Practically Feasible and Economically Viable Method of Disposal of Plastic Waste

Eco Friend and Co.

2009

This report is prepared on behalf of MPCB (Maharashtra Pollution Control Board) by Eco Friend and Co. This is a comprehensive report of practically feasible and economically viable method of disposal of plastic waste, generated at dumpsites in Greater Mumbai.

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Special Thanks to:
Mrs Valsa R. Nair Singh, IAS
Secretary (Environment) G.O.M., and Chairperson, MPCB,
Mr. Mahesh Pathak, I.A.S., Honorable Member Secretary MPCB,
Dr. Y. B. Sontakke, Regional Officer (H.Q.) MPCB,
And all individuals who contributed to make this report possible

PREAMBLE

In India, changing economy after the Liberalization in the early 90s led to fast urbanization. While the job opportunities in the villages were limited, the rapidly growing population forced people to migrate to cities where plenty of jobs suddenly became available due to establishment of Call Centers, Back Processing Offices etc., by multinationals wishing to cut their operating costs. Though the salaries offered in India by the MNCs were lower than those in their own countries, they were way above the local standard. This led to new found prosperity in the urban areas and what is popularly called "Disposable Income" for many Indians. Simultaneously, as the demand for consumer goods in their own countries was getting saturated, multinationals producing consumer goods found a huge market in India and they put up their manufacturing facilities here. Aided by advertising in the fast growing print and electronic media, sales of consumer goods from shampoos to cars rose exponentially through newly opened Malls and Company Show Rooms. The capitalistic concept of "Use & Throw" soon found takers particularly the young generation in India – and thus there was a quantum jump in the wastes generated, particularly in Indian cities.

Today, plastic in its numerous forms finds number one position in the materials used for manufacturing goods on large scale, i.e., consumer goods, and their packaging. This is due to its low weight and high strength and durability, ease of manufacturing and low cost. Unfortunately, these very qualities make it the most difficult material to dispose off. Another drawback encountered equally in its manufacturing and the disposal processes is its toxicity and the resulting pollution.

The problems of urbanization faced by governments all over the world today include providing facilities not only for their basic needs of food, clothing and shelter to a large number of people staying in a comparatively small area, but also make arrangements for supplying fuel and electricity to their homes, and provide drains, roads, bridges, mass community transport systems, fuel filling stations, recreational facilities, etc., and arrangements for the waste collection and its disposal. Though compared to developed countries, urbanization has been relatively sudden in India, the Governments have been able to provide the infrastructural facilities in the existing cities in a fairly well manner by use of advanced technology, but waste collection and its disposal is one problem for which it has not been possible so far to find a lasting solution in India.

Urban wastes typically come from small or large Industry operating within a city, Construction Activity, Malls, Shops, Business Establishments, Hotels, Hospitals, Vegetable, Fruit, Fish & Meat Markets, Animal Slaughter Houses, Places of Worship, Public places such as Railway Stations, Bus Stops, Roads, Gardens, and from each home, be it independent, in Housing Societies, Colonies, etc.

Rules have been made and are becoming more and more effective in tackling Industrial Hazardous Wastes and the Bio-medical Wastes, but the rules for handling of urban wastes, *applicable to every municipal authority responsible for collection segregation, storage, transportation, processing and disposal of municipal solid wastes,* called the Municipal Solid Wastes (Management and Handling) Rules, 2000 will take some time to be effectively implemented.

The basic problem is the well known lack of discipline and civic sense in the Indian communities.[1]

It was in response to the Writ Petition by Mrs. Almitra H Patel & others in 1996 versus the Union of India and others that made the Supreme court to pass a judgment on 4th October 2004 [2] that, despite the law being in force for 4 years, a lot deserves to be done for implementation of the Municipal Solid Wastes (Management and Handling) Rules, 2000.

[1] Things can improve - Read lessons from Surat, Kolkota, Mumbai, Chandigarh…- almitrapatel.com 216 on MSW
[2] Supreme Court Order on MSW 4 Oct 2004

The Honorable Court in its order noted that the MOEF had written to all State Pollution Control Boards requesting them to formulate time bound action plan for Management of MSW in respect of metro cities and state capitals, and directed the Central Government to examine the matter and file the proposed Action Plan for the State capitals and metro cities, to be followed by other cities, in Court.

The Honorable Court observed that as per a note from the petitioner, in Maharashtra the number of authorizations granted for Solid Waste Management (SWM) had increased to 98 % after the order of 26 July 2004, and that as per a suggestion of the petitioner, so as to put a focus on the issue, the State had created a Solid Waste Management Cell, and rewarded its cities for good performance.

The MPCB had submitted an affidavit[3] dated 24th September 2004 to the Supreme Court on the status of implementation of the Municipal Solid Wastes (Management and Handling) Rules, 2000 in the State of Maharashtra and the steps taken by the MPCB in this regard. The affidavit among other things, submits that the Board has to implement several environmental legislations, for which the manpower and infrastructure available with the board is not commensurate with the requirements of the responsibilities added since its formation in 1974, and that the Management of the MSW by the local bodies shall be successful with the participation of private sector based on options such as Build Own and Operate (BOO) and Build, Own, Operate and Transfer (BOOT) basis depending upon the situation. This is particularly required for the local bodies, which have financial and technical constraints in proper management of the MSW in compliance with the rules.

In order to assist the local bodies for preparation of agreement for management of MSW between local bodies and the operator of the facility, MPCB had then engaged the services of M/s CRISIL to formulate such documents in consultation with All India Institute of Local Self-Government, Mumbai and Commissioner and Director, Municipal Administration, Government of Maharashtra.

The MPCB had also put up a note on the implementation of MSW Rules 2000 in October 2004, listing also the constraints / difficulties in the implementation of the same.[4]

During 2005, the MPCB formulated Guidelines for citizens for management of MSW[5]

In pursuance of the above stated policy of the MPCB, and in order to help out the MCGM to sort out the problem of Plastic waste which forms a part of MSW, the MPCB has given Eco-Friend and Company the responsibility of suggesting practically feasible and economically viable ways of disposal of the plastic waste.

This report aims at pointing out practically feasible and economically viable ways to solve the problem of disposal of plastic wastes found in the Municipal Solid Wastes in Mumbai and similar fast growing cities of Maharashtra.

[3] Affidavit submitted to Supreme Court on behalf of the MPCB dated 24 Sept 2004
[4] Implementation of MSW rules by MPCB – Oct 2004
[5] MPCB Guidelines for Citizens for Management of MSW

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1. EXECUTIVE SUMMARY

Concerned by the 6 lakh tons of waste (Mumbai generates approximately 7000 tons per day of Municipal Solid Waste - briefly called MSW) accumulated at the sea-shore and dumped at Deonar after the infamous episode of deluge in Mumbai on 26th July 2005, the Maharashtra Pollution Control Board (MPCB) has communicated to the Municipal Corporation of Greater Mumbai (MCGM) to dispose of the Plastic waste in MSW at dumpsites by way of destruction in Cement Clinker Manufacturing Kilns.

It is found that plastic waste is normally mixed with the MSW, and the non-biodegradable nature of the waste results in heaps of MSW not getting bio-degraded for long time at dumpsites. The biodegradable processes such as bio-methanation, vermiculture, etc. recommended for conversion of the wet wastes in MSW into useful manure, gas and electricity get badly affected by the presence of the plastic, and it is necessary to segregate the waste from the MSW to allow the biodegradable processes to work efficiently. Recycling of such plastic waste is not economical as the waste is a mix of all types of plastics in smaller sizes, which are not already lifted by the rag pickers and are difficult to separate. Use of such waste as an alternative fuel in Cement Kilns is a better option compared to burning the waste in Incinerators for energy recovery, which is being increasingly questioned by environmentalists. Disposal of the waste in Blast furnaces has not yet been tried in India.

The largest cement manufacturer in the country, the Associated Cement Company along with Indian centre for Plastics in the Environment (ICPE) established for the first time in India that all plastic waste could be co-processed safely in Cement Kilns in Indian conditions. A systematic trial was conducted during 29th – 31st March 2008 at ACC's plant at Kaymore near Jabalpur in Madhya Pradesh with active support from the CPCB and the Madhya Pradesh Pollution Control Board. The technology has since been put into practice at the Kaymore and Kulu (Himachal Pradesh) plants of the ACC, and plants near Koimbture and Chennai are expected to follow suit.

The MPCB has also requested other cement companies to accept this technology. Eco Friend and Company, working in the field of Collection and Transportation of Hazardous Waste and Bio-Medical Waste for the past several years and having expertise in Disposal of all types of Wastes, was appointed by the MPCB to carry out a pilot study for the MCGM area and suggest practically feasible and economically viable methods of disposal of plastic waste, including disposal in Cement Kilns, their pollution potentials and pros and cons.

Accordingly, a team of experts from Eco Friend and Company went into all aspects of management of Plastic Waste, its quantification vis-a-vis that of the MSW, its availability at the dumpsites in a segregated form, method of segregation, etc.

The subject of Management and Handling of Plastic Waste is quintessentially, the subject of Municipal Solid Waste Management. The team therefore studied the numerous reports generated by various prestigious organizations who have taken pains to study the subject of Municipal Solid Waste Management (SWM) in detail, along with the study of the practical and economic ways of Plastic Waste Management and Disposal. Visits were made to the dumpsites, to the offices of the MCGM, to Recyclers and others engaged in the work to confirm the veracity of the reports and the technologies available. The findings and recommendations are presented in this report.

Destruction of Plastic Waste in Cement Kilns is the option that can be adapted by the MCGM only for the wastes in the dumpsites. The Cement companies themselves recommend that the well known principle of 3 R's - Reduce, Reuse, and Recycle should be followed in the hierarchy of Waste Management. Naturally, the practice of Reduce and Reuse has to be followed by the Waste Generators.

Recycling principally refers to Recovery, which itself is divided into Material Recycling and Energy Recovery. Material recycling is again divided into Mechanical and Feedstock Recycling. The choice between Mechanical Recycling, Feedstock Recycling and Energy Recovery depends upon the types of plastics waste.

Mechanical Recycling includes a wide variety of processing techniques and a range of processing methods and luckily, all are being followed in India, for the technology is simple and cheap. Pure grade production scrap may only have to be reground and reprocessed, mixed plastics have to be mechanically separated and if contaminated, also washed clean and dried. All these steps increase the cost depending upon the degree of contamination. To avoid the extra work and cost, proper segregation of wastes at source gives great ease in handling and recycling the wastes.

The trend of most Recyclers of Plastic Wastes in India is to get the pure grade production scrap (waste) directly from Industry using plastic in a big way, such as for manufacture of packing of goods, and even segregate it if mixed, into various types of plastics for recycling. This is a profitable business, not requiring any support from the municipalities.

For the contaminated waste, which is normally the case with Plastic Waste picked up by the rag pickers along with other dry, recyclable wastes from MSW in the streets in the absence of practice of Segregation at Source, the practice is to sell this waste to "kantawalas", who transport it to the bigger dealers in scrap having go-downs for storage and segregation. Cleaning by washing and subsequent drying is not feasible in Mumbai, in the absence of a large quantity of water and space that it requires. Such waste is transported to far off places such as Malegaon directly from the dumping grounds. Though the legislation requires that it is the duty and responsibility of the Municipality, little has been done to provide properly covered waste collection centers where rag pickers can sell their wastes to willing organizations, which in turn, can arrange for the segregation at the centre and sell for some profit the waste for disposal to scrap dealers / recyclers. The MCGM has started this activity with the help of NGOs in Mumbai, but has not been able to provide space needed for such centers throughout Mumbai.

The result is that similar work is being done in parallel by private individuals an unorganized (and in some cases, illegal) manner but it has a huge employment potential.

It is the first recommendation of the team that until the practice of Segregation at Source becomes a habit with the people, such Recycling should be encouraged by the MCGM through private partnership as an organized industry, providing space, tax reliefs, incentives, etc.

Use of Plastic Waste in Construction of Tar Roads, a technology that is simple, proven, economically viable through private partnership as is happening in Bangalore, is the next option, which can be immediately put in practice. It will require initiative on part of the MCGM to make it a success. Part of the wastes collected by the rag- pickers can be diverted for use in this option.

After collection of the portions that can be recycled by mechanical recycling, there remain numerous very small, heavily contaminated plastic articles, multi-layered composites or cross-linked products, which are allowed to remain in the waste causing solid waste problem. They may constitute a maximum of 1% of the total MSW at the dumpsite. The best way of reutilizing these portions is to try Energy recovery from these, by properly incinerating, or by disposing in Cement Kilns or in Blast furnaces. For reasons given earlier, Co-processing in cement kilns is recommended. This recovers their calorific value and at the same time disposes of the waste in a scientific manner without causing any environmental hazards. Typically, segregated wastes having plastics and similar combustible material having calorific values as low as 2500 k cal / kg have been used in India.

Conversions of all types of mixed, contaminated plastics without any segregation and without thorough cleaning of the waste is also possible by converting the waste into Fuel (RDF) This technology is in development stage, but may take precedence in future over Recycling and use of Plastic Waste in Cement Kilns, where some modifications in the feed section and a lot of spade work in terms of plant trials, establishing ways of continually testing the wastes and ascertaining that the quality of cement and the prescribed emission levels are met at all times, is required on behalf of the cement companies. Besides, the cement companies may not be able to offer any price for the waste, which will have to be delivered to their doorstep in a safe manner.

A big initiative on the part of MCGM (or other municipalities in Maharashtra which are located close to cement manufacturing plants, for the transportation costs can be prohibitive) will be required. Willing private entrepreneurs to segregate the waste from the dumpsites, pack and transport it to cement companies will also need to be attracted to participate in this proposal. It is likely that the economics will not work out in favor of the municipalities in Maharashtra unless an in depth analysis is undertaken by the municipality, which takes into consideration the long term and ultimate savings in the costs for the treatment of the MSW due to the tangible and intangible benefits resulting by removal of the plastic wastes from the MSW. The CPCB has directed all the Pollution Control boards in the country to encourage this technology. The other options available for plastic waste disposal, such as plasma pyrolysis, are not yet viable in India.

Detailed report on finding an economical and practically viable option for the Disposal of Plastic Waste in the MCGM area and similar fast growing cities in Maharashtra follows.

2. LEGISLATION ON MUNICIPAL SOLID WASTE

[6]A public interest litigation was filed by Almitra H. Patel and another in The Supreme Court of India in the year 1996 (Special Civil Application No. 888 of 1996) against the Government of India, all state Governments and several municipal authorities in the country alleging that they have failed to discharge their obligatory duty to manage municipal solid waste appropriately. The Supreme Court set up an Expert Committee, which deliberated on the issue after consulting 300 municipal authorities in class I cities and other stakeholders by holding regional workshops in Mumbai, Delhi, Chennai, and Kolkata. It submitted its report to the Supreme Court in March, 1999 making detailed recommendations, which were circulated to all the class I cities and various stakeholders through the Government of India with interim directions for implementation. To ensure compliance, the principal recommendations of the Supreme Court appointed Committee have been incorporated in the Municipal Solid Waste Management and Handling) Rules 2000 notified by the Ministry of Environment and Forest in September 2000.

Municipal Solid Waste [Management and Handling) Rules 2000

The Ministry of Environment and Forest notified Municipal Solid Waste (Management and Handling) Rules 2000 after widely circulating the draft rules in 1999 inviting objections and suggestions if any and made it mandatory for all municipal authorities in the country, irrespective of their size and population, to implement the rules.

To Improve the Systems the following Seven Directives are given:

1. Prohibit littering on the streets by ensuring storage of waste at source in two bins; one for biodegradable waste and another for recyclable material.
2. Primary collection of biodegradable and non-biodegradable waste from the doorstep, (including slums and squatter areas) at pre-informed timings on a day-to-day basis using containerized tricycle / handcarts / pick up vans.

[6] SOLID WASTE MANAGEMENT P. U. Asnani
From SWM (Report 2005) India Infrastructure Report 2006 Pg 160 to 189

3. Street sweeping covering all the residential and commercial areas on all the days of the year irrespective of Sundays and public holidays.
4. Abolition of open waste storage depots and provision of covered containers or closed body waste storage depots.
5. Transportation of waste in covered vehicles on a day to day basis.
6. Treatment of biodegradable waste using composting or waste to energy technologies meeting the standards laid down.
7. Minimize the waste going to the land fill and dispose of only rejects from the treatment plants and inert material at the landfills as per the standards laid down in the rules.

The rules are to be implemented and monitored in a time bound manner (See Table - Timeframe for the implementation of the Rules)

Chapter 2 -Table 1: Timeframe for the Implementation of the Rules

Pollution Control Boards as well as national and international institutions to guide the cities and towns in implementing the rules expeditiously.

S. No.	Compliance criteria	Schedule
A	Setting up of waste processing and disposal facilities	By 31 December 2003 or earlier
B	Monitoring the performance of waste processing & disposal facilities	Once in six months
C	Improvement of existing landfill sites as per provisions of these rules	By 31 December 2001 or earlier
D	Identification of landfill sites for future use and making site(s) ready for operation.	By 31 December 2002 or earlier

Manual for Municipal Authorities

Government of India, Ministry of Urban Development set up an expert panel to prepare a national manual on solid waste management to help the municipal authorities adopt appropriate systems of solid waste management. The manual was published in May 2000 and made available to all the states.

