Material on Plastic Waste Management

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Central Pollution Control Board (CPCB)

An Overview of Plastic Waste Management

1.0 PLASTICS

1.1 What are plastics?

“Plastics are non-biodegradable, synthetic polymers derived primarily from petro-fossil feedstock and made-up of long chain hydrocarbons with additives and can be moulded into finished products (excluding compostable plastic or polymer confirming IS/ISO 17088:2008) (Reference: Text Book on Plastic Material by Prof. J.A. Brydson). These polymers are broken in presence of suitable catalyst, into monomers such as ethylene, propylene, vinyl, styrene and benzene. These monomers are then chemically polymerized into different categories of plastics.

1.2 Categories of plastics

A. **Recyclable Plastics (Thermoplastics):** PET, HDPE, LDPE, PP, PVC, PS, etc.
B. **Non-Recyclable Plastics (Thermoset & others):** Multilayer & Laminated Plastics, PUF, Bakelite, Polycarbonate, Melamine, Nylon etc.

As per BIS Classification, there are seven categories of plastics:

Symbol	Short Name	Scintific Name	Used In
1	PET	Polyethylene Terephthalate	Watter bottels, PET Bottles , etc.
2	HDPE	High Density Polyethylene	Milk/detergent Bags, Carry bags, Container etc
3	PVC	Polyvinyl Chloride	Cables, Pipes, Floorings etc
4	LDPE	Low Density Polyethylene	Carry bags , films
5	PP	Polypropylene	Medicine bottles, cereal liners , Packaing films etc
6	PS	Polystyrene	Foam Packaing, Tea Cups , ice cream cups, etc
7	O	Others	Thermoset plastics, Multilayer & Laminated Plastics, PUF, Bakelite, Polycarbonate, Melamine, Nylon etc.

1.3 Description of Plastic Waste

Plastic products have become an integral part in our daily life as a basic need. It produced on a massive scale worldwide and its production crosses the 150 million tonnes per year globally. In India approximately 8 Million tonnes plastic products are consumed every year (2008). Its broad range of application in films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household and industrial products, and building materials. It is a fact that plastics will never degrade and remains on landscape for several years. Mostly, plastics are recyclable but recycled products are more hazardous to the environment than the virgin products. The recycling of a virgin plastic material can be done 2-3 time only, because after every recycling, the plastic material is deteriorated due to thermal pressure. Considering, 70% of plastic consumption is converted as waste, approximately 5.6 million tons per annum (TPA) plastic waste is generated in country, which equals to 15342 tons per day (TPD).

1.4 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 plastic waste disposal on land makes the land infertile due to its impervious nature.
- Burning of plastics generates toxic emissions such as Carbon Monoxide, Chlorine, Hydrochloric Acid, Dioxin, Furans, Amines, Nitrides, Styrene, Benzene, 1, 3- butadiene, CCl_4, 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, metalised pouches and other thermoset plastic poses disposal problems.
- Sub-standard plastic bags, films etc. pose problem in collection and recycling.
- Littered plastics give unaesthetic look and choke the drain.
- 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 environment problems due to unsound recycling practices.

2.0 Salient Features of the PWM Rules, 2011:

(i) The plastic carry bags used for the purpose of carrying or dispensing commodities but don't include these bags which are integral part of packaged products. The thickness of bag shall not be $<40\mu$;

(ii) Carry bags can also be made from compostable plastics conforming IS/ISO:17088:2008;

(iii) Prescribed Authority for registration, manufacture & recycling shall be State Pollution Control Board (SPCB) or Pollution Control Committee (PCC). And for enforcement of Rules relating to use, collection, segregation, transportation & disposal of plastic waste, shall be concerned Municipal Authority;

(iv) Multilayered pouches or sachets used for packaging of gutkha etc. shall not use plastic material in any form;

(v) Every carry bags made from plastic shall bear a label or mark "recycled" as per IS:14534:1998. Each carry bag made from "Compostable Material" shall bear a label "Compostable" & shall conform to IS/ISO:17088:2008;

(vi) No carry bag shall be made available free of cost by retailers to consumers. The concerned Municipal Authority may be notification determine the minimum price for carry bags in order to encourage re-use so as to minimize plastic waste generation;

(vii) Each State Government shall for constitute a State Level Advisory (SLA) Body to monitor implementation of Rules. This body shall meet once in a year and may invite experts, if it considers necessary.

(viii) **The Plastic Waste Management (PWM) shall be as under;**

(a) recycling, recovery or disposal of plastic waste shall be carried out as per the rules, regulations and standards stipulated by the central government from time to time;

(b) recycling of plastics shall be carried out in accordance with the Indian Standard IS 14534:1998 titled as Guidelines for Recycling of Plastics, as amended from time to time;

(c) the Municipal Authority shall be responsible for setting up, operationalisation and co-ordination of the waste management system and for performing the associated functions, namely:- (i) to ensure safe collection, storage, segregation, transportation, processing and disposal of plastic waste; (ii) to ensure that no damage is caused to the environment during this process; (iii) to ensure setting up of collection centres for plastic waste involving manufacturers; (iv) to ensure its channelisation to recyclers; (v) to create awareness among all stakeholders about their responsibilities; (vi) to engage agencies or groups working in waste management including waste pickers, and (vii) to ensure that open burning of plastic waste is not permitted;

(d) for setting up plastic waste collection centres, the Municipal Authority may ask the manufacturers, either collectively or individually in line with the principle of Extended Producer's Responsibility (EPR) to provide the required finance to establish such collection centre;

