of plastic waste into fuel-oil

This technology is used by few municipalities like Vadodara (Gujarat), NDMC (New Delhi), etc. Process block diagram for Conversion of plastic waste into liquid fuel-oil is shown at Figure 4. The cost of establishing plastic fuel-oil plant of 100 kg/day capacity is about 18 lakhs and monthly operational cost is around Rs. 87,000. Payback period for such plant is between 3 to 4 years.

7.4 Utilization of Non-recyclable Plastics

Non-recyclable plastics comprise of soiled plastic wastes which are not economical or viable for recycling. Non-recyclable multilayered and metalized plastic waste and thermoset plastic wastes also come under the classification of non-recyclable plastics. The non-recyclable plastics segregated from the material recovery facilities or any other sources can be utilized by cement plants for energy recovery by co-processing, or can be used in production of Refuse Derived Fuel for industrial use or can be utilized in Waste to Energy plants.

8. DISPOSAL OF PLASTIC WASTE

Non-availability of required infrastructure for recycling of plastic wastes or in case of limitations in establishing linkages with Cement industry for co-processing or other utilization such as production of plastic waste based fuel oil or in road construction; the local authorities may consider setting up plastic waste disposal facility. Setting up of disposal facilities may also be considered in case of tourist place, hill-stations, pilgrimage, coasts and other remote places where the options for recycling or utilization could not be envisaged.

8.1 Type of Disposal Facilities

§ Plasma Pyrolysis based Disposal Facility Plasma pyrolysis technology is the disintegration of organic/inorganic compounds into gases and non-leachable solid residues in an oxygen-starved environment. Different types of plastic waste such as polyethylene bags, soiled plastic, metalized plastic, multi-layer plastic and PVC plastic can be disposed through Plasma Pyrolysis Unit.

In Plasma Pyrolysis, firstly the plastics waste is fed into the primary chamber at 850oC through a feeder. The waste material dissociates into carbon monoxide, hydrogen, methane, higher hydrocarbons etc. Induced draft fan drains the pyrolysis gases as well as plastics waste into the secondary chamber where these gases are combusted in the presence of excess air. The inflammable gases are ignited with high voltage spark. The secondary chamber temperature is maintained at 1050oC. The hydrocarbon, CO and hydrogen are combusted into safe carbon dioxide and water. The process conditions are maintained such that it eliminates the possibility of formation of toxic dioxins and furans molecules (in case of chlorinated waste). This process is used by few Municipalities and hospitals; however, this can be useful for tourist place, hill stations, pilgrimage, coasts and other remote places. The process flow diagram of plasma pyrolysis for disposal of plastic waste is shown at Figure 5.

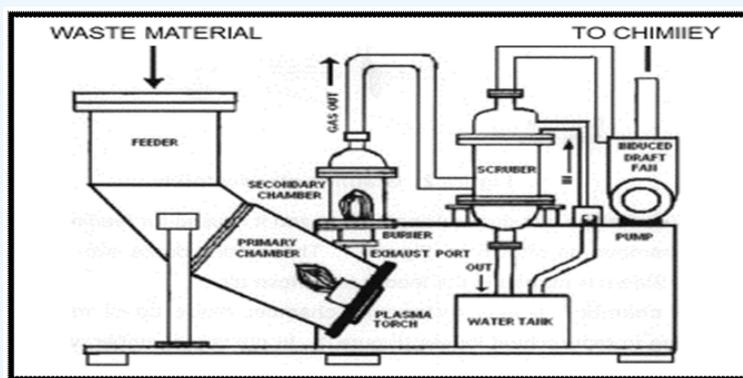


Figure 5: Process Flow Diagram of Plasma Pyrolysis for Disposal of Plastic Waste

Approximately plant cost of capacity 1 Ton/day is 1.7 Crore and 6.5 Crore for capacity of 10 Tons/day plant, excluding operational cost. Payback period of plasma pyrolysis plant of higher capacity (>1Ton/day) is around 4 to 5 years. With energy recovery system, plasma pyrolysis plant will be profitable.