[7]Excerpts from Supreme Court Order dated 5th October 2004:

The Municipal Solid Wastes (Management & Handling) Rules have been enforced for the last about four years, but lot deserves to be done in implementation of those Rules. In the affidavit filed by the Ministry of Urban Development, it is inter alia, stated in para 8.3 (page 4119 of Vol-12) that MOEF has written to all State Pollution Control Boards (SPCBs) requesting them to formulate time bound action plan for management of Municipal solid waste in respect of metro cities and State capitals and has also addressed that issue in the 50th conference of Member Secretaries and Chairman of all SPCBs /PCC (Pollution Control Committees) held in March' 2004 at Delhi. It is necessary and appropriate to make a beginning that an action plan for management of MSW in respect of metro cities and States capitals is prepared by Ministry of Urban Development in consultation with all concerned, including, Ministry of Environment and Forest and the Central Pollution Control Board so that the implementation, based on the said plan, can commence without any further delay in the State capitals and metro cities to be followed by other cities. We direct the Central Government to examine the matter at the earliest, since considerable time has already elapsed since the matter was addressed in the Conference of March, 2004. The proposed action plan shall be filed in Court within six weeks.

As a result of the Hon. Supreme Court's orders on 26.7.04, in Maharashtra the number of authorizations granted for Solid Waste Management (SWM) has increased from 32% to 98%, in Gujarat from 58% to 92% and in MP from NIL to 34%. No affidavits at all have been received from the 24 other States/UTs for which CPCB reported NIL or less than 3% authorizations in February 2004. All these States and their SPCBs can study and learn from Karnataka, Maharashtra and Gujarat's successes.

Unless each States creates a focused "Solid Waste Management Cell" and rewards its cities for good performance, both of which Maharashtra have done, compliance with MSW Rules seems to be an illusion.

The State Governments and the Central Government and concerned SPCBs / PCCs should examine the aforesaid aspects and respond thereto within six weeks.

Comment by Eco Friend and Co.
It can therefore be said with certainty that Implementation of the Municipal Solid Wastes (Management & Handling) Rules 2000 had suffered even after 4 years of the rules being in force and needed to be taken up on priority by the Authorities responsible for implementing them.

[7] CPCB on Municipal Solid Waste Management - Order of Supreme Court on Management of Municipal Solid Waste, dated 5th Oct, 2004

[8]Responsibility for Implementation

The entire responsibility of implementation as well as development of required infrastructure lies with municipal authorities. They are directed to obtain authorization from the state pollution control boards / committees for setting up waste processing and disposal facilities and furnish annual report of compliance. The Secretary, Urban Development Department of the respective state government is responsible for the enforcement of the provisions in metropolitan cities. A District Magistrate or a Deputy Commissioner of the concerned district is responsible for the enforcement of these provisions within the territorial limit of his jurisdiction. The state pollution control boards are expected to monitor the compliance of standards regarding ground water, ambient air, leacheate quality and the compost quality including incineration standards as specified in the rules. The state board or the committee is directed to issue authorization to the municipalities when asked for within 45 days and the central pollution control board is expected to coordinate with the state boards in regard to implementation of the rules. Several training programs and workshops have been organized by the central government, state governments, Central Pollution Control Board, State PCBs / PCCs.

However, there is a definite awareness among local bodies as well as policymakers to solid waste management systems. There has at least been some progress in the right direction in five years' time, which is not a mean achievement for India. Even the US, which has been trying to follow efficient SWM practices for the last 25 years, only 25 per cent solid waste is recycled and 15 per cent waste is utilized for waste to energy and remaining 50 per cent of waste including organic matter is being land-filled even today. The situation in India is fast improving with regular monitoring by the Supreme Court,
initiatives by various state governments, large financial support from the central government on the recommendation of 12th Finance Commission, allocation of urban renewal funds to the states and technical and financial support from various ministries and national and international organizations.

[8] SOLID WASTE MANAGEMENT P. U. Asnani
From SWM (Report 2005) India Infrastructure Report 2006 Pg 160 to 189

3. REASONS FOR NON-COMPLIANCE

As per the Municipalities, compliance in waste collection is constrained by:

- lack of public awareness, motivation, education;
- lack of wide publicity through electronic and print media;
- lack of finances to create awareness;
- resistance to change;
- difficulty educating slum dwellers;
- lack of sufficient knowledge on benefits of segregation;
- non cooperation from households, trade and commerce;
- unwillingness on part of citizens to spend on separate bin for recyclables;
- lack of litter bins in the city;
- non availability of primary collection vehicles and equipment;
- lack of powers to levy spot fines;
- lack of financial resources for procurement of tools and modern vehicles.

In creating treatment and disposal facilities, the constraints outlined were:

- paucity of financial resources as well as lack of support from state government;
- non-availability of appropriate land;
- prohibitive time and cost considerations in land acquisition and implementation of treatment and landfill technologies;
- lack of technical knowhow and skilled manpower for treatment and disposal of waste;
- low quality of municipal solid waste;
- delay in clearance of disposal sites.

[9]Drawbacks in present SWM Services:

1. Absence of Community Participation.
2. No Storage of Waste at Source.
3. Apathy of Municipal Authorities.
4. No System of Primary Collection from the Doorstep.
5. Open waste storage depots causing spillage, and necessitating multiple handling.
6. Open, Multiple and Faulty Transportation of Waste.
7. Little Processing of Waste.
8. Unscientific Disposal of Waste.

[9] SOLID WASTE MANAGEMENT P. U. Asnani
From SWM (Report 2005) India Infrastructure Report 2006 Pg 160 to 189

Constraints / Difficulties in implementation faced by the MPCB

1. Non availability of suitable land and handing over of the same to concerned local bodies.
2. Lack of technical awareness among personnel's with respect to waste processing technologies, Selection of proper waste processing technology with respect to waste quantum generation, development of landfill sites.
3. The local bodies in coastal area are facing the difficulties in identification of suitable land due to CRZ notifications.
4. The locational policy of State Government in respect of notified Rivers (RRZ Policy) doesn't allow for such type of activity.
5. Non availability of sufficient funds with local bodies.
6. Lack of public awareness/participation.
7. Negligent / reluctant personnel's with ULB's.
8. Inadequate manpower with the Board for implementation and compliance verification with MSW Rules.

4. STEPS TAKEN FOR STRINGENT IMPLEMENTATION

Considering the magnitude of the Plastic waste found in MSW in Maharashtra and Mumbai in particular, steps were taken by several bodies to control Manufacturing and usage of Plastics and the same are mentioned below:

A. Legislation by the Central Government:

Recycled plastics Manufacture and usage Rules, 1999 under the Environment (Protection) Act, 1986 on September 2, 1999

MOEF Recycled Manufacture and Usage (Amendment) Rules, 2002
Recycled Manufacture and Usage (Amendment) Rules, 2003

B. Legislation by the State Government:

a. Maharashtra Plastic Carry Bags (Manufacture and Usage) Rules, 2006.
b. Maharashtra Non-Biodegradable Solid Wastes Rules, 2006

C. [10]Legislation by the MCGM:

In order to ensure proper compliance of the Municipal Solid Wastes (Management and Handling) Rules 2000, the Municipal Corporation of Greater Mumbai notified the rules to be known as "The Municipal Corporation of Greater Mumbai Municipal Solid Waste (Prohibition of Littering, and Regulation of Segregation, Storage, Delivery and Collection) Rules 2005" under Section 368 of the Mumbai Municipal Corporation Act 1888. These Rules shall apply to every public place within the limits of Municipal Corporation of Greater Mumbai, to every generator of municipal solid wastes and to every premises under the ownership or occupation of any person within the limits of Municipal Corporation of Greater Mumbai.

Comment by Eco Friend and Company:
The above have been superseded by Municipal Solid Waste (Prohibition of Littering and Regulation of Segregation, Storage, Delivery & Collection) Rules 2006 by a Notification with effect from 1st March 2006.

[10] www.mcgm.gov.in.

Summary of relevant parts of the BMC Solid Waste (Prohibition of Littering and Regulation of Segregation, Storage, Delivery and Collection) Rules 2006:

a. Segregation, Storage, Delivery and Collection of Municipal Solid Waste

1. Segregation of waste: the following 6 types of waste to be kept unmixed at the source: bio-degradable ("wet"), specified household hazardous, untreated bio-medical, construction and demolition, garden and horticultural, and non-bio-degradable ("dry") waste.
2. Delivery of segregated waste to the BMC: All waste to be held with waste-generator or at designated spots till time of picking up by BMC vehicle.
3. Biodegradable waste: Segregated bio-degradable waste to be delivered to the BMC or to designated spots.
4. Composting by all generators: On issuance of a Notice, all generators to compost bio-degradable waste at source or at designated spots, else BMC will charge a fee to collect the same.
5. Composting of biodegradable waste by bulk and new constructions: Bulk generators and owners / occupants of new constructions to compost bio-degradable waste at source within 6 months of these Rules coming into effect, else BMC will charge a fee to collect the same.
6. Household hazardous waste: shall be stored separately and delivered to the collection vehicle which shall be provided weekly / periodically by the BMC / MPCB.
7. Untreated Bio-medical waste: shall be stored separately and delivered to the collection vehicle which shall be provided weekly/periodically by the BMC / MPCB.
8. Construction and Demolition waste: shall be stored separately and collected on request from the generator and payment of a fee to the collection vehicle which shall be provided by the BMC / its Agents.
9. Non-bio-degradable ("dry") waste : both recyclable and non-recyclable, shall be stored separately and delivered to the dry waste collection vehicle which shall be provided by the BMC or to the community (dry waste) storage centers notified by the BMC, or to the authorized rag pickers' cooperatives, licensed recyclers or scrap dealers that may be appointed as Agents of BMC.
10. Bulk garden and horticultural waste: All bulk garden and horticultural waste will be kept un-mixed and composted at source failing which BMC will charge a fee to collect the same.
11. Fines: Non-compliance of segregation of waste as specified in 5.1 - 5.10 will attract fines.
12. Community waste storage centers: Where waste is delivered to a community waste storage bin, whether located inside any premises or in a public place, the waste shall be deposited inside the bin, in a segregated manner as specified.
13. Burning of waste: Disposal of waste by burning at any location is prohibited.
14. Action against transport contractor / BMC employee: Strict and swift action will be taken against the Transport Contractor and/or BMC employee, for mixing segregated waste at any point of collection; or for not picking up waste as per the specified time schedule.

b. Obligatory Responsibilities of the Brihanmumbai Municipal Corporation

1. Infrastructure facilities: BMC will provide the required infrastructure facilities to facilitate compliance of these Rules before imposing penalties.
2. Assistance for reducing waste: BMC will provide incentives to generators of waste for reducing waste by composting and recycling, and these incentives will be based on the savings made by BMC by the reduction of the volume of garbage to be transported.
3. Citizen Resource Base: BMC will provide lists of composting experts, licensed scrap dealers, dealers of recyclables, container / bin manufacturers, agencies with expertise in recycling, etc. that to facilitate / support citizens in recycling waste
4. Trade Refuse Charges: BMC will rationalize the Trade Refuse Charges applicable to hotels, restaurants, and other units, so that it is linked to the volume of net waste generated.
5. Purchase of compost: The Department of Parks and Gardens of the BMC will purchase any extra compost, if available, from the generator, at a specified fixed price as notified, subject to quality standards.
6. Model composting units: BMC will set up composting units (either vermi-composting or bio-methanation) in public parks and gardens, as well as provide other infrastructural and resource support for such initiatives.
7. Bio-degradable puja articles: BMC will collect bio-degradable puja articles at designated sites near water bodies such as beaches, lakes, ponds, etc. in special containers or “kalashas”, and this collection will then be composted at a suitable location.
8. Bio-degradable waste processing units: BMC will set up composting or bio-methanation units for the further processing of bio-degradable waste that is collected by BMC and that is not already composted.
9. Point-to-point waste collection services: The generator must bring stored waste for delivery to a “ghanta-gadi” (bell-ringing vehicle) that shall be provided by BMC for collection from designated points.
10. Collection at source: BMC will provide for the collection of waste at source from within the premises of a building or group of buildings from waste storage receptacles kept on the premises to which BMC vehicles / workers are provided access.
11. Data about waste received at landfill: BMC will release publicly, monthly data about the quantity of each category of waste going to the landfills and waste processing sites.
12. Community waste storage centers: The BMC will continue and maintain community waste storage centers where required, in public places, where segregated waste shall be delivered and thereafter collected by the BMC.
13. Data about phasing out of community waste storage centers: BMC will release data about the number and location of the community waste storage centers that are phased out, and the corresponding point-to-point collection for that area that has been established prior to the bin being removed.
14. Dry waste sorting and exchange centers: BMC will notify ward-wise dry waste sorting centers, where such solid waste is transported, and then sorted by BMC or its Agents such as registered cooperative societies of rag pickers /licensed recyclers.
15. Time schedule and route of collection: The daily / weekly time schedules and routes of BMC’s collection of different types of solid waste will be fixed and notified in advance.

16. Local Area Citizen Groups: Any registered Local Area Citizen Group that includes in its stated aims and objectives, maintenance of cleanliness and promotion of waste reduction, segregation and recycling in their neighborhood, and that is willing to take the responsibility of keeping an area clean will be recognized as Agents by BMC to do so.
17. Special Drives: BMC will undertake special drives for the enforcement of these Rules in "high priority" areas and those areas where Local Councilors / Government or Corporate bodies or registered/established Local Area Citizen Groups come forward to collaborate.
18. Stakeholder awareness, education and training: BMC and the NGO Council will draw up and execute a coordinated plan of action for education, awareness, and training of stake-holders and invite proposals for a city-wide Awareness and Outreach programme.
19. Documentation of successful initiatives: BMC along with the NGO Council will invite documentation of successful initiatives in cleanliness so as to form part of the Citizen Resource Base. Recognition and awards will be given to such best practices.
20. Info-line and FAQ section: BMC along with the NGO Council shall set-up a special "Info-line" and FAQ section with all relevant policies, procedures, forms, and other details. The FAQ section will also be available online and at all Ward offices.
21. Complaints: The existing Online Complaint Management System (OCMS) will be upgraded or a new one will be set up to integrate with the implementation of these Rules. Statistics of complaints and Action Taken Reports (ATR) shall be displayed in the OCMS.
22. Cleanliness Reporting Teams: BMC will take cognizance of the periodic reports filed by the citizen Cleanliness Reporting Teams and take action on the same in areas such as route planning, penalties levied, cleanliness drives, awareness efforts, etc. Action based on such reports shall be displayed at the concerned Ward Office, and on the BMC website.
23. Expressions of Interest: : Expressions of interest will be invited by BMC through public advertisement to initiate special projects for keeping an area clean, setting up segregation, recycling or waste processing facilities, etc.
24. Area Improvement schemes: Citizens are encouraged to suggest to BMC "area improvement / beautification schemes" for their locality; such schemes will be reviewed and assessed jointly by BMC and the NGO Council.
25. Surprise checks: BMC will conduct surprise checks in various parts of the Municipal limits, with a view to encourage compliance.
26. Enforcement Squads: BMC will strengthen its existing system of Nuisance Detectors and Enforcement Squads by incorporating support from other government agencies, as well as from Local Area Citizen Groups or other volunteers as required.
27. Information regarding Fines: Details of fines collected by BMC, its Agents or Nuisance Detector's will be shared publicly by the BMC.
28. Redressal Mechanism: BMC along with the NGO Council will set-up a Redressal mechanism at the Ward level for non-redressal of complaints within the specified time, cases where fines have been wrongly levied, etc.
29. Joint Review with NGO Council: BMC and the NGO Council will jointly review the effective implementation of these Rules, at least twice a year, and share the same publicly.

30. Designated officers and periodic reports: Officers will be designated at Ward and Zonal levels that will be responsible for the implementation of these Rules, including preparing micro-plans and schedules as required.
31. Specific Annual Targets: Specific Annual Targets shall be set by BMC & shall be publicly announced.
32. Transparency: All such information that is to be made available to the public by BMC shall also be shared with the NGO Council may be publicly displayed on www.karmayog.org
33. Co-ordination with Government Bodies: BMC shall co-ordinate with other government agencies and authorities to ensure compliance of these Rules.

c. Penalties

1. Contravention of these Rules will attract a fine as specified in the Schedule of Fines.

2. The Schedule of Fines also factors in a "familiarisation / warning period" for the understanding / implementation of these Rules; in the Familiarization Period, the Fine for contravention is half the actual amount or nil.