(e) recyclers shall ensure that recycling facilities are in accordance with the Indian Standard: IS 14534:194 titled as Guidelines for Recycling of Plastics and in compliance with the rules under the Environment (Protection) Ad, 1986, as amended from time to time;

(f) the concerned Municipal Authority shall ensure that the residues generated from recycling processes are disposed of in compliance with Schedule II (Management of Municipal Solid Wastes) and Schedule III (Specifications for Landfill Sites) of the Municipal Solid Wastes (Management and Handling) Rules, 2000 made under the Environment (Protection) Act, 1986, as amended from time to time;

(g) the Municipal Authority shall incorporate the said rules in the Municipal Bye- laws of all the Urban Local Bodies;

(h) the Municipal Authority shall encourage the use of plastic waste by adopting suitable technology such as in Road Construction, Co-incineration etc. The Municipal Authority or the operator intending to use such technology shall ensure the compliance with the prescribed standards including pollution norms prescribed by the Competent Authority in this regard.

(ix) Each SPCB or PCC shall prepare and submit Annual Report to CPCB by **30th day of September** each year. The Central Pollution Control Board (CPCB) shall consolidate the report on use of plastic carry bags, sachets/pouches etc. and management of plastic waste. The consolidated report alongwith recommendations on implementation of the Plastic Waste (Management & Handling) (Amendment) Rules, 2011 will be submitted to MoEF by **30th Day of December**.

3.0 An Overview of Plastic Waste Management:

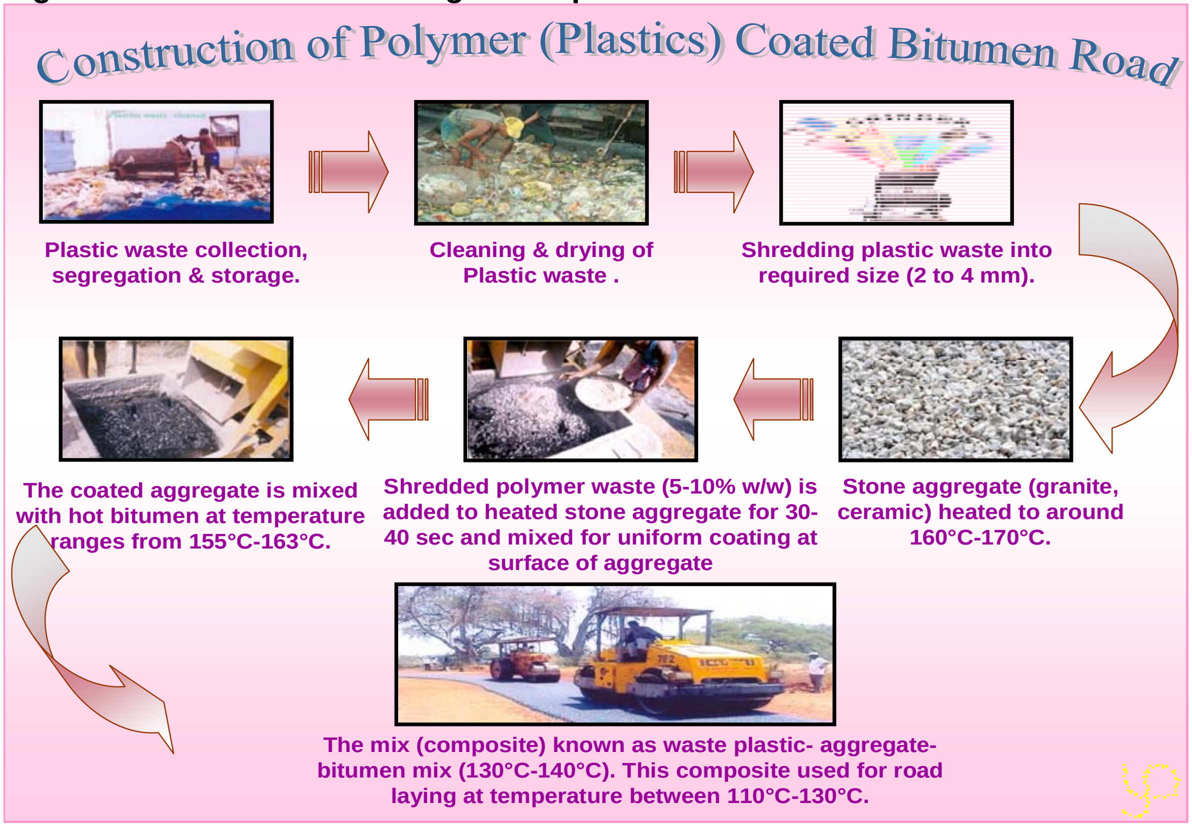
Disposal of plastic waste is a serious concern in India. New technologies have been developed to minimize there adverse effect on the environment. Currently Worldwide accepted technology used for the plastic disposal is incineration, however, the incinerators designed poorly, releases extremely toxic compounds (chlorinated dioxins and furans) therefore, raising several environmental issues. In India for safer disposal of plastic waste various technologies have been experimented. Some of these are described as below;

3.1 Utilisation of plastic waste in road construction;

3.1.1 Polymer Blended Bitumen Roads

The process of road laying using waste plastics is designed and the technique is being implemented successfully for the construction of flexible roads at various places in India. A brief description is given at **Figure 1.**

Figure 1 : Schematic flow diagram of plastic coated bitumen road construction



3.1.2 Merits of Polymer Blended Bitumen Roads

- **Stripping and pothole formation:** Bitumen film is often stripped off the aggregates because of the penetration of water, which results in pothole formation. This is accelerated during the movement of vehicle. When polymer is coated over aggregate, the coating reduces its affinity for water due to non-wetting nature of the polymer and this resists the penetration of water. Hence the penetration of water is reduced which resists stripping and hence no pothole formation takes place on these roads.
- **Leaching:** Polymer will not leach out of the bitumen layer, even after laying the road using waste plastics-bitumen-aggregate mix.
- **Effect of Bleeding:** Waste polymer-bitumen blend shows higher softening temperature. This increase will reduce the bleeding of bitumen during the summers.
- **Effect of fly ash:** It is also observed that the fly ash does not leach from this mixture.