Merits of Plasma Pyrolysis Technology:-

- ✓ The plasma pyrolysis system can resolve the problems associated with particularly non-recyclable and low grade plastic waste.
- ✓ Generation of extremely high temperature in oxygen starved environment makes this technology useful for the safe destruction of plastic wastes.
- ✓ This technology (PPT) can safely destroy chlorinated as well as multi-layer plastic wastes.
- ✓ The plasma pyrolysis system can be installed in tourist/hilly locations
- ✓ PPT for the disposal of plastic waste along in conjunction with energy recovery makes it economically viable in higher capacity systems.

8.2 Disposal of plastic rejects / Inerts from recycling units

The rejects and inert generated from recycling of plastic waste can be disposed in sanitary landfills as per the provisions under Solid Waste Management rules, 2016. Thermoset plastic waste shall be processed and disposed of as per the guidelines issued from time to time by the Central Pollution Control Board.

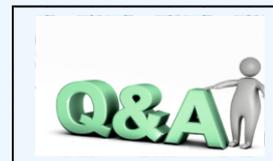
9. COMPOSTABLE PLASTIC CARRY BAGS/FILMS

An alternate to petro-based plastic carry-bags/films has been introduced i.e. compostable (100% bio-based) carry-bags/films conforming IS/ISO: 17088. The PWM Rules 2016 also encourages the use of compostable carry-bags and products by exempting minimum thickness criteria of 50µm. Further, as per provision 4 (h) of PWM Rules, 2016, the manufacturers or sellers of compostable plastic carry bags shall obtain a certificate from the Central Pollution Control Board (CPCB) before marketing or selling their products. The manufacturers/sellers of compostable carry bags/products are required to apply to CPCB as per Standard Operating Procedure (SOP) available on CPCB's Website (http://cpcb.nic.in/Plastic_waste.php). Thereafter, certificate will be issued to manufacturer/seller, those fulfilling criteria as per SOP. CPCB has issued 'Certificate' under Rule 4(h) of PWM Rules, 2016 to firms for marketing and selling of compostable carry bags/films in Indian market. The lists of such firms are given on CPCB's website.

10. FREQUENTLY ASKED QUESTIONS (FAQS)

Q-1: What is plastic?

Plastic means material which contains as an essential ingredient a high polymer such as polyethylene terephthalate, high density polyethylene, Vinyl, low density polyethylene, polypropylene, polystyrene resins, multi-materials like acrylonitrile butadiene styrene, polyphenylene oxide, polycarbonate, Polybutylene terephthalate.



Q-2: What are the different categories of Plastics?

There are seven different types of plastics.

- i) Polyethylene terephthalate (PET or PETE)
- ii) High-density polyethylene (HDPE)
- iii) Polyvinyl chloride (PVC)
- iv) Low-density polyethylene (LDPE)
- v) Polypropylene (PP)
- vi) Polystyrene (PS)
- vii) Other types of plastics (ABS, PPO, PC, PBT etc.)

Q-3: What are the statistics for plastic waste generation in India?

As per the study conducted by Central Pollution Control Board (CPCB) during 2011-12 in 60 major cities of India, it has been observed that 4059 T/day of plastic waste is generated from these cities. The fraction of plastic waste in Municipal Solid Waste (MSW) varies from 3.10% (Chandigarh) to 12.47% (Surat). Average plastic waste generation is around 6.92% of MSW. With extrapolation of the plastic waste generation data from 60 major cities, it is estimated that approximately 25,940 T/day of plastic waste is generated in India. The data revealed that 94% plastic waste comprises of thermoplastic fraction, which is recyclable such as plastic carry bags, PET, LDPE, HDPE, PVC etc. and remaining 6% belongs to the family of thermoset and other categories of non-recyclable plastics such as SMC, FRP, multi-layered, thermocol etc., which is non-recyclable.

Q-4: Are there any Rules notified by the Government of India for efficient management of plastic waste?

The Government of India notified Plastic Waste Management (PWM) Rules, 2016 on 18th March, 2016, superseding Plastic Waste (Management & Handling) Rules, 2011.

Q-5: What are the salient features of Plastic Waste Management Rules, 2016?