SCHEDULE I: Schedule of Fines
SCHEDULE II: Illustrative list of different types of Municipal Solid Wastes*
SCHEDULE III: List of specified household hazardous waste
SCHEDULE IV: List of bio-medical waste
SCHEDULE V: Specific Annual Targets

Ch 4 -Table 1: *Illustrative list of different types of Municipal Solid Wastes

Organic Wastes	Inorganic Wastes	
Biodegradable	Recyclable	Non-recyclable
· Kitchen Wastes · Tea Leaves · Egg Shells · Vegetables · Fruit and Vegetable peels · Meat · Bones · Flowers, fruits & vegetables · Garden and animal wastes · Leaf litter · Soiled paper · Scraps of paper · House dust after cleaning · Coconut shells	· Newspapers · Paper books and magazines · Glass · Wires · Metal objects · Plastic · Metals · Rags · Leather · Rexine · Rubbers · Thermocol / Styrofoam	· Old medicines · Paints · Fluorescent tubes · Spray cans · Fertilizers & pesticide containers · Batteries · Shoe polish · Other domestic hazardous wastes

D. [11]Action Plans by the CPCB:

Pursuant to the Hon'ble Supreme Court order dated 4.10.2004, CPCB interacted with Pollution Control Boards to get the action plans prepared from local bodies of 35 metro cities and 24 State Capitals.

E. [12]Steps Taken by the MPCB:

Out of 250 ULBs, MPC Board issued Authorization to 246 ULBs and Applications of 02 ULBs were refused by the Board due to RRZ/CRZ notification. The applications of 02 ULBs were under process of issuance of Authorization. Total quantum of Municipal Solid waste generation in the state of Maharashtra was 20567.96 MT/Day. The detail break up of waste quantum generation in the state of Maharashtra is as below:
% waste generation in the Corporation area - 64.66 % (13299 MT/D),
% waste generation in the 'A' class Municipal Councils - 25.88% (5322.46 MT/D);
% waste generation in the 'B' & 'C', class Municipal Councils - 9.46% (1946.50 MT/D)

F. [13]Actions taken by the MPCB:

Comment by Eco Friend and Company:
Several actions were taken by the MPCB from time to time to oversee the administration of the above Rules formed by the Central and the State Governments.

[11] From CPCB Website
[12] From MPCB Web Site IMPLEMENTATION OF MUNICIPAL SOLID WASTE (M&H) RULES, 2000
[13] From MPCB Website

2. QUANTUM AND NATURE OF MUNICIPAL SOLID WASTE (MSW) IN MUMBAI

[14]CPCB on MSW Waste Generation and Composition –

1. CPCB with the assistance of NEERI has conducted survey of solid waste management in 59 cities (35 metro cities and 24 state capitals-2004-05).
2. Total quantity of waste generated in the country (based on weighment exercise by local bodies) is not reported. However, Ministry of Urban Development in its manual on solid waste management (year 2000) has estimated waste generation of 100,000 MT.
3. CPCB with the assistance of NEERI has conducted survey of solid waste management in 59 cities (35 metro cities and 24 state capitals in 2004-05).
4. Quantities and waste generation rates in Mumbai is as under:

Chapter 5 – Table 1.

S. No	Name of City	Population (As per 2001 census)	Area (Sq. Km)	Waste Quantity (TPD)	Waste Generation Rate (kg/c/day)
59	Greater Mumbai	1,19,78,450	437	5320	0.45

5. Characterization of waste is necessary to know changing trends in composition of waste. Based on composition/ characterization of waste, appropriate selection of waste processing technologies could be selected.

Chapter 5 – Table 2

Sr. No	Name of City	Compostable (%)	Recyclables (%)	C/N Ratio	HCV* (Kcal/Kg)	Moisture (%)
59	Gr. Mumbai	62.44	16.66	39.04	1786	54

[14] From CPCB Web Site

[15]MPCB on MSW Quantity

Chapter IV- Table 3: Municipal Solid Waste Generation T/day in the State

Sr. No.	Name of Local Body	Class	Population	Quantity of MSW In MT/Day	Details of Authorization/ Approval by MPCB	Form II submission (Y / N)
1	Mumbai	Corp.	Above 1 crore	7,000	Authorization refused for 3 sites	Yes

Changing economy, increasing floating population coming for work from mofussil areas, migrant labour due to rising building construction activity and proliferation of slums have made a tremendous difference in the composition of MSW in Mumbai over the last few years.

[16]As per the MCGM Solid Waste Department (SWD) personnel interviewed, the MSW in Mumbai is divided into two broad categories – "Refuge" & "Debris & Silt." The former consists of the wastes collected from Households, streets, hotels, shops, offices and commercial establishments, slaughter houses etc and the latter comprise of waste collected from city drains / nallas and building construction activity.

Current figures of "Refuge" and "Debris & Silt" obtained from the SWD are in the range of 5500 – 6500 & 1500- 2000 MT per day, respectively.

[15] From MPCB Web Site
[16] See Interviews by Eco Friend and Company Team, elsewhere in this report.

3. QUANTUM OF PLASTIC WASTE IN MSW IN GREATER MUMBAI

A. Indicative Survey done by NEERI

Chapter 6 -Table 1: Physical Characteristics of MSW in Indian Cities

Population Range	No. of cities surveyed	Paper	Rubber, Leather & Synthetics	Glass	Metal	Total Compostable Matter	Inert Material
0.1 to 0.5	12	2.91	0.78	0.56	0.33	44.57	43.59
0.5 to 1.0	15	2.95	0.73	0.56	0.32	40.04	48.38
1.0 to 2.0	09	4.71	0.71	0.46	0.49	38.95	44.73
2.0 to 5.0	03	3.18	0.48	0.48	0.59	56.67	40.07
5.0 & above	04	6.43	0.28	0.94	0.80	30.84	53.90

Note: All values are in per cent calculated on wet weight basis.
Source: NEERI (1995)

B. Survey done by CPCB

Physical Composition of MSW in 1 million plus Cities and State Capitals across India (28 cities, Mumbai not included) was categorized by CPCB as follows -

1. Total Compostable,
2. Recyclables (Paper etc, Plastic, Glass & Metal) and
3. Others including inert material (Inert, Rubber & Leather, Rags, Wood, Coconut & Bones)

The percentage of Plastic in MSW found in bigger cities of Ahmedabad, Bangalore, Lucknow, Nagpur, Vadodara and Vizagapatanam was reported to be 5.29, 9.72, 7.45, 7.45, 7.58 & 9.24 respectively.

The report says that increasing use of plastics is changing the composition of municipal solid waste and causing harm in the processing of waste. The use of plastics has increased 70 times between 1960 and 1995.
Source: CPCB (2000)

C. From CPCB website data

CPCB on their website on "Plastic and Waste Maqnagement Issues" says,

It is estimated that approximately 4-5 % post-consumer plastics waste by weight of Municipal Solid Waste (MSW) is generated in India.

D. Figures from ENVIS*: April – June 2009

Plastics constitute only about 5% of MSW in major urban cities in India

[*ENVIS is a periodical published by the Indian Centre for Plastics in Environment (ICPE) whose area of activity is Capacity Enhancement Programmes on Management of Plastics, Polymer Waste and Bio-Polymers, Impact of Plastics on Eco System
Members of the Advisory Committee of NSWAI include Mrs. Almitra H. Patel (M.S. MIT USA) Member, Supreme Court Committee Solid Waste Management, Principal Secretary, Water Supply & Sanitation Department, Government of Maharashtra. and Mr. R. K. Garg, Ex-CMD, Indian Rare Earths Ltd. Emeritus President, NSWAI.
Managing Committee of NSWAI for the year 2008-2011 has apart from Mr. T K Badyopadhyay of Indian Centre for Plastics in Environment as members, officials from MIDC, persons from Public and Private Corporate industry such as NEERI, TERI, TCE, Tata Power Co Ltd, Excel Industries Ltd & an Invited Member from the MPCB. **VICE PRESIDENT**]

Comment by Eco Friend and Company:

In the absence of clear data regarding its quantum Mumbai, from the CPCB and ENVIS reports quoted above, it can be safely assumed that Plastic Waste forms at least 5 % of the MSW.

Refer also [17]CPCB Programme / projects >Wastes>Plastic wastes...which puts the figure at 9 % of the Total 1.20 Lac tones per day of MSW generated in India.

From today's quantum of MSW in Mumbai estimated at 7000 to 8000 MT (Metric Tons) per day, the plastic component therefore works out to approximately 400 MT / day.

[17] CPCB Programme/projects >Wastes>Plastic wastes...Environmental Issues and Challenges

4. TECHNOLOGIES AVAILABLE FOR PROCESSING, TREATMENT, AND DISPOSAL OF MUNICIPAL SOLID WASTE

Technologies Available:

The main technological options available for processing / treatment and disposal of MSW are : Composting, Vermicomposting, Waste to Energy, Anaerobic Digestion / Biomethanation, Incineration, Production of Refuse Derived Fuel (RDF) also known as Pelletization, Gasification and Pyrolysis, Plasma Pyrolysis, and Sanitary Landfilling / Landfill Gas Recovery.

Not all technologies are equally good. Each one of them has advantages and limitations.

Factors Governing Choice of Technology

The decision to implement any particular technology needs to be based on its techno-economic viability, sustainability, as well as environmental implications, keeping in view the local conditions and the available physical and financial resources.

The key factors are:
1. the origin and quality of the waste;
2. presence of hazardous or toxic waste;
3. availability of outlets for the energy produced;
4. market for the compost/anaerobic digestion sludge;
5. energy prices/buyback tariff for energy purchase;
6. cost of alternatives, land price and capital and labour cost;
7. capabilities and experience of the technology provider.

8. TECHNOLOGIES AVAILABLE FOR PROCESSING, TREATMENT, AND DISPOSAL OF PLASTIC WASTE IN MSW

Broadly, the following technologies are available:

1. Recycling, consisting of making Plastic Granules to be moulded into goods thereafter.
2. In the construction of Tar Roads.
3. Conversion into Petroleum (Refuse Derived fuel, or RDF).
4. Disposal in Cement Manufacturing Kilns.
5. Disposal in Blast furnaces.
6. Energy recovery and /or Generation of Power in Incinerators.
7. Plasma Pyrolysis.
8. [18]Disintegrating plastics by processing into the basic Chemicals which are harmless.
9. [19]Disposing off the waste by using some bacteria.

Some of these options will be discussed in detail in later part of this report.

[18]Weikepedia
[19] Weikepedia

9. INITIATIVES TAKEN AND WORK DONE BY PRIVATE INSTITUTIONS AND SOCIAL ORGANIZATIONS IN MUMBAI

It is gratifying to note that besides CPCB, MPCB, MCGM and the MMRDA who have a direct stake and responsibility on the subject of Disposal of Municipal and Plastic Wastes, several organizations have done enormous amount of work towards finding solutions to the problems created by Municipal Solid Waste in India.

Relevant to this report and prominent among the reports published by these are –

A. Save Bombay Committee on Integrated Solid Waste Management Programme

B. School of Planning, CEPT University, Ahmedabad on New Practices of Waste Management, Mumbai

C. India Infrastructure Report on Solid Waste Management

D. The Bombay Community Trust on Solid Waste Management in Mumbai

E. Inderscience Enterprises Ltd. on the Role of NGOs, Rag Pickers and Pollution Control Boards in Solid Waste Management.

F. National Solid Waste Association of India (NSWAI) on Integrated Solid Waste Management

In their given objective of finding economical and practical solution to the disposal of Plastic Wastes in Mumbai, the reports of work done in the past years by the MCGM and the above (and several other) organizations in Municipal Waste Management, of which Plastic waste forms an inevitable part, was studied in detail by members of the team making this report. The veracity of the reports was confirmed by visiting some of the sites in Mumbai, and by interviewing some persons actually involved in the work.

The reports are representative of the basic work of the organizations, and not necessarily that of the subject of Disposal of Plastic waste. However, the views expressed, solutions provided and recommendations made in their reports on Recycling of Plastic Waste found in MSW are very much practical. Their merits are that they are environmentally sound and take into account besides Technical,

also the Social and Economical aspects. Some have gone to the extent of suggesting sources of funds for the work of SWM.

For those interested in the details, relevant portions from these reports are reproduced as Annexures at the end of this report.

10. THE ISSUE OF PLASTIC WASTES

A. [20]CPCB on Plastics Waste: Environmental Issues and Challenges

The quantum of solid waste is ever increasing due to increase in population, developmental activities, changes in life style, and socio-economic conditions, Plastics waste is a significant portion of the total municipal solid waste (MSW). It is estimated that approximately 10 thousand tons per day (TPD) of plastics waste is generated i.e. 9% of 1.20 lacs TPD of MSW in the country. The plastics waste constitutes two major category of plastics; (i) Thermoplastics and (ii) Thermoset plastics. Thermoplastics, constitutes 80% and thermoset constitutes approximately 20% of total post-consumer plastics waste generated in India. The Thermoplastics are recyclable plastics which include; Polyethylene Terephthalate (PET), Low Density Poly Ethylene (LDPE), Poly Vinyal Choloride(PVC), High Density Poly Ethylene (HDPE), Polypropylene(PP), Polystyrene (PS) etc. However, thermoset plastics contains alkyd, epoxy, ester, melamine formaldehyde, phenolic formaldehyde, silicon, urea formaldehyde, polyurethane, metalised and multilayer plastics etc. The environmental hazards due to mismanagement of plastics waste include the following aspects:

- Littered plastics spoils beauty of the city and choke drains and make important public places filthy;
- Garbage containing plastics, when burnt may cause air pollution by emitting polluting gases;
- Garbage mixed with plastics interferes in waste processing facilities and may also cause problems in landfill operations;
- Recycling industries operating in non-conforming areas are posing unhygienic problems to the environment.

Main Features of the Plastics Manufacture and Usage (Amendment) Rules, 2003

Regulation of plastics waste, particularly manufacture and use of recycled plastics carry bags and containers is being regulated in the country as per "Recycled Plastics Manufacture and Usage Rules, 1999 and as amended in 2003. According to these Rules:

- No person shall manufacture, stock, distribute or sell carry bags made of virgin or recycled plastic bags which are less than 8 x 12 inches in size and having thickness less than 20 microns.
- No vendor shall use carry bags/containers made of recycled plastics for storing, carrying, dispensing or packaging of food stuffs;
- Carry bags and containers made of recycled plastic and used for purposes other than storing and packaging food stuffs shall be manufactured using

[20] □ Parivesh □ Central Pollution Control Board pages 139 - 143

pigments and colorants as per IS 9833:1981 entitled "List of pigments and colorants for use in plastics in contact with food stuffs, pharmaceuticals and drinking water"

- Recycling of plastics shall be undertaken strictly in accordance with the Bureau of Indian Standard specification: IS 14534:1998 entitled "The Guidelines for Recycling of Plastics"
- Manufacturers of recycled plastic carry bags having printing facilities shall code/mark carry bags and containers as per Bureau of Indian Standard specification: IS 14534:1998 (The Guidelines for Recycling of Plastics).
- No person shall manufacture carry bags or containers irrespective of its size or weight unless the occupier of the unit has registered the unit with respective SPCB/PCC prior to the commencement of production.
- The prescribed authority for enforcement of the provisions of these rules related to manufacturing and recycling is SPCB in respect of States and the PCC in Union Territories and for relating to use, collection, segregation, transportation and disposal shall be the District Collector/ Deputy Commissioner of the concerned district.

Options for Plastic Waste Management

a. Recycling of Plastic Wastes through environmentally sound manner

Recycling of plastics should be carried in such a manner to minimize the pollution during the process and as a result to enhance the efficiency of the process and conserve the energy. Plastics recycling technologies have been historically divided into four general types -primary, secondary, tertiary and quaternary.

Primary recycling involves processing of a waste/scrap into a product with characteristics similar to those of original product.
Secondary recycling involves processing of waste/scrap plastics into materials that have characteristics different from those of original plastics product.
Tertiary recycling involves the production of basic chemicals and fuels from plastics waste/scrap as part of the municipal waste stream or as a segregated waste.
Quaternary recycling retrieves the energy content of waste/scrap plastics by burning / incineration. This process is not in use in India.

Steps Involved in the Recycling Process

Selection: The recyclers / re processors have to select the waste / scrap which are suitable for recycling /reprocessing.
Segregation: The plastics waste shall be segregated as per the Codes 1-7 mentioned in the BIS guidelines (IS:14534:1998).
Processing: After selection and segregation of the pre-consumer waste (factory waste) shall be directly recycled. The post consumer waste (used plastic waste) shall be washed, shredded, agglomerated, extruded and granulated

b. Polymer Coated Bitumen Road

The CPCB has undertaken a project in collaboration with Thiagarajar College of Engineering Madurai to evaluate the performance of polymer coated built roads laid during 2002-2006 in different cities.
The observations are as below:

- The coating of plastics over aggregate improves Impact, Los Angels Abrasion and Crushing Value with the increase in the percentage of plastics.
- The extracted bitumen showed almost near value for Marshall stability. The entire road was having good skid resistance and texture values.
- All the stretches in the roads have been found reasonably strong.
- The unevenness index values of these roads are nearly 3000 mm/km, which indicate a good surface evenness.
- The plastic tar roads have not developed any potholes, rutting, raveling or edge flaw, even though these roads are more than four years of age.
- Polymer coated aggregate bitumen mix performs well compared to polymer modified bitumen mix.
- Higher percentage of polymer coating improves the binding strength of the mix.
- Foam plastics have better binding values.

c. Plastic Waste Disposal through Plasma Pyrolysis Technology (PPT)

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 PPT enable it to dispose off all types of plastic wastes including polymeric, biomedical and hazardous waste in a safe and reliable manner.