3.1.3 Demerits of Polymer Blended Bitumen Roads

There is no observable demerit either in this process or in the road characteristics. For the last several years various roads have been laid using waste plastics are functioning well.

3.2 Co-processing of Plastic waste in Cement Kiln (Link)

3.2.1 Operating Manual for Co-processing of Plastic Waste in Cement Kilns

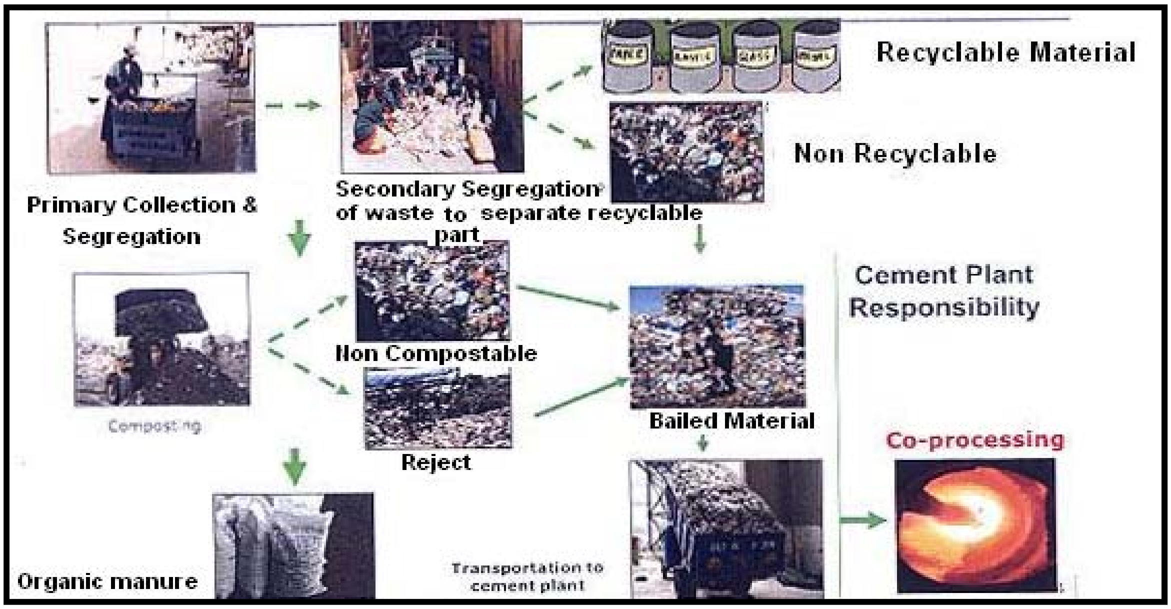
3.2.2 Introduction

Plastic waste generated from different cities and towns is a part of municipal solid waste (MSW). It is a matter of concern that disposal of plastic waste is causing many problems such as leaching impact on land and ground water, choking of drains, making land infertile, indiscriminate burning causing environmental hazards etc. Plastics waste being non-biodegradable is littered in most of the cities/towns and their-by giving an ugly appearance. It is estimated approximately 15,342 tons/day (TPD) of plastic waste (on per capita basis) is generated in the country. To get rid of plastic waste disposal problems, Central Pollution Control Board (CPCB) in association with MP Pollution Control Board has taken initiative to use the plastic waste in cement plant at ACC Kymore (Katni, MP). The stack monitoring result revealed that emission values are found below the standard set for Common Hazardous Waste Incinerators. After getting encouraging results CPCB has granted permission to many cement plants to co-process the hazardous and non-hazardous (including plastic) waste in their kilns after trial burns.

3.2.3 Co-processing of plastic waste as Alternative Fuel and Raw Material (AFR):

Co-processing refers to the use of waste materials in industry process such as cement, lime or steel production and power stations or any other large combustion plants. Co-processing indicate substitution of primary fuel and raw material by waste, recovering industry and material from waste. Waste material such as plastic waste used for co-processing are referred to as alternative fuels and raw material (AFR). Co-processing of plastic waste offers advantages for cement industry as well as for the Municipal Authorities responsible for waste management. In other hand, cement producers can save fossil fuel and raw material consumption, contributing the more eco-efficient production. In addition, one of the advantage recovery method used in existing facility, eliminating the need to invest on other plastic waste practices and to secure land filling.