Following are the salient features of the PWM Rules, 2016:

- § These rules shall apply to every Waste Generator, Local Body, Gram Panchayat, Manufacturer, Importer, Producer and Brand Owner.
- § Carry bag made of virgin or recycled plastic, shall not be less than fifty microns in thickness. The provision of thickness shall not be applicable to carry bags made up of compostable plastic, complying IS/ISO: 17088.
- § Waste Generators including institutional generators, event organizers shall not litter the plastic waste, shall segregate waste and handover to authorized agency and shall pay user fee as prescribed by ULB and spot fine in case of violation.
- § Producer, Brand Owner need to work out modalities for waste collection system for collecting back the plastic waste within a period of six months in consultation with local authority/State Urban Development Department and implement with two years thereafter.
- § Promote use of plastic waste for road construction or energy recovery or waste to oil or co-processing in cement kilns etc.
- § Only the registered shopkeepers or street vendors shall be eligible to provide plastic carry bags for dispensing the commodities after paying plastic waste management fees (minimum 48,000 Rs. per annum) to concerned Local Body.
- § SPCB/PCC shall be the authority for enforcement of the provisions of PWM Rules, 2016, relating to registration, manufacture of plastic products and multi-layered packaging, processing and disposal of plastic wastes.
- § Concerned Secretary-in-charge of Urban Development of the State or a Union Territory and concerned Gram Panchayat in the rural area of the State or a Union Territory shall be the authority for enforcement of the provisions of PWM Rules, Rules relating to waste management by waste generator, use of plastic carry bags, plastic sheets or like, covers made of plastic sheets and multi-layered packaging.

Q-6: Is there any provision in PWM Rules, 2016 regarding use of plastic waste for various purposes?

As per the provision 5 (b), local bodies shall encourage the use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery or waste to oil etc. The standards and pollution control norms specified by the prescribed authority for these technologies shall be complied with.

Q-7: Who are the prescribed authorities for plastic waste management as per PWM Rules, 2016?

As per the Rule 12 of PWM Rules, 2016, the concerned Secretary-in-charge of Urban Development of the State or a Union Territory and Gram Panchayat in rural area shall be the authority for enforcement of the provisions of these rules relating to waste management by waste generator, use of plastic carry bags, plastic sheets or like, covers made of plastic sheets and multilayered packaging. Besides, as per Rules 6(1), every local body shall be responsible for development and setting up of infrastructure for segregation, collection, storage, transportation, processing and disposal of the plastic waste either on its own or by engaging agencies or producers.

Q-8: What are the major technologies available for plastic waste management?

Following are the major technologies for plastic waste management:

- § Utilization of Plastic Waste in Road Construction (As per IRC: SP: 98-2013).
- § Co-processing of Plastic Waste in Cement Kilns.
- § Conversion of plastic waste into liquid RDF (Oil).
- § Disposal of plastic waste through Plasma Pyrolysis Technology (PPT).

Q-9: Which States and Union Territory in India are using plastic waste management technologies?

As per information provided by State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) in Annual Report for the 2014-15 on Implementation of PWM Rules, few States/UTs namely; Himachal Pradesh, Nagaland, West Bengal, Tamil Nadu, Karnataka Pondicherry etc. are utilizing plastic waste in construction of bitumen roads. Some of the cement plants around 38 cement plants have been granted permission to use hazardous waste including all types of plastic waste for co-processing. Also, Institutions and Departments like Goa Medical College, Andaman & Nicobar Islands Municipal Committee have tried Plasma Pyrolysis Technology for the disposal of plastic waste. Some other States like Gujarat, Maharashtra, Chhattisgarh, Delhi etc. are using the process for conversion of plastic waste into liquid fuel.

Q-10: What are the major constraints in use of plastic waste disposal technologies across whole country?

Non-availability of segregated plastic waste is the major issue due to which plastic waste disposal technologies are not much successful in India. Also, modalities for disposal of plastic waste disposal have not been finalized by Municipal Authorities.

Q-11: What is the status of commercial viability of technologies for the disposal of plastic waste?