In plasma pyrolysis, firstly the plastics waste is fed into the primary chamber at 850 deg 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 around 1050 deg C. The hydrocarbon, carbon monoxide and hydrogen are combusted into safe carbon dioxide and water. The process conditions are maintained so 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 (CO2, H2O) 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 very high temperatures ensure treatment of all types of waste without discrimination.

The CPCB has initiated the study in association with Facilitation Centre for Industrial Plasma Technologies (FCIPT), Institute of Plasma Research (IPR) The objectives of the study are to conduct performance study of the PPT on 15 kg/hr prototype demonstration system developed by FCIPT/ IPR for proper

disposal of plastics waste and also monitor air quality parameters e.g. suspended particulate matter (SPM), carbon monoxide (CO), hydrocarbons (HC), benzene, dioxins, furans etc. with regards to gaseous emissions. CPCB also proposes to undertake study on safe disposal of plastics waste using higher capacity (approx. 50 kg/hr) plasma pyrolysis system as in future and may set up prototype plasma pyrolysis plant on demonstration basis (15 kg/hr waste disposal capacity) at specific locations (hilly and pilgrimage) in consultation with State Government.

d. Conversion of Plastics Waste into Liquid Fuel

A research-cum-demonstration plant was set up at Nagpur, Maharashtra for conversion of waste plastics into liquid fuel. The process adopted is based on random de-polymerization of waste plastics into liquid fuel in presence of a catalyst. The entire process is undertaken in closed reactor vessel followed by condensation, if required. Waste plastics while heating upto 270 C to 300 C convert into liquid-vapour state, which is collected in condensation chamber in the form of liquid fuel while the tarry liquid waste is topped-down from the heating reactor vessel. The organic gas is generated which is vented due to lack of storage facility. However, the gas can be used in dual fuel diesel-generator set for generation of electricity.

Environment related observations during the process

- There are no liquid industrial effluents and no floor washings as it is a dry process.
- There are no organized stack and process emissions.
- Odour of volatile organics has been experienced in the processing area due to some leakages or lack of proper sealing
- Absolute conversion of liquid-vapour was not possible into liquid, some portion of gas (about 20%) is connected to the generator. However, the process will be improved in full-scale plant.
- PVC plastics waste is not used and if used, it was less than 1%. In case PVC is used, the chlorine can be converted into hydrochloric acid as a by-product.
- The charcoal (charcoal is formed due to tapping of tarry waste) generated during the process has been analysed and contain heavy metals, poly aromatic hydrocarbon (PAH) which appears to be hazardous in nature. The source of metals in charcoal could be due to the presence of additives in plastics and due to multilayer and laminated plastics.
- Monitoring of process fugitive emissions in the work area as well as emissions from the engines/diesel generator sets is necessarily required (where this liquid fuel is used) for various parameters such as CO, HCl, Styrene, Benzene, VOCs.

Biodegradable Plastics

The environmentally degradable polyolefin films are defined as those materials that contain degradation process of polyolefin article (bag/film/ sheet) under conditions of composting. Often queries are raised regarding biodegradability of plastics but clear-cut answer is not available about the biodegradability of plastics. In view of above, CPCB has initiated a study in collaboration with Central Institute of Plastics Engineering and Technology (CIPET) to establish

the biodegradability and compostability (e.g. fragmentation rate, degradation rate and safety) of polymeric material available in India and abroad. The study will include:

- Inventorisation and assessment of the manufacturing status of biodegradable plastics in India particularly with reference to processing technologies and the environmental issues.
- Establishment of the degradation rate (change in chemical structure, decrease in mechanical strength, fragmentation or weight loss) of the polymeric material or plastics material under laboratory scale composting conditions.
- Finding out self-life and its impact on environment (soil, water of plastics with reference to colour and additives, once it is disposed off)
  Assessment of effects on foodstuffs with reference to natural colours and additives.

B. [21]CPCB on Plastic and Waste Management Issues:

It is estimated that approximately 4-5 % post-consumer plastics waste by weight of Municipal Solid Waste (MSW) is generated in India. The plastics waste generation is more i.e. 6-9 % in USA, Europe and other developed countries due their consumption habits. As per data available on MSW, approximately, 4000-5000 tons per day post consumer plastics waste is generated, however, pre-consumer waste or scrap is directly utilized in the industry itself. The plastics waste constitutes tow major category of plastics; (1) Thermoplastics' and (2) Thermoset plastics. Thermoplastics, constitutes 80% and Thermoset, constitutes approximately 20% of total post-consumer plastics waste. The Thermoplastics are recyclable plastics which include; PET, LDPE, PVC, HDPE, PP, PS etc., however, Thermoset plastics contains Alkyd, Epoxy, Ester, Melamine Formaldehyde, Phenolic Formaldehyde, Silicon, Urea Formaldehyde, Polyurethane, Metalised and Multilayer Plastics etc. The major problem in plastics waste management is of collection, segregation and disposal. At present, the plastics waste disposal is done through unorganized sectors i.e. Rag pickers and Kabariwaslas. More importantly, the collection, segregation and to an extent disposal system is carried out through unscientific method which create environmental problem as well as an "Eyesore". Therefore, there is need to reorganize whole recycling process and in this context, CPCB has enlightened this issue to a extent by developing new recycling technique as well as developed innovative technologies for disposal of plastics waste such as "utilisation of plastic waste in road construction" and "re-engineering the recycling process".

[22]Role of NGOs in Environmental Management

Enactment of statutes on Pollution Control and the experience gained in implementation of the various provisions of these Acts in the past more than two decades had indicated that Govt. machinery alone cannot effectively cope-up

[21] From CPCB Website - CPCB on Plastic and Waste Maqnagement Issues
[22] From CPCB Website - Role of NGOs

with the task of pollution control until supported by the masses. The need for participation of masses in achieving the targets committed in the Policy Statements for Abatement of Pollution has been felt strongly. Public interest litigations have successfully demonstrated that responsible and concerned NGOs and public spirited individuals can bring about significant pressure on polluting industries for adopting pollution control measures.

NGO being one of the most effective media to reach the people these days may play a significant role in this regards. NGOs are assisting the State Pollution Control Boards to a greater extent in providing first hand information and generating mass awareness with regard to control of pollution and can better function in this field in the following ways :

- By conducting preliminary river surveys and survey in air pollution control area for identification of any pollution source.
- By keeping vigil on abstraction of water/discharge of sewage trade effluent by any industry in quantity in relation to flow/volume.
- By conducting sampling and analysis of river/well water to ascertain the quality of river/well water.
- By providing information regarding any cause or permit any poisonous, noxious or polluting matter into any stream or well or on land or in air.
- By keeping vigil in the surrounding area, river, well, land and air against pollution and reporting to State Board/Central Board, if found any.
- By providing information whether any river stretch requires prohibition on use for disposal of polluting matters – for notification under Section 24 of the Water Act.
- By providing information regarding violation of consent such as discharges in odd hours etc.
- By publishing the minimum height of the stack/chimney prescribed for the industry/industrial operation etc. and ambient air and ambient water standards.
- By publishing the notified restricted areas where industries, industrial operations etc. shall not be carried out or shall be carried out subject to certain safe-guards.
- By providing information on fish kill or other sudden damage to the environment not noticed by the State Board.

As far as, Central Board is concerned, it has been extending its full co-operation by providing financial assistance for conducting mass awareness programme in their area. The water testing kit developed by CPCB is being provided to NGOs on subsidized rates making their task easy. Simultaneously the technical publications are also being provided on subsidized rates to NGOs by CPCB. In addition to the above, CPCB has been conducting Inter-action meets and Training Programmes through selected Institutions and capable NGOs to other NGOs especially for those working at grass-root level in villages, town and cities.

In all, we appreciate the aptitude and efforts of NGOs who have played magnificent role in this field of environment protection. We expect many more NGOs will come forward to take-up the issues regarding environmental management and promote sustainable development. *Int. J. Environmental Technology and Management, Vol. 7, Nos. 3/4, 2007 369*

C. MPCB Guidelines to citizens on Recycling (2005)

Community solid waste management planning should be based on an analysis of the quantity and composition of the area's municipal and commercial waste streams to determine what can feasibly be managed by source reduction and recycling.

- Joint planning by community/environmental groups/recyclers to minimize contractual problems and other issues involving municipal personnel and to maximize environmental benefits is encouraged.
- Economic considerations of recycling should include avoided disposal fees, the avoidance of future clean-up costs, and the costs of future land acquisition, transportation, and facility development. Disposal cost savings of recycling programs should be publicized. Disposal surcharges may be used as means of financing recycling programs.
- The establishment of stable markets for recycled materials is essential. Awareness should be created to promote procurement of products containing a high content of recycled and recyclable materials, and require that contracts specify products with the highest practical percentage of recycled content.
- Products and packaging materials should be conspicuously labeled to indicate recycled content, including post-consumer content, recyclability, toxicity and appropriate disposal.
- Household and small quantity commercial toxic and hazardous wastes should be segregated, labeled and collected separately in community-level programs that recycle, treat, or otherwise safely manage those wastes.
- A comprehensive waste management program should aim to recover all useful materials, with zero trash the ultimate goal. After source separation of recyclables, remaining salvageable materials should be recovered from the waste stream.
- Discarded tires should be recapped, reused as rubber, or reclaimed by processing into material for road surfacing or other uses. Burning of tyres is strongly discouraged to prevent emission of toxic or harmful gases.
- Components of the waste stream such as wood waste, construction and demolition debris, and white goods (e.g., stoves and refrigerators) should be removed and processed to recover the material. Refrigerants should be recovered and recycled.
- Items, which can be repaired such as furniture, tools and small appliances, should be recovered and made available to the public through second-hand shops, charitable organizations or waste exchanges.

Thin polythene bags (carry bags)

Thin polythene colored bags in municipal waste are well known to cause hazards to the natural environment and to animals. These bags contain toxic metals and are non bio-degradable.
They cause damage to municipal drainage systems and storm water drains by choking. In July 2005, Mumbai city faced a major flood disaster: one of the reasons given for the flooding was the blockages created in the drainage system by plastic litter.

When these plastic bags get mixed with MSW, they are difficult to separate from other waste. If they are dumped on land with other MSW, they do not get degraded by microorganisms and will remain in the soil for years together, preventing rainwater seepage into the ground. These bags are also reported to be a cause of the death of many animals that feed on garbage dumps.

Plastic bags should not be dumped into municipal garbage. If segregated at source, they can be recycled.

It is best if the authorities provide different colored containers for storing and handling the different kinds of wastes. The following colors are recommended:

- Green container : Biodegradable waste
- White container : Recyclable waste
- Black container : Others (Inorganic/Hazardous waste)

The biodegradable waste can be treated and disposed off/ used as manure in the premises or it can be given to the local municipality vehicle for further disposal.

The recyclable waste can be sold to the raddiwala or scrap dealer.

MPCB and Municipality can be contacted for disposal of other (inorganic / hazardous) waste.

Dry Waste Recycling

Dry waste such as paper, shampoo bottles, glass, note books, wires, safety pins, caps of mineral bottles, plastic utensils and toys, etc., can be handed over to rag pickers and kabaris who can further carry the waste for recycling or reuse.

Some items that can be recycled or reused are given below:

- **Paper**
  Old copies, old books, paper bags, newspapers, old greeting cards, Cardboard box
- **Plastic**
  Containers, bags, sheets
- **Glass and ceramics**
  Bottles, plates, cups, bowls
- **Miscellaneous**
  Old cans, utensils, clothes, furniture

- **Only Biodegradable Plastics should be sent for recycling.**

Guidelines for Waste Management :

There is a constitutional obligation of each citizen under Article 51A (g) to protect the environment. Each citizen should contribute to protect the environment by **reducing, reusing and recycling** solid waste and thereafter managing its safe disposal. Cleanliness starts from the house. Each citizen should ensure that the solid waste generated from his/her house is segregated, stored and disposed of as per the guidelines provided to protect the environment. Non Governmental Organizations (NGOs) should take up initiatives to work with local residents to improve the sanitation, segregation of waste, garbage management, etc. They can play an active role in organizing surveys, studies and new technologies to attract private entrepreneurs to take up solid waste management as a project on a professional level. NGOs should help to create awareness in the society about cleanliness, importance of waste segregation, ill-effects of improper waste management and to promote education and awareness in schools. NGOs should involve the community in waste management. NGOs also should encourage minimization of waste through in-house backyard composting, home composting, vermin-composting and biogas generation.

a. Waste Management at Source

Reduction and Reuse, Recycling

- Community solid waste management planning should be based on an analysis of the quantity and composition of the area's municipal and commercial waste streams to determine what can feasibly be managed by source reduction and recycling.
- Joint planning by community/environmental groups/recyclers to minimize contractual problems and other issues involving municipal personnel and to maximize environmental benefits is encouraged.
- Economic considerations of recycling should include avoided disposal fees, the avoidance of future clean-up costs, and the costs of future land acquisition, transportation, and facility development. Disposal cost savings of recycling programs should be publicized. Disposal surcharges may be used as means of financing recycling programs.
- The establishment of stable markets for recycled materials is essential. Awareness should be created to promote procurement of products containing a high content of recycled and recyclable materials, and require that contracts specify products with the highest practical percentage of recycled content.
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- Components of the waste stream such as wood waste, construction and demolition debris, and white goods (e.g., stoves and refrigerators) should be removed and processed to recover the material. Refrigerants should be recovered and recycled.
- Items, which can be repaired such as furniture, tools and small appliances, should be recovered and made available to the public through second-hand shops, charitable organizations or waste exchanges.

The Central Government, to perform its functions effectively as contemplated under sections 6, 8, and 25 of the Environment Protection Act, 1986, has also made or issued other Rules, Notifications and Orders that impinge upon the environmentally safe handling of wastes. These include:

- The Bio-Medical Wastes (Management & Handling) Rules, 1998.
- The Recycled Plastics (Manufacture and Usage) Rules, 1999.
- The Plastic Rules: Prohibit the usage of carry bags or containers made of recycled plastics for storing, carrying, dispensing or packaging of foodstuffs.
- Prescribe that the minimum thickness of carry bags made of recycled plastics shall not be less than 20 microns.
- Directs the manufacturers of carry bags that the carry bags and containers shall be in natural shape or white in color.
- Stipulate that recycling of plastics shall be undertaken strictly in accordance with the standards prescribed by the Bureau of Indian Standards. The manufacturers of recycled plastics carry bags shall mark their products as 'recycled'.
- This notification also provides that the Plastics Industries Association through member units shall undertake self-regulatory measures.

b. Non- segregated waste on the street

Action taken by the MPCB & CPCB

The Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs) within the given powers to them under relevant Acts and Rules have been attempting to persuade local bodies to take appropriate measures for the treatment and disposal of domestic sewage and municipal solid waste.
The Supreme Court of India has given directives to all States to comply strictly with Municipal Solid Waste Management Rules Maharashtra Pollution Control Board. Maharashtra Pollution Control Board has given authorization to 245 Urban Local Bodies for MSW management. MPCB in consultation with AIILSG have prepared the checklist for identification of processing and disposal sites to facilitate effective implementation of MSW rules.

Maharashtra State Government also has formed the District Level Committee under Chairmanship of District Collector for identification / selection of landfill sites. MPCB has extended financial assistance to five local bodies for model/demo projects which will guide ULB as a road map for development of projects which will guide ULB as a road map for development of MSW project and its proper operation and maintenance.

Urban Local Bodies, MPCB and State Government are working together to manage the increasing load of MSW, however public participation and community level treatment of MSW will help to decrease the load on Municipal solid Waste Management.

c. Home Composting – Citizens's Action

Do's and Don'ts to assist the authorities :

- Carry your own cloth or jute bag when you go for shopping.
- Say no to all plastic bags as far as possible. Replace with paper, cloth and jute bags.
- Reuse the soft drinks pet bottles.
- Segregate the waste in the house as wet and dry. Keep two garbage bins and see to it that the biodegradable and the non-biodegradable material is put into separate bins and disposed of separately.
- Dig a compost pit in your garden and put all the biodegradable waste into it to provide you with rich manure for your garden.
- See to it that all garbage is thrown into the municipal bin for further disposal of municipal solid waste. Do not litter on road or in offices, theatres, market places and/or any other common public places. When you go out, do not throw paper and other wrappings or even leftover food here and there; make sure that it is put into a dustbin.
- Do not throw the waste/litter on the streets, drains, open spaces, water bodies, etc.
- Community storage/collection of waste in flats, multi-storied buildings, societies, commercial complexes, etc.
- Manage excreta of pet dogs and cats appropriately.
- Provide waste processing/disposal at a community level.
- Organize public education and awareness programs. Increase awareness in children by interesting education programs in schools.

D. [23]A Note on Plastic Recycling:

Plastic recycling is the process of recovering scrap or waste plastics and reprocessing the material into useful products, sometimes completely different in form from their original state. Before recycling, plastics are sorted according to their resin identification code, a method of categorization of polymer types, which was developed by the Society of the Plastics Industry in 1988. Polyethylene Terephthalate, commonly referred to as PET, for instance, has a resin code of 1. When compared to other materials like glass and metal materials, plastic polymers require greater processing to be recycled.[citation needed] Plastics have a low entropy of mixing, which is due to the high molecular weight of their large polymer chains. A macromolecule interacts with its environment along its entire length, so its enthalpy of mixing is large compared to that of an organic molecule with a similar structure. Heating alone is not enough to dissolve such a large molecule; because of this, plastics must often be of nearly identical composition in order to mix efficiently.