Figure 2 : Co-processing of plastic waste



3.2.4 Types of AFR including plastic waste for co-processing:

This refers to waste material used for co-processing such waste typically include plastics, paper, cardboard, tetra-pack, packaging waste, waste tyres, waste oil, bio-mass waste cloths, auto-motive, shredder residues, hazardous industrial waste, obsolete pesticide, outdated drugs, chemical etc. Whereas plastic waste include carry bags, broken PET bottles, broken trays, pens, discarded plastic gift items, multi-layer and metalized pouches such as gutka, biscuits, namkeen, wafer pouches and packagings. However, as per Holcim Policy, some wastes are banned for co-processing, it include;

(i) Anatomical Hospital Waste;

(ii) Asbestos containing wastes;

(iii) Bio-medical waste;

(iv) Electronic Scrap;

(v) Entire batteries;

(vi) Explosives;

(vii) High concentration Cyanide waste;

(viii) Mineral Acids;

(ix) Radioactive wastes and

(x) Unsorted Municipal Solid Waste (MSW)

3.2.5 Pre-processing of plastic waste :

The plastic waste should be received in segregated and bundled form in HDPE/Jute bags. Then the plastic waste will be sun dried and subjected to shredding before feeding into cement kilns. However, PVC containing plastic waste will not be accepted in cement kilns as it impair the cement quality.

3.2.6 Modification in cement kilns:

Different feed points can be used to insert AFR into the cement production process. The most common ones are;

- The main burner at rotary kilns outlet end;
- The rotary kiln inlet end;
- The pre-calciner burners;
- The mid kiln (for long wet and dry kilns).

AFR including plastics waste typically fed to the kiln system as the same way as traditional raw material e.g. normal raw material supply. AFR containing components e.g. plastics waste have to feed into high temperature zones and long residence time in kiln system. The 3 Ts; time, temperature, turbulence in cement kilns in complete combustion of waste material while absorbing the energy and material present in it without impacting the quality product. The alkaline environment of cement process acts as a natural scrubber of the acidic process, if generated. Before accepting AFR including plastic waste cement plants shall modify their feeding system and install a conveyor-belt, one hopper, one winch machine, and one double flap damper. (A sketch flow diagram for feeding system and plastic waste handling system at ACC Plant Kymore are shown at above **Figures 2**. Besides, cement plants shall set-up a minimum laboratory facility to characterize plastic waste in respect of moisture content, calorific value, heavy metal contents, ash contents, Carbon (C), Hydrogen (H), Nitrogen (N), Sulphur (S), Chloride (Cl), and Volatile Carbon to carry out these test analytical instruments such as Thermo-Gravimetric Analyser (TGA) , Bomb-Calorimeter and C, H, N & S Analyser.

3.2.7 Indicative Operating Manual for Co-processing of plastics waste is indicated below:

Sr. No.	Item	Description	Action to be taken by
1	Collection of plastics waste	Concerned Municipal Authority should create system for collection of plastics waste from Dustbin/ Dhallaos through Public Private Partnership (PPP) Mode on any other feasible method.	Municipal Corporation, Nagar Palika & Cantonment Boards
2	Segregation & Pre-processing of plastics waste	Collected plastics can be reprocessed/sorte recyclable and non-recyclable. The recyclable plastics waste will be transported to ne cement kilns for co-processing by concerned Municip Authority.	Municipal Corporation, Nagar Palika & Cantonment Boards
3	Identification of cement factory	Mapping of cement kilns for accepting co-processing of plastic waste in same State or neighboring State. An agreement shall be signed between Munic Corporations and Cement kilns.	State Pollution Control Boards & Pollution Control Committees
4	Modification for feeding plastic waste (PW) in cement kilns	Cement Industry to set-up storage facility, shredder, conveyor-belt, one hopper, one winch-machir and one double-flap damper. A sketch flow diagram is attached.	Concerned Cement Industries
5	Setting-up of laboratory for plastics waste analysis	Cement industry shall set-up a minimum lab facility To analyse plastics waste before sending for co-processing. The instrumentati include Thermo-Gravimetric Analyser, Bomb-Calorimeter and C, H, N & S Analyser.	Concerned Cement Industries
6	Monitoring of emission by cement industry/ SPCBs	Cement Industry shall monitor the stack emis in respect of routine parameters and hazardous pollutants (HAPS)	Concerned Cement Industries and SPCBs/PCCs
7	Forwarding progress Report to CPCB	Forwarding quarterly progress report of Co-processing of plastic waste to CPCB.	SPCBs/PCCs and Cement Industries

3.3 Plasma Pyrolysis Technology (PPT)

3.3.1 Introduction

Plasma Pyrolysis is a state of the art technology, which integrates the thermo-chemical properties of plasma with the pyrolysis process. The intense and versatile heat generation capabilities of Plasma Pyrolysis technology enable it to dispose of all types of plastic waste including polymeric, biomedical and hazardous waste in a safe and reliable manner. Pyrolysis is the thermal disintegration of carbonaceous material in oxygen-starved atmosphere. When optimized, the most likely compounds formed are methane, carbon monoxide, hydrogen carbon dioxide and water molecules.

3.3.2 Process Technology:

In Plasma Pyrolysis, firstly the plastics waste is fed into the primary chamber at 850^0 C 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 1050^0 C. 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). The conversion of organic waste into non toxic gases (CO_2, H_2O) is more than 99%. The extreme conditions of plasma kill stable bacteria such as bacillus stereo-thermophilus and bacillus subtilis immediately. Segregation of the waste is not necessary, as the very high temperatures ensure treatment of all types of waste without discrimination.