The CPCB has not carried out any study in respect of commercial viability of technologies for the disposal of plastic waste. However, to get rid of huge quantity of generated and littered plastic waste, the commercial viability of the disposal technologies may not be a hurdle while disposing plastic waste. The technologies for treatment and disposal plastic waste such as energy recovery, road construction, Plasma Pyrolysis, co-processing etc. are indirectly saving fossil fuel in the form of bitumen, coal, electrical energy etc.

Q-12: What are the technologies available in developed countries for the disposal of plastic waste?

As per available information the plastic waste in the developed countries is disposed largely through incineration.

Q-13: Whether CPCB issued any guidelines for encouraging the use of plastic waste management technologies for the disposal of plastic waste?

The Central Pollution Control Board (CPCB) has developed and circulated following Guidelines to SPCBs/PCCs and UDDs;

- i) Guidelines for disposal of Thermoset Plastic.
- ii) Guidelines for disposal of plastic waste in co-processing

Q-14: Whether CPCB issued any direction in this regard?

CPCB issued Directions under Section '5' of the Environment (Protection) Act, 1986 to Municipal Commissioners of 46 Million Plus Cities & 20 State Capitals and 112 Executive Officers of Municipalities situated on the bank of river Ganga, that Municipal Commissioners and Executive Officers to ensure disposal of plastic waste and to prevent littering in public, religious & historical places. This shall also include preparation of comprehensive action plan for collection, segregation, storage and adopting appropriate technologies such as road construction, co-processing, converting into liquid fuel, plasma pyrolysis etc.

Q-15: What is the alternate to conventional petro-based plastic carry bags/products?

An alternate to petro-based plastic carry bags/films is the compostable carry bags conforming IS/ISO: 17088 irrespective of thickness. Besides, as per provision 4 (h) of PWM Rules, 2016, the manufacturers or sellers of compostable plastic carry bags shall obtain a certificate from the Central Pollution Control Board before marketing or selling their products.

Q-16: How certificate can be obtained for marketing and selling compostable carry bags/products?

The manufacturer/seller of compostable carry bags/products has to apply to CPCB as per Standard Operating Procedure (SOP), available on CPCB's Website (http://cpcb.nic.in/Plastic_waste.php). The certificate will be issued to manufacturer/seller, fulfilling criteria mentioned in SOP.

11. DO'S AND DON'TS

S.No	Do's
1	Use >50um plastic carry bags/sheet/ or like.
2	Use Virgin plastic carry bags for storing/packaging/food stuffs.
3	While buying /receiving goods from groceries / shops, except the material only greater than 50 µm thick plastic or compostable bags. Check for label on carry bags.
4	Dispose PW in a bin meant for collection of dry waste
5	Send plastic waste for co-processing in cement kilns.
6	Carry, jute/ cloth bag, while going for purchasing vegetables/ groceries etc.
7	Report to local authorities and SPCBs about any incident about open burning of plastic waste
8	Dispose the plastic waste only in designated (dry waste) bins
9	Minimize use of plastic carry bags.
10	If required, use only compostable plastic bags for disposing wet waste.
11.	Avoid using plastic pouches for buying / storing any liquid food items from vendors.
12.	Consume food preferably placed in glass/ metal/ ceramic plates/ cups/ tumblers etc.

Table 4: Do's for Plastic waste management

S.No.	Don't
1	Don't use / accept <50um plastic carry bags/sheet or not having labels specifying the thickness.
2	Don't accept plastic goods not having recycling symbol
3	Don't use colored or recycled plastic bags/ sheets for storing/packaging/food stuffs.
4	Don't litter plastic waste so as to avoid choking of drains, ingestion by cattle
5	Don't mix plastic waste with wet waste (bio-degradable waste.)
6	Don't ask for plastic carry bag from shopkeeper or vendor.
7	Never burn plastic waste

Table 5: Don'ts for Plastic waste management

STATUS OF PLASTIC WASTE MANAGEMENT – AT A GLANCE

(Updated in April, 2018)