[23] [REF: http://en.wikipedia.org/wiki/Plastic_recycling]

When different types of plastics are melted together they tend to phase-separate, like oil and water, and set in these layers. The phase boundaries cause structural weakness in the resulting material, meaning that polymer blends are only useful in limited applications. Another barrier to recycling is the widespread use of dyes, fillers, and other additives in plastics. The use of biodegradable plastics is increasing. If some of these get mixed in the other plastics for recycling, the reclaimed plastic is not recyclable because the variance in properties and melt temperatures.

Many such problems can be resolved by using a more elaborate monomer recycling process, in which a condensation polymer essentially undergoes the inverse of the polymerization reaction used to manufacture it. This yields the same mix of chemicals that formed the original polymer, which can be purified and used to synthesize new polymer chains of the same type.

Option is the conversion of assorted polymers into petroleum by a much less precise thermal de-polymerization process. Such a process would be able to accept almost any polymer or mix of polymers, including thermo set materials such as vulcanized rubber tires and the biopolymers in feathers and other agricultural waste. Like natural petroleum, the chemicals produced can be made into fuels as well as polymers. A pilot plant of this type exists in Carthage, Missouri, USA, using turkey waste as input material. Recently, a process has also been developed in which many kinds of plastic can be used as a carbon source in the recycling of scrap steel. Yet another process that is gaining ground with startup companies (especially in Australia, United States and Japan) is heat compression.[citation needed] The heat compression process takes all unsorted, cleaned plastic in all forms, from soft plastic bags to hard industrial waste, and mixes the load in tumblers (large rotating drums resembling giant clothes dryers). The most obvious benefit to this method is the fact that all plastic is recyclable, not just matching forms. However, criticism rises from the energy costs of rotating the drums, and heating the post-melt pipes.

The SPI resin identification coding system is a set of symbols placed on plastics to identify the polymer type. It was developed by the Society of the Plastics Industry (SPI) in 1988, and used internationally. The primary purpose of the codes is to allow efficient separation of different polymer types for recycling.

Recycling number	Unicode	Abbreviation	Polymer name	Uses once recycled
1	#x2673;	PETE or PET	Polyethylene terephthalate	Polyester fibres, thermoformed sheet, strapping, and soft drink bottles
2	#x2674;	HDPE	High density polyethylene	Bottles, grocery bags, recycling bins, agricultural pipe, base cups, car stops, playground equipment, and plastic lumber
3	#x2675;	PVC or V	Polyvinyl chloride	Pipe, fencing, and non-food bottles
4	#x2676;	LDPE	Low density polyethylene	Plastic bags, 6 pack rings, various containers, dispensing bottles, wash bottles, tubing, and various molded laboratory equipment
5	#x2677;	PP	Polypropylene	Auto parts, industrial fibers, food containers, and dishware
6	#x2678;	PS	Polystyrene	Desk accessories, cafeteria trays, plastic utensils, toys, video cassettes and cases, and insulation board and other expanded polystyrene products (e.g., Styrofoam)
7	#x2679;	OTHER or O	Other plastics, including acrylic, acrylonitrile butadiene styrene, fiberglass, nylon, polycarbonate, & polylactic acid.	

E. [24]MCGM on Plastic Waste Management

Integrated Approach on Plastic Waste Management

The strategy for effective management of plastics wastes should entail the three R's: Reduction, Reuse and Recycling of wastes. Hence, the action programme suggested by the Task Force includes a package of Preventive, Promotional and Mitigative (PP) measures to achieve these objectives. The implementation of the strategy will require active involvement of all sections of the society in which the industry and the civic authorities are the key partners. They have to act in unison to discharge their responsibilities. Public participation and catalytic

[24] MOU between BMC & Citizens – http://www.karmayog.org/

support from the Government are the two important pre-requisites for implementation of the strategy. The action programme for implementation of the strategy covers the following components:

Preventive measures: Minimizing use of plastics, segregation of wastes and compliance of environmental guidelines

Promotional measures: Improvement in waste collection system and recycling technologies.

Mitigative measures: Public awareness programme and penalties for littering, fire protection and safety measures. .

Institutional Mechanism

Establishment of a network of concerned Industry Associations, and the Indian Centre for Plastics in the environment (ICPE), for Government-industry interaction.

Action Programme

- Guidelines on Plastics Packaging: Packaging constitutes 52% of plastics consumption. Accordingly, this issue was addressed by the Task Force and 'Guidelines on Plastics Packaging and Packaging Waste' were prepared. Guidelines lay down measures aimed, as the first priority, at preventing the production of packaging waste, and as additional fundamental principles, at reusing, at recycling, and other forms of recovering packaging waste, and hence, at reducing the final disposal of such waste.
- BIS Guidelines/Specifications: The manufacture of products using recycled plastics should follow appropriate BIS "Guideline for Recycling of Plastics" and Indian Standard "Recycled Plastics for the manufacturing of Products-Designation", which have been finalized by Bureau of Indian Standards (BIS).
- Limits to Recycling: Beyond Type-II materials; (post-consumer plastics waste of unknown origin having visible impurities, as per BIS Guideline), recycling of plastics waste should be banned. Alternatively, use of such plastics wastes (beyond Type-II) should be resorted to for energy recovery. Recycling of multilayer film packaging and plastics wastes beyond Type-II also be considered for use as composites and volume applications, such as substitutes for wood/concrete products.
- Circulation of Dirty Coloured Plastics Carry-bags/Products, Consumer items, such as toys, water bottles, Kodum, carry bags etc., should not be allowed to use recycled plastics wastes, beyond Type-I (100%). Instead a blend with virgin plastics be encouraged (50:50), and efforts should be made not to downgrade the quality and performance of end products. Re processors using dirty plastics wastes for the manufacture of consumer items will be warned of the environmentally unsound practice. Manufacture of dirty coloured carry-bags with visible contamination and their circulation in the market should be banned.
- Recycling Logistics: The integrated plastics wastes management needs the cooperation and participation of plastics industry, local authorities and the consumers. The industry needs to take the lead in supporting pilot collection

schemes with the objective of channelizing more and more post-consumer plastics wastes for recycling.

- Consumer Awareness Programme: Social and environmental issues relevant to the plastics industry should be addressed by the industry. For this, it is recommended that a country-wide consumer awareness programme be launched from time to time through media, exhibitions, newsletters, publications, video films, posters etc., for the education of common man, environmentalists, Government Departments, trade associations, educational institutions etc.
- Applications Development Research: Appropriate applications development research programme should be launched by the industry in association with, and participation of waste reprocessors, government agencies CSIR, DST and other R&D institutions. In order to prevent repeated generation of plastics wastes, there should be shift from consumer products to volume applications, like synthetic lumber etc., where recycling plastics wastes could be technologically absorbed.
- Penalties for Littering: Post-consumer plastics wastes is primary source of littering, as seen around in public places. This should be contained by promoting dustbins culture. Local authorities should promote anti- littering measures; enforce provisions of existing laws, and by imposing deterrent penalties. In this connection, it is recommended that provisions contained in HP Non-biodegradable Garbage (Control) Act, 1995 and rules 1996, may be referred to.
- Incentives: In order to prevent indiscriminate generation of plastics wastes and promote recycling incentives, technical and financial assistance should be provided. Plastics products with appropriate recyclate content should attract price preference/incentives. To promote increased use of plastics wastes, incentives, like concessions in sales tax, excise duty and custom duty, for up gradation of recycling technology, import of technology, equipment and machinery, may be considered for the better use of plastics wastes. Incentives should be provided by the plastics industry to rag pickers and NGOs for increased collection of plastics wastes from public places.
- Recycling/Reprocessing machinery Equipment: These are already being manufactured in India. The existing units mostly depend upon local machinery. However, there is a scope of up gradation of recycling technology in tune with the scale of operations, and use of improved machinery. The plastics industry/waste recycling units should compile and inventory of such machinery and their requirements.
- Hazardous Plastics Waste: Plastics waste generated as a result of use of large number of products in Health and Medicare, i.e. hospitals, nursing homes/clinics, should be carefully segregated. Infected plastics waste products should not be resorted to for materials recycling. Same is applicable in respect of plastics containers/packaging, used for shorting of hazardous and toxic chemicals including insecticides, pesticides, and petroleum products. These should be carefully segregated from waste stream, and not resorted to materials recycling, but incinerated as per Notification on Bio Medical Waste issued by Ministry of Environment and Forests. Only clean packaging waste, like films, EPS shaped mouldings, glucose bottles etc., are to be segregated for materials recycling.
- Fire Protection and Safety Measures: Appropriate fire protection/safety measures should be planned in and around plastics wastes dumps, waste dealers markets, and reprocessing units, to prevent fire accidents. Waste dumps and dealers' markets should be located in specified industrial areas.

- Networks for Concerned Industry Associations: To facilitate monitoring growth and diversification of plastics packaging industry - both flexible, like carry/shopping bags, multilayer film packaging, film wraps etc., and rigid packaging, like EPS shaped moulded packaging, blow moulded containers, PVC PET bottles, disposables used in hotel and catering establishments, it would be necessary for each of these products manufactures to form into individual Associations, with a view to promoting waste management as a result of their use, encouraging organized recycling, and upgrading its technology. In this connection, the plastics industry should resort to concepts of minimizing plastics waste, reuse and increased materials recycling.
- Centre for Plastics in the environment: Government - Industry Interaction The Task Force recommended setting up of an autonomous Institution under the name "Indian Centre for Plastics in Environment" (ICPE). Social, environmental and technical issues in respect of plastics industry/processors with specific emphasis on waste should be handled by this Centre based on the pattern followed by similar institutions abroad. The plastics industry is advised to work out modalities of funding and operation, and finalize and setup of the Centre.

F. [25]Case for removing apprehension regarding perceived environment negatives of plastics

By Dr. A.N. Bhat, Director General
Indian Centre for Plastics in the Environment*

*ICPE brings out a Quarterly Publication and is sent free of cost to all those interested on Plastics and environment.

ICPE engaged itself to implement the recommendations and guidelines issued by the Committee constituted by the Honourable Supreme Court of India in 1999 in Mumbai (see Eco-*Echoes* issue Oct- Dec 2004, Oct- Dec 2006) and is continually involved in the activities promoting Plastic Recycling and Waste Management throughout India (see Eco-*Echoes* issue April - June 2009)

ICPE has taken a strong initiative, and spared no efforts or resources to conduct numerous studies in the processing of Plastic waste notably in

1. the construction of roads in Mumbai and Kolkata (see Eco-*Echoes* issue April - June 2004),
2. to get Fuel (Alka Zadgaonkar in Nagpur- see Eco-*Echoes* issue Jul-Sept & Oct-Dec 2004)
3. in finding Plastics Recycling Options (see Eco-*Echoes* issue Oct-Dec 2006)
4. in Co-processing in Cement Kilns (with ACC – see Eco-*Echoes* issue Oct-Dec 2008)

[25] http://www.icpeenvis.nic.in/index.html

Criteria for environment friendliness

For discussing environment friendliness of any product we need to keep a few important criteria in mind.

These are (i) conservation of resources e.g. raw materials, energy, water and minimization of emission to air/water during manufacture (ii) performance superior to alternatives, help conserve resources and (iii) recyclability, biodegradability, reusability or alternative disposal methods with least burden on environment.

If one strictly applies these criteria, plastics will clearly be seen to be an environment friendly material.

Processing and resource conservation

Take the case of first criterion. Plastic processing involves mild temperatures, thereby using less energy, and does not result in polluting water or air, the way paper or jute manufacturing pollutes. It is perhaps for this reason that Central Pollution Control Board in their Guidelines for Management of Consent and Authorization (2001) has classified plastic processing under Green category while paper and jute belong to Red category. In view of this, it is difficult to understand why many times the so called environmentalists appeal to consumers to use paper bags instead of plastic bags!

Performance / weight ratio

On the second criterion, plastics out performs other substitutes. This is because of an inherent property of plastics. Their performance/weight ratio is very high. It has been estimated that for packing 500gm. of coffee one would need 500gm of glass container, 130gm of tin container, but only about 12gm in case of plastic packaging. Imagine the extent of conservation of resources by plastic. The advantage does not stop here. If we had to transport one tone of packed coffee from one part of the country to another, one would need to transport one additional tone in case of glass packaging, 260kgs in case of tin, while it would be only 24kgs in case of plastics. This would result in saving on fuel, wear and tear or carrier trucks, as well as that of road etc. Indirectly plastics usage as a packaging material is a great boon on environment grounds. Plastic has also prevented massive deforestation by offering wood substitutes like furniture, building material, crates etc. In fact plastics have rendered help in afforestation programnmes in a major way e.g. nursery bags, drip irrigation etc. Minor irrigation system using sprinklers (drip and minor) have been reported to help in conserving water to an extent of 40% to 70%. Plastic packaging prevents wastage of agricultural products and processed foods to an extent of 25-30%. Plastic woven sacks conserve 4 million tones of cement avoiding losses via seepage as in traditional sacks. Similarly plastic pipes conserve material e.g. 1 Km of plastic pipe uses 1.7 MT while 1Km metal pipes need 10 MT. Thus plastic enables to get more out of less, and ensures sustainable development programmes.

Recyclability and Disposal

Coming to the third criterion, viz disposal issues, it should be noted that plastics are crushable and highly compactable occupying less space in landfills. They are predominantly eco-neutral and do not leach any chemicals to contaminate soil and ground water. In fact plastic films and sheets are used for protecting lining of hazardous landfills. Some people fear that plastic being non-biodegradable can cause harm to environment. For the types of application of plastics, its non-biodegradability is an asset. In any case, total mineralisation of a solid waste is a very lengthy process requiring special anaerobic conditions and methanogenic bacteria. Newspapers/telephone directories from landfills after 40 years were readable. Similarly perishable products like waste food, raked loaves and lumber was found in landfills even after 25 years.

In India we already recycle 60% of plastics from both industry and urban waste stream.

Briefly, let us look at a scenario if plastic packaging were replaced with traditional materials like paper, cloth, jute, metals etc. This will lead to a major penalty on the economic system. Phenomenal increase would be affected in weight of packaging (300%), volume of waste (160%), energy requirement (100%), and cost of packaging (210%). There are thus no eco viable alternatives to plastics in modern society.

If from the above analysis plastics are environment friendly, why is there so much of opposition to use of plastics from environmentalists or regulatory agencies in the country? The indiscriminate littering of light plastic bags by our people on the roads, parks, beaches and other public places results in ugly sight. Inefficient and inadequate management of solid waste in our country compounds the problem. There is thus a need to educate masses against littering, and improving solid waste management by civic authorities. This can be achieved by combined efforts from Government, Industry and Citizen groups.

Before concluding this paper, it would be useful to refer to some of the myths regarding safety issues in use of plastics, and provide factual details. It is particularly widespread in case of PVC products.

PVC and safety issues: Myths and Facts

Some people are worried that PVC may contain Vinyl Chloride Monomer (VCM), which is believed to be a carcinogen. Actually this link was made in the 70's. With introduction of revised production technology, since late 70's, not a single case of angiosarcoma has been identified among workers in any PVC factories. The problem has been eliminated.

Have most of our NGOs been fair in terming plastic as the main environmental pollutant while ignoring the lax attitude of citizens about littering particularly of thin plastic carry bags and absence of litterbins?

Another wide spread myth is that PVC is a potential source of dioxin. The fact is that dioxin emissions have declined by 50% since 1970 even though PVC production has more than doubled. There is also an allegation that burning of PVC results in dioxin generation. The fact is that most types of combustions produce dioxin. It is wrong to blame any specific material for dioxin production. There are reports that after a fire in a PVC recycling warehouse in Germany, dioxin levels in fire gases were comparable to the amount of dioxin found in unrestricted agriculture soil. Similarly when blood test of 26 people exposed to the fire was carried out dioxin content did not exceed that of unexposed subjects.

PVC does not cause disposable problem in Municipal solid Waste (MSW) to the extent it is made out. Nearly 75% PVC is used in pipes, profiles and cables which have a long (50-100 years) that do not form part of MSW. About 10-15% PVC consumption is in packaging and disposal application. MSW has been less than 0.5% weight of PVC. The contribution of acid generation from PVC is less than 0.25% of the total. Major sources are sulphur dioxide from thermal power station (69%), nitrogen oxide (29%) from auto emission.

G. [26]Apt Recycling May Solve Crisis

By Dhurjati Mukherjee
New Delhi, July 29, 2009

The use of plastics, which are petroleum derivatives and non bio-degradable, is very common nowadays, especially in the form of polythene bags, both in urban and rural India. Early this month, the Minister of State of Environment & Forests, Jairam Ramesh, appeared to have got the green activists upset, when he told the Lok Sabha that there is a general belief in the country that plastic bags have been banned, which is not a solution. The entire world uses them and they came as an alternative to paper bags, which he added could be more hazardous to the environment as it would imply cutting more trees.