3.3.3 Environment Related Observations

Stack emission monitoring of different categories plastic waste such as (i) 100% Polyethylene Waste (ii) 80% Polyethylene + 20% PVC Waste was carried out by VIMTA Lab. It has been observed that the emission of toxic pollutants such as dioxins and furans from the plasma pyrolysis system developed by FCIPT is lower than the norms set for incinerator. The summary of the results are mentioned in the Table 1:

Table 1: Dioxins & Furans Emissions from Plasma Pyrolysis System

Sr. No.	**Specifications**	**CPCB Norms** **(As per The Gazette of India)**	**Emission from Plasma System** **(80% Polyethylene + 20% PVC Waste)***	**Emission from Plasma system** **(100% Polyethylene Waste)***
1.	Dioxins and Furans **(Stack)**	0.1 ng/Nm^3 TEQ	0.00004 ng/Nm^3	0.00001 ng/Nm^3
2.	Dioxins and Furans **(Scrubber Water)**	(Norms are not mentioned)	0.36 pg/L	0.58 pg/L
3.	Dioxins and Furans **(Primary Residue)**	(Norms are not mentioned)	<0.01 ng/Kg	<0.01 ng/Kg

Note: All the results are corrected to 11% O_2 concentration

3.4 Recycling of plastics through environmentally sound manner:

The main goal for developing green recycling of waste plastic was to design an extruder, which would have "Zero Significant Adverse Environmental Impact". This has been achieved by assigning right motor of minimum capacity, selecting optimum L/D ratio, heat sealing and right temperature for the processes and trapping all the emission in pollution control gadget and treating the pollutants to produce byproducts. The Extrusion & Palletization processes have been redesigned to make the pollution from the process to a minimum level and as a result to enhance the efficiency of the process. The details of process are shown in Flow Chart, which is given below:

Flow-Chart of the "Green Recycling Process" – The Pilot Plant

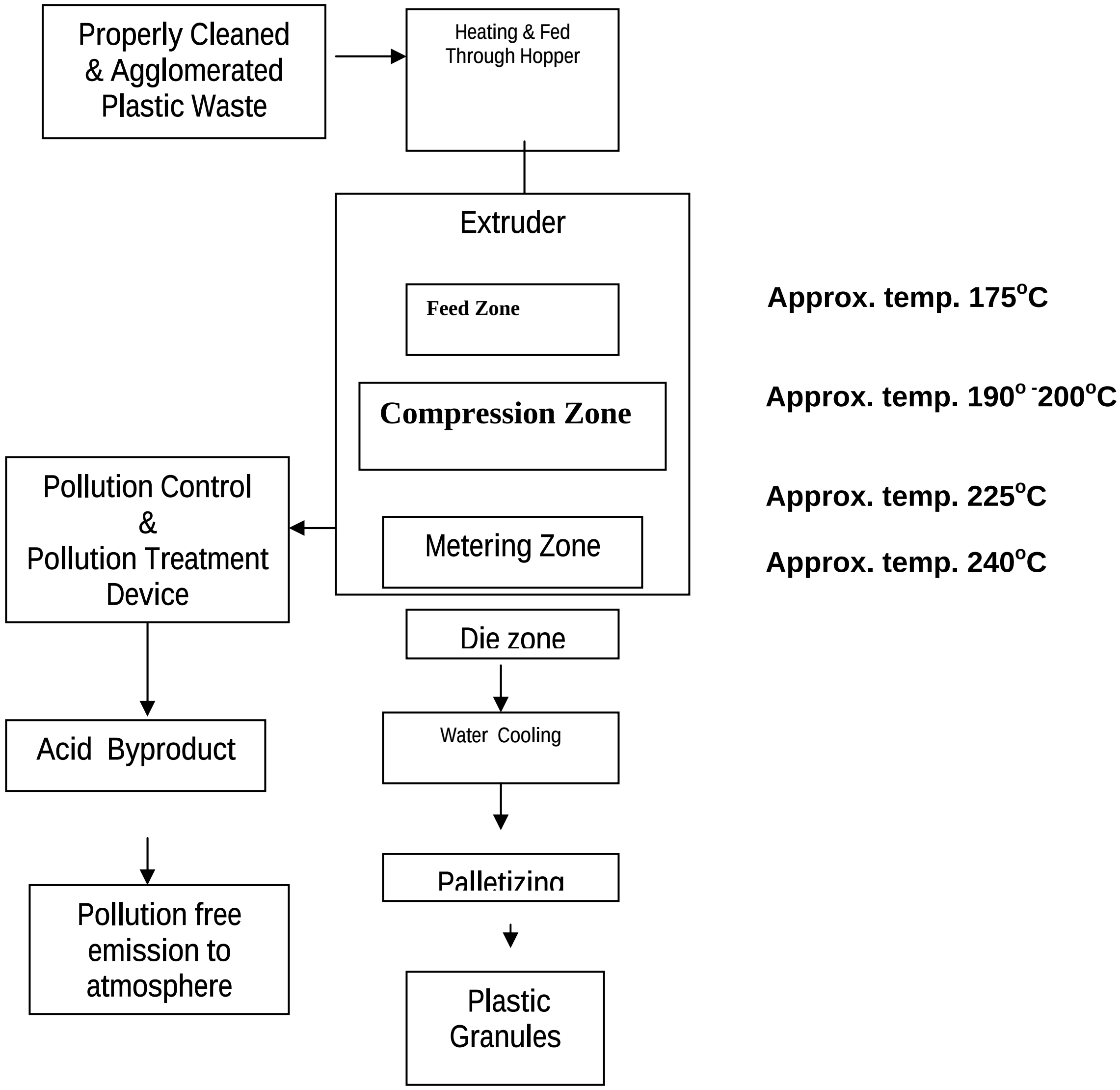


Photo: **The Pilot Plant showing plastic waste recycling through environmentally sound manner**