Sl. No.	Items	Description	
1	Total Population 2010-11 (as per census 2010-11)	1,210,193,422	
2	Estimated Plastic Consumption in 2010-11	14 Kg/Capital/Year	
3	CPCB Study on Plastic Waste Management in 60 major cities (2010-11)	Per Year	Per Day
		1277865 Tons (TPA)	3501 Tons (TPD)
4	Plastic Waste Generation per Capita	9.92 kg	27 gm
5	Plastic Waste Generation (Approximation)	9.46 Million Tons	25940 Tons
6	Plastic Waste Collection (Estimated: 60% by weight)	5.67 Million Tons	15564 Tons
7	Uncollected Plastic Waste (Estimated: 40% by weight)	3.78 Million Tons	10376 Tons
8	a) CPCB Study on MSW generation in 60 major cities (2010-11)	1.85 Million Tons	50592 Tons
9	No. of Plastic Manufacture and Recycling Unit in SPCBs/PCCs (As per PWM Annual Report 2016-17)	2688	
10	No. of Unregistered Units	255	
11	No. of States & UTs issued separate Act/Notification	21 [Andaman & Nicobar Island, Arunachal Pradesh, Chandigarh, Daman Diu & Dadra Nagar Haveli, Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Lakshadweep, Madhya Pradesh, Maharashtra, Nagaland, Punjab, Rajasthan, Sikkim, Tripura, Uttar Pradesh, Uttarakhand]	
12	No. of States & UTs Ban/Partial Ban Plastic Carry Bags	Details are Given Below	
	(i) Completed Ban (Through Notification/Act)	21 [Andaman & Nicobar Island, Arunachal Pradesh, Chandigarh, Daman Diu & Dadra Nagar Haveli, Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Lakshadweep, Madhya Pradesh, Maharashtra, Nagaland, Punjab, Rajasthan, Sikkim, Tripura, Uttar Pradesh, Uttarakhand]	
	(ii) Partial Ban (Through Executive Order)	5 [Goa, Gujarat, Kerala, Odisha, West Bengal]	
13	Name of States & UTs increased the thickness of plastic carry bags i.e >50µm	2 [Tamil Nadu: 60 µm, Puducherry: 51 µm]	
14	Plastic Waste Utilization	CPCB has formulated Guidelines for Collection, Segregation & Disposal of Plastic Waste those are listed below: 1. Utilization of Plastic Waste in Road Construction (As per IRC: 98-2013) 2. Co-processing of Plastic Waste in Cement Kilns 3. Conversion of Plastic Waste into liquid RDF (Oil) 4. Disposal of Plastic Waste through Plasma Pyrolysis Technology (PPT)	
15	Use of Carry Bags made from compostable Plastic or Materials	As per the provision of 4(h) of Plastic Waste Management Rules, 2016, as amended 2018, "the provision of thickness shall not be applicable to carry bags made up of compostable plastic. Carry bags made from compostable plastics shall conform to the Indian Standard: IS17088:2008 titled as Specifications for Compostable Plastics, as amended from time to time. The manufacturers or seller of compostable plastic carry bags shall obtain a certificate from the Central Pollution Control Board before marketing or selling."	
16	List of Certified Manufacturers/Seller of compostable carry bags/products	1. M/s Nature Tec. Chennai (Manufacturer); 2. M/s Sunshield Biotech LLP (Truegreen), Mumbai (Seller); 3. M/s Track Mark International, Haryana (Seller); 4. M/s Plasto Manufacturing Co., Bangalore (Manufacturer); 5. M/s Kuloday Technopark Pvt. Ltd., Daman (Manufacturer);	

12. RECOMMENDATIONS ON IMPLEMENTATION

- § Municipal Authorities shall set-up plastic waste management system and dispose Plastic Waste using various technology such as Road Construction, Co-processing, PW into Liquid Fuel etc.
- § Promote eco-friendly compostable carry bags (conforming IS/ISO: 17088) and certified by CPCB.

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NPC is a national level organization to promote productivity culture in India. Established as a registered society in 1958 by Government of India, it is an autonomous, tripartite, not for profit organization with equal representation from the Government, Employers and Employees' organizations, apart from technical & professional institution on its governing council. Besides providing training, consultancy and undertaking research in the area of productivity, NPC also implements the productivity promotion plans and programmes of the Tokyo based Asian Productivity Organization (APO), an inter-governmental body of which the Government of India is a founder member.

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