Instead, the Minister assured that the Government would pursue a policy of encouraging bio-degradable plastic, which though an expensive proposition, is in a promising stage. Indeed, plastic waste is a significant portion of the total municipal solid waste (MSW) and estimates reveal that 10,000 tonnes per day of such waste is generated i.e. 9 per cent of 1.20 lakh tones of the total MSW. The plastic waste constitutes two major categories: thermoplastics and thermo set plastics. The former constitute 80 per cent and the latter 20 per cent of the total post-consumer plastic waste generated. Both these types are non-biodegradable and have a long working lifetime.

The environmental hazards due to mismanagement of plastic waste includes: littered plastics spoil the cities' beauty and choke drains; garbage containing plastics when burnt cause air pollution by emitting gases; garbage mixed with plastics interferes in waste processing facilities and may cause problems in landfill operations; plastic waste contaminates the soil, thereby impairing

[26] (Copyright India News & Feature Alliance) E-Mail : newseditor@sarkaritel.com

agricultural productivity; and recycling industries operating in non-conforming areas are posing unhygienic problems to the environment.

Apart from these, scientists have found that plastic waste interferes with the flow path of sub-surface water, thus responsible for development of local anomalous high ore water pressure, which consequently lowers the strength of the mass. This has caused a failure of the slope and led to landslides. Recent investigation of landslides in Darjeeling and other areas have found that the soil collapses once the plastic waste enters the sub-surface. Besides, plastics that enter water bodies and lakes affect pisciculture.

Regulation of plastic waste has become a problem though there is the Recycled Plastics Manufacture & Usage Rules, 1999 and subsequently amended in 2003. In recent years, there has been development of standards and guidelines for reuse of plastic waste into construction of roads, pavements, conversion of post consumer plastics into crude oil, in blast furnace/cement kiln, densification of multi-layer and laminated post consumer plastics into card-boards, lumber etc.

It has to be admitted, as the Minister rightly pointed out, that recycling if carried out as per approved procedures and guidelines, may not be an environmental or health hazard though a section of environmentalists do not quite agree questioning its practicality. Various initiatives are being taken for recycling, reuse and disposal of plastic waste. But these technologies are not very popular and most municipalities are grappling with the problem of proper management of plastic waste.

The best option is, of course, recycling in an environmentally sound manner. But it is also a fact that most civic bodies fail to collect and dispose waste. Instead of implementing technological innovations States such as Himachal Pradesh, Jammu & Kashmir, West Bengal other than Delhi have banned the use of plastic bags. Recycling technologies, however, have been divided into four general types – primary, secondary, tertiary and quaternary. While primary recycling involves processing of waste/scrap into a product with characteristics similar to those of the original product, secondary recycling involves characteristics different from original product. Tertiary recycling helps the production of basic chemicals and fuels from plastic waste/scrap as part of the municipal waste stream or as a segregated waste. The quaternary recycling, which is most complicated, retrieves the energy content of waste/scrap plastic by burning/incineration but this process is not in use.

In recent times, various organizations (including the Central Pollution Control Board) have experimented in the use of polymer-coated bitumen in road construction and the results are quite satisfying. The mixture is taken out at around 130-140 degree Celsius from the mini hot mix plant and used for road laying. Optimally 10 per cent of bitumen is replaced with plastic wastes. This process is found beneficial in two ways --it saves the fossil fuel and also solves the problem of plastic waste amicably. The process is rather simple and can be used with existing technology and the roads too have been found to be better in marshal value strength, leaching, bleeding, stripping etc.

Besides, experiments of conversion of plastic waste into liquid fuel have also been undertaken. After proper cleaning and drying, the waste plastic is poured into specially designed steel reactor in absence of oxygen and in the presence of

coal and certain catalytic additive. It is heated to 300-3500 C to convert into liquid vapour, which is then collected in a condensation chamber in the form of liquid fuel while the tarry liquid waste is topped-down from the heating reactor vessel. The organic gas that is generated can be used in dual fuel diesel generator set for generation of electricity.

Importantly, there are other methods of conversion of plastic waste. The post consumer waste of PET jars, bottles etc. can be recycled through a chemical process. These small pieces are washed, dried and shredded into small pieces and fed into the reactor as semi-solid strings in presence of certain chemicals and at desired temperature (around 2700 C). The strings are then air-cooled and converted into staple fibres and resins. The former can be used as fibres (rayon) for manufacture of carpets, mattresses and clothing materials.

The other conversion option is to clean, dry, shred the plastic scrap and send the same into mechanical densifier in high pressure. This material is converted into solid plank which is then cut into desired pieces for use in doors, partition walls, furniture etc. However, the downside is that during the process the dust generated may contaminate the ambient environment.
Though these technologies are available, most of the municipalities are not doing much in managing plastic waste properly. Very few States have started to recycle and/or reuse such waste for productive purposes. Given the situation, it may be imperative the ban on low-quality plastics be enforced strictly enforced all over the country. If not, it could have far-reaching negative effects.

Besides, recycling must be undertaken effectively in accordance with specifications of the Bureau of Indian Standards (BIS). The State Governments should initiate measures to popularize recycling and reuse technologies so that the plastic waste could productively be used. Perhaps, offering subsidy to recycling plants could be an answer.—INFA

H. Disposal of Plastic Wastes

[27]**From MATHRUBHUMI, Friday, October 30, 2009 by Prof. P. C. Menon**

Plastic is an indispensible material in the modern world. It is an industry involving millions of crores of Rupees all over the world. India alone produces and exports plastic materials worth millions of Rupees, providing employment and job opportunities to crores of people. Any idea of closing down the industry or banning its production and distribution is nothing short of suicide. It is impossible to find a suitable substitute in the near future. The reason why the use of plastic is so popular and wide spread is the convenience of use, the protection it gives to otherwise perishable materials and the safety it renders in packaging. Plastic carry-bags come in handy at stores and vegetable shops, eliminating the need to carry bags when you go shopping. It is practically impossible to carry enough number of cloth bags unless you are certain about the quantum of things you plan to buy. Therefore, it is better to believe that the world cannot think of Life without Plastic. What we require is a regimen to dispose of used plastic properly. Of course, a well planned awareness program is

[27] From www://mathrubhumi.org/index.php

inevitable, but a total ban on the production and use of plastic materials is both unwise and impractical. Instead, we have to start thinking on the lines of how used plastic can be re-used, recycled and disposed of in a healthy way. Though it is advisable to use more of bio-degradable plastic, it is not a feasible solution. Some ways to tackle this problem are:

1. Recycling of plastics in an environmentally sound manner. This involves selection, segregation and processing.

2. Build roads using Plastics Waste. Thiagarajar College of Engineering, Madurai has made extensive studies on this and has proved that such roads are much better than bitumen coated roads.

3. Plastics Waste Disposal through Plasma Pyrolysis Technology (PPT). This is a state of the art technology that integrates the thermochemical properties of plasma with pyrolysis process.

4. Conversion of Plastics Waste into Liquid Fuel. A research-cum-demonstration plant was set up at Nagpur, Maharashtra for conversion of waste plastics into liquid fuel.

5. Thermalysis: Thermalysis is process whereby scrap and waste plastics are converted into liquid hydrocarbons that can be used as fuels (diesel, gasoline etc.).

6. Re-use of plastic wastes as binders: Waste plastics, made up of Polyethylene, or Polystyrene softens after heating around temp 130-135 degree C. A study using thermogravimetric analysis has shown that there is no gas evolution in the temperature range 130-135 degree C.The softened plastic has binding property; these molten plastics material can be used as binder. It is found to be a good blend with bitumen for block making, modified light roofing, plastic flooring and polymer reinforced concrete etc. A pilot study has been successfully completed in the the Thiagarajar College of Engineering, Madurai.

7. Use of plastic shredders. A company named Cecon Pollutech Systems Pvt. Ltd. Has produced machines that can shred used plastic into re-usable materials. The shredder shreds all kinds of waste like syringes, needles, glucose bottles, pet bottles of mineral water, plastic lumps, pellets, wood paper, cardboard etc. This can be widely used in Finishing & Producing Industry, Hospitals / Nursing homes, Bio – Medical Waste, Laboratories, Catering Industry, Supermarkets, Municipal Authorities, Pharmaceutical Industry, Plastic Industry, and Card Board Industry.

8. Using Compactors : A **compactor** is a machine or mechanism used to reduce the size of waste material or soil through compaction. A **trash compactor** is often used by homes and businesses to reduce the volume of trash. Normally powered by hydraulics, compactors take many shapes and sizes. A large bulldozer with spiked wheels called a landfill compactor is used to drive over waste deposited by waste collection vehicles (WCVs). WCVs themselves incorporate a compacting mechanism which is used to increase the payload of the vehicle and reduce the number of times it has to empty. This usually takes the form of hydraulically-powered sliding plates which sweep out the collection hopper and compress the material into what has already been loaded.

a. **Commercial use**
   Many retail and service businesses, such as fast food, restaurants, and hotels, use compactors to reduce the volume of non-recycleable waste as well as curb nuisance such as rodents and smell. In the hospitality industry tolerance for such nuisances is particularly low. These compactors typically come in electric and hydraulic operation, with quite a few loading configurations, like Ground-Access, Walk-On and Secured Indoor Chute. These compactors are almost exclusively of welded steel construction for two reasons: durability under pressure and exposure to the elements, as compactors are installed either completely outdoors or sometimes under a covered loading dock.
b. **Residential use**
   There are also trash compactors designed for residential use which, likewise, reduces the volume, smell, and rodent problems of garbage. This can be especially valuable for households which
   regularly dispose of items such as disposable-diaper boxes or the non-edible portions of vegetables from a large garden. Related to this, there are frequently limits to the number of trash bags/receptacles that can be left outside for residential pickup, which further renders such compactors beneficial to such households.
c. **Municipal use**
   In addition to the waste vehicle and landfill use, there are solar-powered trash compactors that can hold the equivalent of 200 gallons of trash before they need to be emptied.

Waste Management System At Bruhanmumbai Municipal Corporation
In Mumbai, the Dry and Wet waste is separated at the source itself, so that the Dry wastes could be further segregated and sent for recycling, resulting in lesser load to the landfill sites. The wet waste is processed through vermiculture or similar process to generate compost. ICPE has joined hands with some NGO's and BMC to propagate the Proper Solid Waste Management culture among the citizens. BMC has given a secured area and a shed for segregation of dry waste, two one- tonner vans to move in the locality for 8 hours to collect dry wastes from households, Identity badges to the rag pickers, who accompany the BMC vans and collect dry wastes from door steps of the households/society buildings and bring them to the sheds for segregation. The dry wastes are product-wise segregated into paper, plastics, metal and others. These segregated dry wastes are stored in the secured sheds for disposal. Scrap dealers come and buy the scraps. The amount thus collected is distributed among the rag-pickers.

The wet wastes are collected by separate BMC vans from the household localities for composting, resulting into zero garbage concept. ICPE has provided collection bins, hand gloves, aprons, masks, etc. to the rag pickers, and promotional literature to the society members. ICPE also co-ordinates with BMC, NGO's and others, provides training to rag-pickers and conducts awareness programmes to the general public, school children, members of the housing societies etc.

The invention of Plastic and the materials made out of it has revolutionized the consumer industry to such an extent that a blanket ban on the production and use of Plastic is unwise. Instead, it is time to think of the above mentioned ways to handle used plasic.

What is possible in a big metropolitan city like Mumbai should certainly be possible in the Corporations, Municipalities and Panchayaths in Kerala. But what we essentially require is a definite change in the mindset. We believe that dirt in our house is decoration in the street. We freely throw out the waste from our house over the walls on to the roads, and blame the government as irresponsible for not clearing the rubbish. Still, there is some hope for us. The valuable service done by Kudumbasree in many respects tells us that something is possible in our State. A further extension of this, with ample help and guidance from the State and Local Self-governments, can go a long way in Waste Management with the involvement of the enlightened public of Kerala.

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I. 'Disposal of plastic is actually a myth'

[28]From The Hindu:

Anti- Plastics view: There are certain people who are against the proliferation of the Plastics, and their views must be taken into account before drawing any conclusion . One such view, which could be representative, is mentioned here :

Plastic defies any kind of progressive attempt at disposal – be it through recycling, burning or land filling. The solution in this case should be a 'zero waste' policy and saying 'no' to plastics.

Hazardous: Plastic is one of the major toxic pollutants of our time.

The next time we do shopping and carry home our purchase in a cute, comfy plastic carry-bag, think: we are contributing to deadly pollution, the ill-effects of which are irreversible and harmful to future generations!

Statistics reveal that daily use plastics like PET bottles, polythene carry bags and HDPE grain sacks account for nearly 20 per cent of Municipal Solid Waste (MSW) in our country!

"In the past decade India's consumption of plastics has grown by 12 per cent a year. Based on various parameters like resin, bondability and heat resilience plastics are categorised in the grade 1 to 7. India's producing a lot of plastic and most of it is of low quality… it is not even worth recycling!," laments

[28] Online edition of India's National Newspaper
Saturday, Jan 19, 2008

Ramakumar Purushotham, Associate Vice President - Energy Upstream, Enzen Global Solutions, an energy and environment consulting firm.

How harmful is plastic
Plastic is one of the major toxic pollutants of our time. Being a non-biodegradable substance, composed of toxic chemicals, plastic pollutes earth, air and water. Plastic wastes clog the drains and especially hits urban sewage systems.

Choked drains provide breeding grounds for disease-causing mosquitoes besides causing flooding during the monsoons.

Plastic wastes being dumped into rivers, streams and seas contaminate the water, soil, marine life and also burning of plastic waste contributes to air pollution.
"The toxic chemicals that go into making of plastic and pose serious threat to living beings of all species on earth are Benzene (which can cause cancer), Styrene (extremely toxic), Sulphur Oxides (which harm the respiratory system), Nitrous Oxides (which adversely affect the nervous system and child behavioural development) and Ethylene Oxides (harms male and female reproductive capacity)," explains Ramakumar.
Can we recycle plastic?

Plastic causes serious damage to environment both during its production and its disposal. "'Disposal' of plastic is actually a myth," says Ramakumar. Once plastic is produced, the damage is done once and for all. Plastic defies any kind of attempt at disposal – be it through recycling, burning or land filling.

"Since plastic does not undergo bacterial decomposition, land filling would mean preserving the poison forever. Landfills are also prone to leaks. The cadmium and lead in the wastes invariably mix with rain water, then seep through the ground and drain into nearby streams and lakes and other water bodies. Thus the water we use gets poisoned. Burning plastics is not a disposal option either. When burned, plastic releases a host of poisonous chemicals into the air, including dioxins, which is a carcinogen," he adds. Apart from these perils, recycling of plastic is known to be uneconomical, dirty and labour-intensive.

Recycling of plastic is also associated with skin and respiratory problems, resulting from exposure to and inhalation of toxic fumes, especially hydrocarbons and residues released during the process.

What is worse, the recycled plastic degrades in quality and necessitates the production of more new plastic to make the original product. Made from the petroleum refining process, plastic is a non-renewable oil based fossil fuel. Experts say that reprocessing of plastics involves the creation of a secondary product known as plastic lumber or clothing fibres, which is also not recyclable and non-biodegradable.

The solution?
The only way to reduce the hazards of plastic is to reduce the use of plastic and thereby force a reduction in its production.

"We should favour Zero Waste policies rather than waste management strategies. Zero waste is a budding global movement aimed at holding manufacturers responsible for the materials they produce and profit from. At the manufacturing level itself, there are some regulations to ensure that the product being manufactured is biodegradable and does not have any adverse effect on the environment. The products should be designed with zero waste in mind, otherwise they should not be considered culturally or ecologically sustainable," advises Ramakumar.

Education regarding waste is also an important first step. As a leading importer of industrialised nation's wastes,

India has suffered under a disproportionate amount of the world's toxic legacy. Banning disposable plastics is one of the most successful ways that a country can protect its people and environment from industries motivated more by profit than by a concern for humanity.

As an alternative to disposable plastics, we should encourage the use of tetra packs, glass bottles, cloth and paper bags which are recyclable.
MYTHILI G. NIRVAN

J. High Court raps Pollution Board for failure to check plastics use

[29]From The Hindu – 31 July 2009

CHENNAI: The Madras High Court has pulled up the Tamil Nadu Pollution Control Board for its failure to strictly implement the Central rules with regard to the sale and use of plastic materials.

"The Board seeks to shirk its duty and responsibility solely on the ground of want of legislation by the State, which in our considered view, cannot be accepted as the Board is empowered to act in terms of the Central rules," a Bench comprising Justices D. Murugesan and K. Venkataraman, said, passing orders on a public interest litigation petition.
The failure to implement the rules was obvious: it was common to see not only plastic paper bags but also plastic cups on the streets of cities, towns and villages. The use of plastics in shops and hotels, contrary to rules, was also common knowledge. Soil and water pollution due to dumping of plastics, and air pollution due to burning of plastic bags, was of greater concern. Consumption of foodstuff packed in such plastic bags endangered the health of the people, it said.