4.0 Status of Plastic Waste Management –At a Glance

(Updated on 30.05.2012)

S. No.	Items	Description	
1.	Total Population 2008 (As per World Bank).	1139964932 (Say 114 Million)	
2.	Estimated Plastic Production in 2008.	8 Million tons	
3.	Plastic Waste Generation (Considering: 70% as waste)*	**Per Year**	**Per Day**
		5.6 Million tons/Year	15342.46 tons/day
4.	Plastic waste Generation per capita.	**Per Year**	**Per Day**
		4.91 kg/Year	13.45 gm/day
5.	Plastic Waste Collection (Estimated: 60% by weight)	**Per Year**	**Per Day**
		3.36 Million tons /Year	9205 tons/day
6.	Uncollected Plastic Waste (Estimated: 40% by weight)	**Per Year**	**Per Day**
		2.24 Million tons /Year	6137 tons/day
7.	a) CPCB study on MSW generation in 60 major cities (2010-11)	**Per Year**	**Per Day**
		1.8466080 Million tons/Year	50592 tons/day
	b) CPCB study on Plastic waste generation in 60 major cities (2010-11)	0.1277847 Million tons/Year	3501 tons/day
8.	No. of Plastic Manufacturer and Recycling Unit in Industrial area	**5511**(30 States and UTs)	
9.	No. of Registration Granted	**2108**	
10.	No of States and UTs Issued Separate Act/Notification	15 [Goa, Haryana , Himachal Pradesh, Karnataka, Kerala Maharashtra, Madhya Pradesh, Nagaland, Punjab, Meghalaya, Chandigarh, Lakshadweep Puducherry, Delhi, Rajasthan]	
11.	**Names of States and UTs Ban Plastics Carry bags**	**Details given as below**	
12.	**(i) Complete Ban (Through Notification/Act)**	**11 [Chandigarh, Sikkim, Nagaland, Delhi, Haryana, Himachal Pradesh, Tripura, Rajasthan, J&K, Andaman & Nicobar Island & Lakshadweep]**	
	(ii) Partial Ban (Through Executive Order)	**10 [Andhra Pradesh, Arunachal Pradesh, Assam, Goa, , Karnataka, Orissa, Tamil Nadu, West Bengal, Mizoram, Uttar Pradesh]**	
13.	Names of States and UTs Increased the thickness of plastic carry bags i.e. **>40 μ**	03 [Maharashtra:50 μ, Tamil Nadu:60 μ and Puducherry: 51 μ]	
14.	Plastic Waste Utilization	(i) Plastic Waste can be utilized in road construction such as in the States of Tamil Nadu, Karnataka, Maharashtra, Puducherry and Himachal Pradesh etc. (ii) Plastic Waste can be co-processed in Cement kilns such as in the States of Madhya Pradesh, Tamil Nadu, Orissa, Andhra Pradesh etc.	
15.	Use of carry bags made from compostable plastic or material	As per Plastic Waste (Management & Handling) (Amendment) Rules, 2011, carry bags can be made from compostable plastic or material confirming IS/ISO:17088:2008	

Abbreviation : MT= Million tons, kg= Kilogram, gm = Gram, μ = micron
*** CPCB report on "Report of the Committee to Evolve Rode Map on Management of Wastes in India".**

5.0 Assessment and Quantification of Plastic Waste Quantification in Sixty Cities

CPCB has sponsored a study to CIPET for Assessment and Quantification of Plastic Waste generation in sixty major cities. The objective of study is given below

- To assess the type, nature and quantum of plastics waste in the country through field survey and physical assessment at 60 towns and Cities.
- Establish a Co-ordination mechanism with local Municipal/Metro corporations in identifying the dump grounds/Localities of higher waste generation for the physical assessment/characterization of MSW as per the prescribed methodology.
- To report on the existing methodology for collection of waste by urban local bodies/Municipal bodies in different states of the country.
- To suggest the viable and appropriate recycling technologies at major cities with investment estimation for effective Plastics waste Management (based on "Zero Waste Concept")