[29] Online edition of India's National Newspaper
Friday, Jul 31, 2009

The Bench observed that recycling may be somewhat useful to avoid pollution, but the impact of the use of plastics on the environment, particularly on the health of human beings and animals, was much more serious. In view of the undisputed devastation of the environment, there could be no excuse for the Board not to implement the rules strictly.

The court said the Union government had introduced in September 1999 the Plastics Manufacture, Sale and Usage Rules empowering the Board to issue registration certificates to units manufacturing or recycling carry bags and so on, and implement the rules. Admittedly, except in some places, practically the rules had not been implemented. Other than some averments relating to the inaction of the State to bring in legislation, the Board had not taken action in terms of the Central rules.

In his petition, A. Narayanan, trustee of Sevaman Trust, prayed for a direction to the authorities, including the Secretaries of the Environment and Forest Department and the Municipal Administration and Water Supply Department and the TNPCB, to ban throughout the State the manufacture, distribution and use of plastic carrybags, irrespective of size and thickness.
He also sought a ban on single-use plastic items less than 150 microns thick, and coloured pots, mugs and so on made of recycled and toxic plastic.

K. Plastics and the Environment:

[30]EDITORIAL ON SWM From ICPE:

The benefits of plastics in various applications in almost all areas of our daily life are well known all over the world including India. Plastics as energy saver is a well understood phenomenon which puts plastics as one of the top listed man made eco friendly materials. Plastics cause minimal CO2 emission during its manufacture (basic raw material), production (products for use) as well as during its transportation/usage compared to alternative materials for the same applications. A recently published Carbon Life Cycle

Analysis conducted by McKinsey & Company under a study project sponsored by International Council of Chemical Associations (ICCA) reveals that **out of top ten Green House Gas Emission Savers in the industry, plastics account for four application areas** – Insulation in the Building Construction, Packaging, Automotives and Piping. The Executive Summary of the cLCA study report has been published in this edition of ICPE Newsletter with the consent of ICCA. ICPE ENVIS Newsletter will continue to bring out such international and national study reports to its readers in India and elsewhere.

In spite of the fact that plastic carry bags and plastic bags have contributed significantly in creating a sustainable, cost-effective, energy efficient, hygienic and environment friendly packaging system for carrying, storing various types of commodities/products including food products, plastic bags/carry bags are under the scanner and are blamed for causing floods by clogging drainage system. **Though plastics constitute only about 5% of MSW in major urban**

[30] ENVIS Apr – Jun 2009

cities in India, it has been realised that thin plastic bags are not picked up by waste pickers due to economic reasons and are left in the waste stream creating waste management problem. To arrest the problem, the Union Government had already banned production and use of plastic carry bags below 20 microns in the entire country in 1999. However it is a reality that thin plastic carry bags are still seen in the market place. It is also a reality that poor littering habits of our people coupled with inadequate infrastructure for waste management have compounded the problems. A report containing the answer of the Hon'ble Environment Minister of India, Mr. Jairam Ramesh, to a question raised in the Indian Parliament recently, has been published in this edition of ENVIS. More attributes of plastics in general and plastic bags/carry bags in particular with comparative analysis with alternatives, would be serially published in ENVIS.
ICPE's position on various issues of plastics and the environment has been briefly covered under the Keynote Address delivered by ICPE's President – Governing Council – Mr. K. G. Ramanathan during seminar on Solid Waste Management held on 5th June, 2009.

As an ongoing dissemination of information, this Edition's Data Sheet contains energy saving data of plastics pipes and windows.

Readers may like to send their views/comments.
T. K. Bandopadhyay
Editor

Keynote Address by Mr. K. G. Ramanathan in PHD Chamber at the Seminar on Solid Waste Management – 5th June 2009

Ladies & Gentlemen, I am indeed delighted to be amongst such distinguished gathering and participate in this important seminar. PHD Chamber deserves our compliments for organising the seminar and assemble a galaxy of experts to discuss the problem of solid waste management. I strongly believe that such open discussion and debate amongst policy makers, experts, NGOs and members of civil society are essential for evolving a rational and practical approach for solving problems such as waste management.

Friends, It is indisputable that the requirements of human beings for modern living have increased enormously over the past decades. For meeting the basic needs of food, clothing and shelter to other requirements such as travel, health, leisure, etc., there is a heavy demand and consumption of wide variety of materials. Waste is only the flip side of our ever increasing consumption needs.

Without being judgemental, let me say, that however much one may romanticize the concept of "simple living", the age of idyllic pastoral life is over. We need to meet the needs of modern man and also solve the problem of waste generation which inextricably is linked to consumption.

Today, I am going to talk about plastics, which are in wide usage from common household items to high technology products. Light in weight yet tough, inert, excellent barrier properties, ease of moulding into flexible or rigid products, transparency when required, have all made the usage of plastic products grow rapidly. Products made from plastics have made significant contribution in the area of medical safety and health care. Agricultural productivity has dramatically improved with plastic water delivery systems, mulching and green houses made from plastic materials. High technology products required for aviation, industry, space science, telecommunication and computers use plastics extensively.

It is important here to note that plastic products consume least amount of energy during its production and usage in comparison to alternate materials such as glass, metals, paper, cloth, etc. In fact plastic products when properly handled leave very low carbon footprint on the earth. Despite all these positive attributes, plastics are generally criticised on the following grounds:

First it is said that plastics are derived from non-renewable resources, viz. oil and hence the usage of plastics should be curbed.

The reality is that only about 4% of crude oil is used in the entire chain of petrochemicals of which plastics is only a part. Moreover use of light weight plastics materials in various applications including in automobiles, reduces the consumption of fuels to such an extent that it more than compensates its use of the crude oil for its production. While the economy of usage of crude oil is always welcome, curbing the use of plastics is not the solution.

The second aspect of criticism relates to the alleged health hazards arising out of usage of plastics.

Plastic products are being subjected to in-depth scientific analysis. These have clearly proved that plastics are not hazardous to health. On the contrary plastic implants are widely used in orthopaedic field and many plastic products are extensively used in the medical field. Plastics are used for blood bags, IV fluid bottles, tubes and for packing of pharmaceutical products. Use of plastics disposable syringes have made treatment of highly transmittable diseases safer. There are clear international and national regulations / standards for usage of plastics that comes into contact with food, pharmaceutical products and drinking water, etc. Therefore, much of the alleged health hazards are pure scare mongering and not based on scientific facts. The issue of dioxin emission during the processing / burning of plastics has also been studied and documented to indicate that plastics and dioxin are not directly related. It is also documented that air and water emissions of various gases and other products during the production of plastics are much lesser compared to the alternative materials for same applications.

The third major criticism is its non-biodegradability.

While it is true that plastics are not amenable to biodegradation like other organic matters, many alternate materials such as glass, metals are also not biodegradable. Moreover, many of the applications for plastics arise from the need for the product to be long-lasting.

Again, LCA and other studies carried out the world over clearly prove that the energy required for production of plastics is much lower than that of alternate materials. Thus the production and usage of plastics demand minimum energy in comparison to other materials and therefore non-biodegradability alone cannot be a consideration while deciding on the appropriate needs of a material. It is also worth noting that biodegradable plastic products have already appeared on the scene, though technology and costs make them currently too expensive for widespread usage. I am sure the problem would be overcome with more R & D in this field.

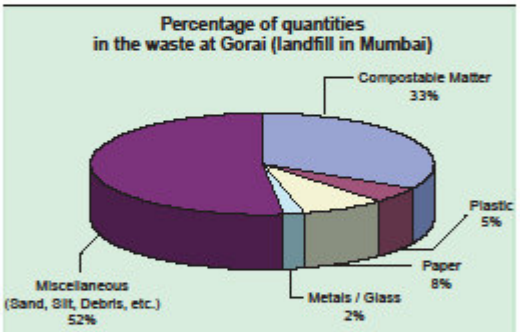
Lastly the problem of disposal of plastic waste is held against the usage of plastics. Plastics are blamed as the major cause of municipal Solid Waste problem.

Undoubtedly disposal of plastics waste is indeed posing a serious problem, particularly in the urban areas. Unfortunately the very strengths of plastics, viz., light weight and durability have become enemies of plastics. In our country the problem is compounded by the unfortunate littering habits amongst our people, coupled with inadequate solid waste management infrastructure. As a result, we find all types of dry wastes including plastic waste littered in our surroundings. Even wet waste is found accumulated around street corners and elsewhere.

WORKSHOPS & SEMINARS

Without minimizing the problem of plastics waste, the reality is that plastics waste form only about 5% of the MSW stream in major Indian cities. There is no problem of disposing the plastics waste per se, as they are 100% recyclable. Even thin plastic carry bags, which are considered as villain by the authorities, can be recycled into products, which are of non critical usage. The main problem is in segregation of waste at source and efficient collection of all wastes including plastic wastes from households. Developed nations, which consume plastics in much higher quantities than India have put in efficient system of segregation and collection coupled with public awareness programmes on anti littering and recycling. Unfortunately, we are far behind the developed countries in this area.

The thin plastic carry bags, though recyclable are thrown around carelessly after use. As picking of lightweight carry bags do not pay a reasonable return to the waste pickers for their efforts, they leave them behind. As a result, these plastics bags end up as a major urban nuisance. In order to minimise this problem, Ministry of Environment, Government of India had come up with rules specifying minimum thickness of plastic carry bags. Some State Governments had further modified the rules by increasing the minimum thickness. These steps are meant to promote reuse and better collection after disposal of plastic bags. Strict implementation of these rules should minimize the plastic carry bag nuisance.



The waste characterization study by NEERI and Others further reveals following categories of waste for which appropriate processing technologies have to be selected and installation of facilities is done:

1.	Compostable matter (Short-term biodegradable: Food waste, leafy matter, fish, meat, fruits, etc.)	30-40%	approx. 2340 tpd
2.	Energy content material (Long-term biodegradable: Tree prunes, paper products, coconut shells, textiles, bamboo baskets, banana stump, etc.)	12-20%	approx. 936 tpd
3.	Recyclables plastic, glass, metals, rubber	8-15% (largely scavenged)	approx. 624 tpd
4.	Miscellaneous mixed waste including sand, silt, sanitary diapers, etc.	20-30%	approx. 1560 tpd
5.	Debris & construction material	30-35%	approx. 2340 tpd
	Total (based on minimum range)		7800 tpd

Source: NEERI report on Solid Waste Management (2006), Mumbai

However, the long-term solution lies in putting up an efficient solid waste management infrastructure. It should start with segregation of dry and wet waste at source backed by a continuous public education programme. Since plastics are valuable material and are fully recyclable, we should promote setting up recycling centres at different points in major cities for converting post consumer plastics waste into products for non-critical applications such as furniture, buses, shelters, etc.

Apart from conventional mechanical recycling, alternate processes of plastics recycling are also required to be encouraged. Low-end plastics waste can be disposed of safely for co-processing in cement kilns. Recent trials undertaken by ICPE in co-operation with ACC and Madhya Pradesh Pollution Control Board with support from Central Pollution Control Board has clearly established the viability of such disposal. In fact, many European countries dispose all their post consumer plastics waste in cement kilns and steel furnaces. Similar successful experiments have been done for production of industrial fuel from all types of plastics waste. Plastics wastes have also been used to construct asphalt roads successfully in Tamil Nadu, Karnataka and Mumbai. These trials undertaken by ICPE with local authorities have clearly established the viability of disposing plastics waste, which can add economic value without dilution of any safety norms.

Friends, it is my belief that the problem of plastics waste can be solved on a long-term basis, only on the basis of fruitful partnership between Government agencies, local bodies, plastic industry and general public. Mass awareness against littering and for segregation of waste at source has to be created. Adequate infrastructure and systems for efficient disposal of Solid Waste including Plastics waste will have to be developed. I believe Government should take lead in initiating a dialogue between local bodies, plastic industry and NGOs to develop a successful model for handling plastics waste. The plastic industry along with retailers and packers, have to play a very important role in assisting the authorities to set up an efficient solid waste infrastructure system.

There cannot be any quick fix solution to the problem of handling Solid Waste including Plastics waste. Plastic products are useful, valuable and economic. They are in fact widely used by general public. There are no viable alternative to these products, which are economic and efficient or less energy consuming. Let us therefore not throw the baby with bath water; but let us solve the problem in a scientific manner with the support of all the stakeholders.

Lastly let my address be not misunderstood as plea for irresponsible consumption and usage of materials resulting into a huge waste management problem. On this World Environment Day, we should dedicate ourselves to the cause of conservation and sustainability, which demand responsible use of materials whether natural or manmade. Therefore the slogan of three R's, viz., Reduce, Reuse and Recycle is of great relevance to use of all materials including plastic products.

L. Some Pertinent points regarding the issue of Plastic Wastes :

From three other issues of ENVIS, reproduced hereafter :

ENVIS
MANAGEMENT OF PLASTICS, POLYMER WASTES AND BIO-POLYMERS AND IMPACT OF PLASTICS ON THE ECO-SYSTEM
Volume 1 - Issue 3 July 2003
INDIAN CENTRE FOR PLASTICS IN THE ENVIRONMENT
"World Bank Aided Program on Environmental Management Capacity Building Technical Assistance Project" and Sponsored by Ministry of Environment and Forests, Government of India.

RECYCLING OF PLASTICS

Plastics have shown rapid and visible growth compared to other materials. This is primarily because of substitution of other materials with plastics as well as its application in new areas. This is because of the materials' durability and versatility. The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 150 million tonnes today.

Plastic Waste and the Indian Dimension

Item	World	India
Per capita consumption	18 kg	4 kg
Recycling (Machine, Industrial & Consumer waste)	15-20%	60%
Plastics in solid state	7%	0.5-2%

From the above table it is found that India is amongst the lowest in generation of waste. India also has amongst the lowest per capita consumption of plastics and consequently, the plastic waste generation is very low as seen in the table. The above table indicates that India has a minimal presence of plastics in solid waste. However, the recycling rate of plastics is amongst the highest in the world.

With growing environmental awareness and the public focused on the increasing amount of plastic waste as a result of increased usage, an effective recycling system is the need of the hour. Today, the recycling industry has also grown exponentially with the Indian Recycling Industry having a turnover of Rs 50 billion with approximately 2,300 recycling units employing 3 lakh people.

Proper disposal and collection of solid waste and management of that waste in an economically and environmentally sustainable way is a viable option in lieu of the traditional methods of landfills. Integrated Waste Management system includes value addition to the waste: energy produced from waste, variable rate charging to consumers, public education and shared responsibility. This requires the participation of producers, consumers and local governments. The results include increased recycling and energy recovery.

Any effective waste management technique usually involves:

Reduce : Source reduction
Reuse : Multiple use of products
Recycle : Mechanical recycling
Recover : Feedstock & energy

We are going to focus on Mechanical Recycling as a key step in dealing with plastic waste management in India.

Mechanical Recycling

The World Resources Foundation recommends that Mechanical Recycling is the best option for the developed world. India too can reap the benefits of recycling due to the following advantages:

- It provides employment opportunities
- No emission of gases or effluents
- Offers ample Business opportunities
- Economical Utility products and
- Low cost Supply Chain

How are plastics mechanically recycled?

They are collected, sorted and baled into like materials, which are then washed and shredded into flakes and then placed into an extruder. The plastic is melted, pushed through

India has one of the highest plastics recycling rates in the world with almost 60% of plastic waste being recycled for its intrinsic value.

the extruder, cooled and pressed through a die and chopped or pelletised into granules almost the same as virgin material.
It is then ready for remaking into new products.

Plastics recycling technologies are generally placed into four categories.
Primary
Secondary
Tertiary
Quaternary

Primary

Although much of clean thermoplastic manufacturing waste is recycled in a primary sense, remelted and reformed, primary recycling by these methods is at present not a viable economic option for the vast majority of post-consumer plastics or manufacturing wastes that are contaminated. Removing contaminants and separating similar plastic resins has been difficult and costly.

Secondary

This technology involves manufacturing of products, with material properties inferior to the original products.

Tertiary

Processes that utilize waste plastics by altering a polymer's chemical structure to manufacture monomers, basic chemicals, or fuels. Tertiary recycling is a range of technological approaches applicable to a wide range of plastic wastes, producing a variety of products that may be substituted for different materials. Tertiary recycling can be divided into three basic categories:

Depolymerization processes: *This requires clean, single-resin plastic wastes and produces monomers or other basic inputs that can be used in the production of new and stainless kind resins.*

Tertiary processes: *They are applicable to mixed and contaminated plastics waste streams and utilize waste plastics as a substitute for crude oil in refinery operations and as substitutes for basic chemicals in refinery recycling and pyrolysis.*

Dissolution processes: *These can be applied to mixed and contaminated waste streams to selectively remove individual resins or classes of resins for further processing and recycling.*

With the exception of Dissolution, Tertiary recycling achieves closed loop recycling. Most of these technologies are in the developmental stage, and with economic viability they will substantially advance recycling efforts. Some Tertiary technologies allow recovery of nearly pure polymers or their constituents from a waste mixture, and the reaction conditions destroy contaminants, allowing the recovered material to be used in food-packaging applications.

Quaternary

The incineration of plastics takes place with heat recovery, either as part of the municipal waste stream or as segregated waste.