The preliminary findings of the study are given in the Table below:-

Table 2

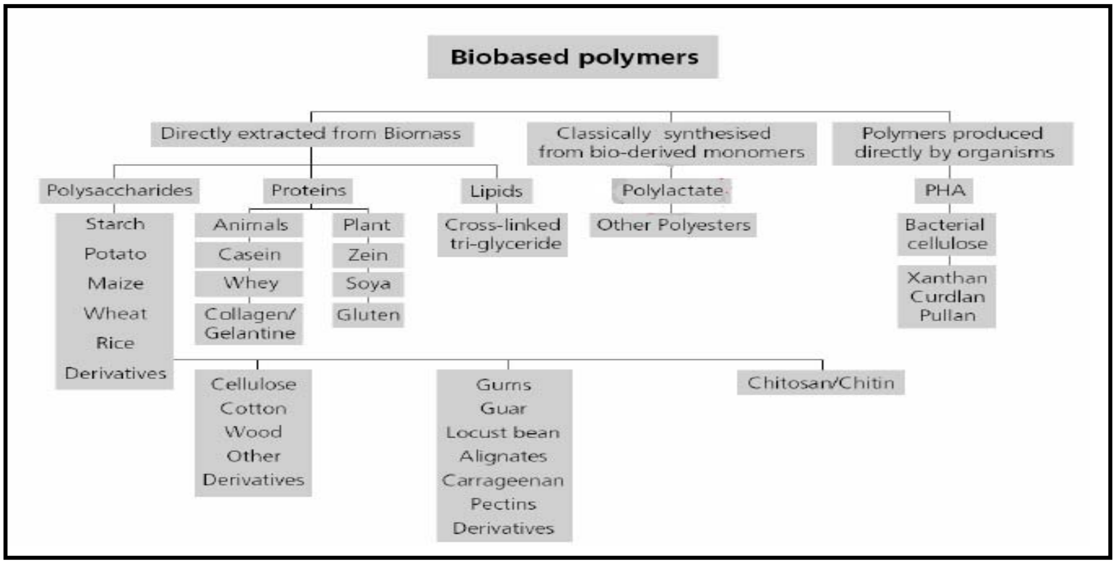
City	TMSW	PMSW	Total Plastic Waste (TPD)
Kavaratti	2	12.16	0.24
Dwaraka	18	8.28	1.49
Daman	25	4.554	1.14
Panjim	25	4.47	1.12
Gangtok	26	11.12	2.89
Jamshedpur	28	3.216	0.90
Silvassa	35	6.077	2.13
Port Blair	45	10.76	4.84
Kohima	45	5.013	2.26
Shimla	50	4.273	2.14
Meerut	52	6.444	3.35
Gandhinagar	97	4.361	4.23
Shilong	97	5.436	5.27
Itanagar	102	5.352	5.46
Agartala	102	5.712	5.83
Aizwal	107	7.948	8.50
Imphal	120	5.132	6.16
Ranchi	140	5.915	8.28
Kochin	150	6.288	9.43
Dhanbad	150	5.008	7.51
Guwahati	204	5.036	10.27
Asansol	210	6.017	12.64

City	TMSW	PMSW	Total Plastic Waste (TPD)
Dehradun	220	6.665	14.66
Patna	220	5.696	12.53
Raipur	224	10.607	23.76
Rajkot	230	6.92	15.92
Tiruvanandapuram	250	6.022	15.06
Pondicherry	250	10.62	26.55
Chandigarh	264	3.098	8.18
Jammu	300	7.226	21.68
Jaipur	310	5.085	15.76
Vishakapattnam	334	9.033	30.17
Nashik	350	5.822	20.38
Bhopal	350	6.594	23.08
Allahabad	350	5.377	18.82
Jabalpur	400	5.175	20.70
Bhubaneswar	400	7.862	31.45
Madurai	450	5.059	22.77
Varanasi	450	5.78	26.01
Agra	520	7.863	40.89
Srinagar	550	5.117	28.14
Amritsar	550	4.44	24.42
Vadodara	600	4.704	28.22
Vijayawada	600	7.352	44.11
Nagpur	650	6.984	45.40
Coimbatore	700	9.473	66.31
Faridabad	700	11.65	81.55
Indore	720	8.805	63.40
Ludhiana	850	5.962	50.68
Surat	1200	12.468	149.62
Lucknow	1200	5.886	70.63
Pune	1300	7.971	103.62
Kanpur	1600	6.666	106.66
Bangalore	1700	8.483	144.21
Ahmedabad	2300	10.5	241.50
Kolkata	3670	11.59	425.35
Hyderabad	4200	4.72	198.24
Chennai	4500	9.54	429.30
Mumbai	6500	6.477	421.01
Delhi	6800	10.13	688.84

Total MSW Generated in 60 cities : 48592 MT/Day
Total Plastic Waste Generated in 60 cities : 3905.64 MT/Day

6.0 Biodegradable & Compostable Plastics

Compostable Plastics: The Plastics that undergoes degradation by biological process during composting to yield CO_2, water, inorganic compounds and biomass at rate consistent with other known compostable material and leave no visible, distinguishable or toxic residue. Biodegradable plastics made with bio-based polymers have been available for many years. Their high cost, however, has meant they have never replaced traditional non-degradable plastics in the mass market.



Types of Biodegradable Plastics: There are several degradable plastic are reported such as: Biodegradable, Compostable, Hydro-biodegradable, Photo-degradable and Biodegradable. Biodegradable Plastic Products: Starch-based products including thermoplastic starch, starch and synthetic aliphatic polyester blends, and starch, Naturally produced polyesters, Renewable resource polyesters such as PLA, Synthetic aliphatic polyesters, Aliphatic-aromatic (AAC) co polyesters, Hydro-biodegradable polyester such as modified PET, Water soluble polymer such as polyvinyl alcohol and ethylene vinyl alcohol, Photo-degradable plastics, Controlled degradation additive master batches

7.1 Specifications for Compostable Plastics (ISO 17088:2008)

The Indian standards for compostable plastic is identical with ISO 17088 : 2008 “Specification for compostable plastics” issued by the International Organisation for Standardization (ISO) was adopted by the Bureau of Indian Standards. The purpose of this specification is to establish standards for identifying and labelling and labelling plastic products and materials that will compost satisfactorily in wellmanaged composting facilities where the typical conditions of composting can be consistently obtained (i.e. a long thermophilic phase, aerobic conditions, sufficient water content, a suitable carbon/nitrogen ratio, etc.). Products meeting the requirements outlined below are appropriate for labeling as “compostable”, “compostable in municipal and commercial facilities” or “biodegradable during composting”.

7.2 Methodology for testing biodegradable & compostable plastics

7.2.1 In order to be identified as compostable, product and materials shall meet the requirement of 6.3, 6.4 and 6.5 using appropriate laboratory tests representative of the conditions found in aerobic composting facilities. When testing finished articles and products, testing shall be conducted starting with the articles and products in the same form as they are intended to be used. For products and materials that are made in several different thicknesses or densities, such as films, containers and foams, only the thickest or most dense products and materials need to be tested as long as the chemical composition and structure remains otherwise the same.

7.2.2 Test samples shall not be subjected to conditions or procedures designed to accelerate disintegration prior to testing as described in 6.3 or 6.4

7.2.3 If the products or materials under test include fillers, the fillers shall be present when the products or materials are tested as described in 6.3, 6.4 and 6.5. However, their inorganic carbon content shall be excluded from the mineralization calculations in 6.4. Products or materials to which fillers are subsequently added, or in which the filler content is changed shall be retested to demonstrate that the new material meets the requirements of 6.3, 6.4 and 6.5. Manufacturers may establish an acceptable range by testing the highest and the lowest concentrations. Examples of fillers include (but are not limited to) calcium carbonate and titanium dioxide.

7.2.4 Products or materials to which catalysts are subsequently added, or in which the content of the catalyst is changed, shall be retested to demonstrate that the new material meets the criteria specified in 6.3, 6.4 and 6.5.

Manufacturers may establish an acceptable range by testing the highest and the lowest concentrations. Examples of fillers include (but are not limited to) organo-metallic compounds such as metal carboxylates and metal complexes.

7.3 Disintegration during composting

A plastic product is considered to have demonstrated satisfactory disintegration if, after 845 days in a controlled composting test, no more than 10% of its original dry mass remains after sieving through a 2,0 mm sieve. The test shall be carried out in accordance with ISO 16929, ISO 20200,ISO 14855-1 or ASTM D 5338 under thermophilic composting conditions without the CO_2-trapping equipment.

7.4 Ultimate aerobic biodegradation

7.4.1 A plastic product is considered to have demonstrated a satisfactory rate and level of biodegradation if, when tested in accordance with ISO 14855-1 ISO 14855-2 or ASTM D 5338, it achieves the ratio of conversion to carbon dioxide (co2 / thCO2) specified in 6.3.2 within the time period sopecified in 6.3.3.

The ultimate aerobic biodegradability shall be determined for the whole material and for each orgaic constituent which is present in the material at a concentration of more than 1% (by dry mass).

Constituents which are present at concentrations of less than 1% do not need to demonstrate biodegradability. However, the sum of such constituents shall not exceed 5%.

7.4.2 For all piolymers, 90% of the organic carbon (relative to a positive-control reference material) shall have been converted to carbon dioxide by the end of the test period (see 6.3.3.) both the positive control and the test sample shall be composted for the same length of time and the results compared at the same

point in time after the activity of both as reached a plateau. The positive control used shall be microcrystalline cellulose.
As an alternative, 90% (in absolute terms) of the organic carbon shall have been converted to carbon dioxide by the end of the test period.

NOTE Although the biodegradation test includes the conversion of the polymers into biomass and humic substances in additions to carbon dioxide, no recognized standard test methods or specifications exist for the quantifications of these conversion products. When such tests and specifications become available, this International Standard may be revised.

7.4.3 The test period shall be no longer than 180 days.

7.5 No adverse effects on ability of compost to support plant growth and compliance with regional and /or national regulations

7.5.1 In order to ensure that the composting of plastic product or material does not have any harmful effect on the finished compost or on the environment and complies with appropriate regional and national regulations, all requirements is specified in 6.4.2 and 6.4.4 shall be met.

7.5.2 The concentration of regulated metals and other toxic substance in the plastic product or material shall not be less than 50% of those prescribed for sludges, fertilizers and composts in the country where the final product will be placed on the market or disposed of.

7.5.3 The plastic product or material shall contain a minimum of 50% of volatile solids.

7.5.4 The seedling germination rate of the finished compost and the plant biomass in the compost shall be no less than 90% of that of corresponding blank compost to which no test or reference material was added at the start of testing, determined in accordance with OECD Guideline 208 with the modifications specified in Annex of EN 13432:2000.

7.6 Merits on the use of biodegradable plastics:

- Compost derived in part from biodegradable plastics increases the soil organic content as well as water and nutrient retention, while reducing chemical inputs and suppressing plant disease.
- Biodegradable shopping and waste bags disposed of to landfill may increase the rate of organic waste degradation in landfills while enhancing methane harvesting potential and decreasing landfill space usage.
- The energy required to synthesis and manufacture biodegradable plastics is generally much lower for most biodegradable plastics than for non-biodegradable plastics. The exception is PHA biopolymers which consume similar energy inputs to polyethylene's. New feedstock for PHA should lower the energy required for their production.
- Biodegradable plastics also offer important environmental benefits through, in many cases, the use of renewable energy resources and reduced greenhouse gas emissions.

7.0 Way Forward for PWM

- Setting-up of systematic mechanism for plastic waste collection, segregation and disposal;
- Recycling of plastic waste in an environmental friendly manner
- Closure of industries in non-conforming areas
- Utilization of plastic waste in road construction (Polymer-coating over stone aggregate);
- Co-processing of plastic waste in cement kiln;.
- Widespread mass awareness programme on use of plastic packaging, and its impact on environment, on littering;
- Extended Producer Responsibility (EPR) or Corporate Social Responsibility (CSR) in management of plastic waste;
- Use of bags made from alternate materials i.e. biodegradable and compostable films, jute cloth, paper etc.