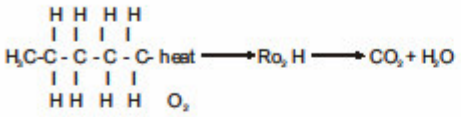
Thermal Degradation of Plastics during Recycling

Plastics go through several heating processes during Mechanical Recycling. Different plastics react differently to thermal processes. Polymers get degraded in presence of heat and the presence of oxygen with heat further accelerates the degradation process. But during recycling, there is neither emission of any toxic gas nor any chemicals are produced. Thermal degradation of some common plastics like, PE, PP, PVC and PS happen in the following ways:

Photo Source: www.degradable.net / retail/ com

Polyethylene (PE)

Thermal degradation of Polyethylene mainly produces carbon dioxide and carbon monoxide. In the presence of atmospheric oxygen and heat, it initially produces hydro peroxides, which ultimately generate carbon dioxide and water.



Polypropylene (PP)

Polypropylene is more prone to thermal degradation as compared to Polyethylene but the degradation process and the end products are similar to PE. Mainly due to thermal degradation in the presence of oxygen, alkyl peroxides and hydro peroxides are produced which ultimately produce carbon dioxide.

Polyvinyl Chloride (PVC)

PVC is adequately stabilized to withstand significant thermal degradation during recycling. Inadequately stabilized PVC releases Hydrochloric Acid during thermal degradation process while recycling. The degraded product exhibits reactions typical of unsaturated Hydrocarbons, and this may be considered as the result of the ejection of chlorine, together with an adjacent hydrogen atom. Thus, it is the polyene structure with conjugated double bonds (dienes) which is generally accepted as the degraded product.

(- CHCl - CH2 -) m ⟶ - CHCl -CH2 - (- CH = CH - CH = CH -) - CHCl - CH2 -

The liberation of hydrogen chloride (HCl) is twice as great in stationery air compared to that in a current of air. Alongwith HCl, also liberated is water, carbon dioxide and small amount of Hydrogen.

The formation of polyene structure is indicated by a change in colour and results in a great loss of mechanical properties.

Properly stabilized PVC does not undergo such degradation process.

There is no evidence of cyclisation during processing or recycling of PVC and no chance of formation of Dioxin or any other chemicals.

Polystyrene (PS)

The thermal degradation of Polystyrene proceeds by a free radical chain mechanism. In the absence of oxygen mainly disintegration of polymer chains occurs, which lead to oligomer or monomer. But the amount of monomer emission at <3000C is negligible.

(Ref: Grassie, developments in Polymer Degradation and Chevassus & Broutelles, Stabilization of Polyvinyl Chloride).

Steps involved in the process of Mechanical Recycling

COLLECTION: Plastics are first recovered from the waste stream and are either brought to a centralized collection point or are picked up by a hauler from designated waste containers. Rag pickers also collect these from municipality dustbins from where they are taken to handlers.

HANDLING: Then, the handlers sort the plastics from the waste, code them and then densify them.

SORTING: Plastics are separated from other materials like steel, aluminium, rubber wastes etc. They are also sorted by resin types- e.g. PET and HDPE plastic materials are separated before they are processed further. This is done manually in India while in developed countries it is done by using an automatic separator that uses infra-red identification or X-ray to identify plastic waste by resin type or color. Labels, caps and rings too are separated from plastic bottles.

CODING: To combat the recycling problem posed by the need to separate different plastics, many manufacturers have adopted a coding system. Containers are stamped with a code indicating the type of plastic from which they are made. Coding makes it possible to sort containers in the recycling process, if they are made of a single type of plastic.

DENSIFICATION: It takes a small quantity of plastic to produce a large volume of items. To avoid the high shipment costs arising from the high Volume to Weight ratio of plastic products, the handlers densify the plastics. This is generally done using Baling and at times, by granulating or grinding the plastics depending upon the market specification.

RECLAMATION: This is when the sorted and densified plastic is converted to flakes or pellets that can be used to manufacture new items. The process of flaking involves granulating it to convert it into small uniform sized chips of material. However, for obtaining clearer material, these flakes are washed, dried and then pelletized. The process of pelletizing involves melting the plastic, extruding it into thin strands and then chopping them into small uniform pieces.

END-USE: The pelletized or flaked plastic can then be sold to the manufacturers of recycled products. From bottles and containers, clothing, automotive accessories, bags, bins, carpet, plastic lumber, film and sheet to hospital supplies, houseware, packaging, shipping supplies, toys are recycled.

Although the above process may seem very simple and straightforward, it poses unique recycling challenges. Recycling plastics is difficult because the plastic waste that comes through is a mix of plastics having different properties. Separating plastics poses problems for the recycling industry. Multi layer packaging also makes it difficult to isolate plastics of one kind as it involves layers of different plastics fused into one container.

India has many success stories in the use of recycled plastics for commercial uses. Thus conversion of automobile battery cases to moulded Luggage, milk film to Barsati film (hamlet covers), plastic woven sacks (PWS) to Niwar Patti are just a couple of the numerous applications made in a country famous for maximum plastics recycling in the world.

Sources of Plastic Waste for Recycling:

Sources of plastic waste can be in houses, industrial products and/or consumer waste.

Machine	Industrial	Consumer
Runners	Barrels	Milk Pouch
Flashes	Crates	Carry bags
Defective articles	Films	Cups/glasses
Purging	Jerry cans	Buckets/mugs
Sweepings	Rotomoulded tanks	Pens
	Cement bags	Mats
	Tarpaulins	Luggage
		TV cabinets
		Footwear
		Films from various consumer packs

Commercial Uses of Recycled Plastics

Name of plastic	Some uses of virgin plastic	Some uses of recycled plastic
PET	Soft drink and mineral water bottles	Multi-layer soft drink bottles, carpet fibres, fleecy jackets
HDPE	Raffia, knitted fabrics monofilaments, nets L-ring barrels, jerry cans, pressure pipes for potable water / gas, housewares, packaging film, luggage, toys	Waste bins, detergent bottles, crates, agricultural pipes, kerbside recycling crates. Plastic lumber, plant pots, traffic cones, toys, outdoor furniture
Rigid PVC	Potable water pipes / pipe fittings, doors and windows, office partitions, window profiles, calendered film for medical tablet packaging, bottles for toiletries	Detergent bottles, tiles, cooling tower frills
Flexible PVC	Wires & cables, shoes/ shoe soles, garden hoses, irrigation hoses, blood bags and medical tubings, upholsteries - tiles	Hose inner core, industrial flooring. shoes / shoe soles
LDPE	Heavy duty/general purpose, packaging bags, cable coating, extrusion coating, various substrates for packaging applications, wide width film for canal lining and cap covers for food storage, milk pouches	Packaging and plant nurseries, bags
PP	Raffia, monofilament, ropes, industrial mouldings, disposable syringes, automobile applications, automotive batteries, furniture, luggage, caps and closures, thermowares, integrally hinged boxes, washing machines	Composite bins, crates, niwar, straps
PS	Yoghurt containers, audio/ video Cassettes, plastic cutlery	Coat hangers, office accessories, rulers, video/CD boxes

ENVIS
MANAGEMENT OF PLASTICS, POLYMER WASTES AND BIO-POLYMERS AND IMPACT OF PLASTICS ON THE ECO-SYSTEM
Volume 1 - Issue 6 October-November 2003
INDIAN CENTRE FOR PLASTICS IN THE ENVIRONMENT
"World Bank Aided Program on Environmental Management Capacity Building Technical Assistance Project" and Sponsored by Ministry of Environment and Forests, Government of India.

PLASTIC PROCESSING AND ENVIRONMENTAL ASPECTS

Executive Summary of the study carried out at the Shriram Institute of Industrial Research sponsored by the Indian Centre for Plastics in the Environment

Plastics because of their versatile properties and cost-benefit ratio have permeated every facet of human life. These wonder materials have substituted traditional materials in most of the end use applications. On account of inherent advantages, the use of plastics has not only become inevitable but also desirable. Despite such usefulness a debate has been going on about their environmental aspects. Plastics being basically organic materials are processed under heat and pressure into desired shapes for specific end use. To investigate the fact whether plastic processing industries can be classified as environmentally friendly or otherwise, a vital need arose to carry out a systematic study based on the experimental data and available literature. Indian Centre for Plastics in the Environment (ICPE) sponsored a research project to SIIR to carry out such study. The study has been divided into two parts, first based on the existing documents (National/International) and second on data generation by experiments.

Thermoplastic polymers comprise more than 90% of polymer industry and major commodity plastics include Polyethylene, Polypropylene, Poly vinyl chloride (PVC), Polystyrene and PET. A number of processing methods/techniques are available to process these materials and major ones are extrusion, injection moulding, calendering and lamination etc. Trends in the production of various polymers in India have been provided and the role of plastics in sustainable development and environment has been discussed in brief. Benefits of plastics in terms of energy efficiency and resource conservation compared to traditional materials like metal and glass have been highlighted. The present report is an attempt towards qualitative and quantitative study of emission sources such as volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) and generation of particulate matter, if any, during the processing of plastic under review.

Each plastic material has been described in terms of its synthesis, processing behavior and environmental aspects, which has been later reinvestigated based on the experimental data using sophisticated polymer characterization techniques like Gas Chromatography, High Pressure Liquid Chromatography (HPLC) and Thermogravimetric analysis (TGA). Based on the available literature, the safe upper processing parameter especially temperature profile has been reported. Details about emission of products up to processing parameters have been highlighted.

Since, so far no Indian study has been undertaken to evaluate the emission criteria of the VOCs and HAPs during the processing of plastics like PE, PP, PVC, PS and PET, international standards have been taken as the reference. Two international standards, American Conference of Government Industrial Hygienists and Federal Occupational Safety and Health Administration (OSHA) have been taken as the reference point for the threshold limit of emission. Gases generated during processing of these plastics were analyzed for the degradation of any VOCs using GC, HPLC and UV spectrophotometric methods. Further thermal degradation behavior has also been monitored by TGA.

Grades of plastics used in the study are commercially available resins from leading Indian plastic/raw material manufacturing companies. Summary of VOCs generated using these experimental techniques are given in Table 1.

Table 1: Determination of Thermal Degradation Products of Polymers

Polymer (processed at temp °C)	Total air absorbed/ adsorbed collected @ 11 pm (Lit.)	Volatile Organic Compounds (VOCs) and HAPs (ppm)			
		VOC as per ASTM D-3686 (GC)	Formic acid, Acetic acid, Acetaldehyde(HPLC)	Formaldehyde(UV Spectrophotometry)	Hydrochloric acid (Colorimetry)
LDPE (170-205°C) Extrusion/Injection moulding	70	Nil	Nil	<1	Nil
LLDPE (180-240°C) Extrusion/Injection moulding	65	Nil	Nil	<1	Nil
HDPE (210-245°C) Extrusion/Injection moulding	60	Nil	Nil	<1	Nil
PP (210-270°C) Extrusion/Injection moulding	75	<1	Nil	<1	Nil
PVC (150-250°C) Extrusion/Injection moulding	45	Nil	Nil	Nil	Nil
PS (190-270°C) Extrusion/Injection moulding	60	<1	Nil	<1	Nil

Threshold Limit Value (TLV of various gases as per OSHA and ACGIH have been given separately in Table 2.

Table 2: Threshold limit for toxic air pollutants in industrial environment

S. No.	Toxic Pollutants	PPM Level
1.	Acetaldehyde	100
2.	Benzene	10
3.	Acetone	5
4.	Acetic acid	10
5.	Formic acid	5
6.	Styrene	100
7.	Formaldehyde	2
8.	Hydrochloric acid	5
9.	Methanol/ Ethanol	5

**Source: American Conference of Govt. Industrial Hygienists (ACGIH), Federal Occupational Safety & Health Administration (OSHA)*

The experimental data generated at SIIR has been compared with threshold limit for toxic air pollutants in Industrial Environment recommended by American Conference of Government Industrial Hygienists. From the above observations it can safely be concluded that there is no generation of VOCs/HAPs during the processing of plastics under normal conditions of processing. Similarly, Thermogravimetric analysis (TGA) in Dynamic and Isothermal modes has been carried out to study the initial decomposition temperature of plastics and thermal stability over an extended period of time. This study assumes significance since any type of emission during the processing of plastic will take place only after initial decomposition temperature (IDT). IDT of the plastics under study are given in table 3.

Table 3: Initial Decomposition Temperature of Polymers

Polymer	Initial Decomposition Temperature
Polyethylene	260°C
Polypropylene	270°C
Polystyrene	280°C
Polyvinyl chloride	250°C
Polyethylene terephthalate	310°C

In practice the processing temperatures are always kept much below IDT.

TGA in the Isothermal mode also gives an insight into the stability of a polymer over an extended period of time. This study is of great significance because it provides a good clue about stability of a polymer vis-a-vis residence time in the machine at the processing temperature. Again it can be safely concluded that residence time of the Polymer in the processing machine is much lower than the time period through which it remains stable, as evidenced by TGA in the Isothermal mode.

Conclusions and recommendations based on the study have been provided where it has been highlighted that plastic processing is an environmentally safe process since no volatile organic compounds/ hazardous air pollutants are emitted during processing.

CONCLUSIONS AND RECOMMENDATIONS

The present study examines the detailed literature/documentation available to assess whether plastic-processing industries can be classified as environmental friendly or otherwise. The study also comprises of detailed experimental work carried out at SIIR using sophisticated instrumental analysis to ascertain the facts about emission of hazardous chemicals/ volatiles during the plastic processing. Since plastics are organic in nature and

are processed under heat & pressure, there is a likelihood of emissions at very high temperatures, as a result of thermal degradation. However in general practice plastics are processed at temperatures, which are much lower than those where degradation takes place; hence the possibility of emissions in the atmosphere is very less. Based on the present study some conclusions have been drawn which are as under:

- Plastics are a class of materials, which are synthetic in nature and are manufactured by polymerization process and are classified as thermoplastic & thermosetting materials. A number of plastics processing techniques are available to make desired end products. These include Injection moulding, Blow moulding, Extrusion, Rotomoulding, Calendering, Lamination etc.
- Plastics play a crucial role in the development of mankind. If the benefits of plastics are compared with traditional materials, it is evident that they help in conservation of resources & saving of energy.
- Emission to environment during processing of plastics is caused by degradation of polymer. The emissions are classified as Volatile Organic Compounds (VOCs), Hazardous Organic Pollutants (HAPs) and particulate matter.

- Experimental techniques such as GC, HPLC & TGA have been used to assess the emission of VOCs & HAPs during injection moulding, extrusion and two roll milling of commonly used polymers like PE, PP, PVC, PS & PC.
- Detailed experimental analysis reveals that plastics processed at their respective processing temperatures generally do not generate any volatile/ hazardous gases. However, at the very high processing temperature of polymer (above 300 - 400°C), thermo-oxidative degradation of the polymer can take place with the formation of oxidized fragments of the degraded polymer. However, such high temperatures are not used in plastics processing industries.
- The experimental data generated by SIIR has been compared with threshold limit for toxic air pollutants in industrial environment, which is based on American Conference of Govt. Industrial Hygienists. This data has been taken as a reference. No Indian data is available, since such study has not been carried earlier.

Emission of Volatile Organic Compounds/ Hazardous Air Pollutants of various polymers at processing temperature has been found as under:

- Low Density Polyethylene (LDPE) : In the processing range (170 - 200°C) of LDPE no emission of formic acid, acetic acid, acetaldehyde were observed. Presence of formaldehyde was found as < 1 ppm.
- Linear Low Density Polyethylene (LLDPE) : In the processing range (180 - 240°C) of LLDPE no emission of VOCs, formic acid, acetic acid, HCl & acetaldehyde were observed. Presence of formaldehyde was found as < 1 ppm.
- High Density Polyethylene (HDPE) : In the processing range (185 - 245°C) of HDPE, no emission of formic acid, acetic acid, HCl & acetaldehyde were observed. Presence of formaldehyde was found as < 1 ppm.
- Polypropylene (PP) : In the processing range (210 - 260°C) of PP, no emission of formic acid, acetic acid, HCl & acetaldehyde were observed. Presence of formaldehyde was found as < 1 ppm.
- Poly Vinyl Chloride (PVC) : In the processing range (150 - 205°C) of PVC, no emission of formic acid, acetic acid, HCl & acetaldehyde were observed. Cyclisation of PVC occurs only after 500°C as reported in literature. Since the processing temperature of PVC as mentioned is much below 500°C, the possibility of cyclic compounds, also referred to as dioxin, is ruled out.

Thermal analysis of polymers indicates that if the processing temperatures are maintained within the specified limits, the VOC, organic air pollutants etc. would not be generated. Therefore based on the present study the maximum processing temperature of different polymers viz. 270°C for PP, 250°C for LLDPE/HDPE, 260°C for PS, 280°C for PET & 250°C for PVC (rigid & flexible) are recommended. Detection of extremely low levels of volatile or hazardous organic pollutants are much less than the internationally recommended threshold values. In general practice of plastic processing as observed during the present study, there is no threat of the emissions of any hazardous gases.

Based on the available literature and the detailed experimental study it can be safely concluded that at normal processing temperatures, processing of PE, PP, PVC, PET & PS do not pose any adverse effect on the atmosphere. Processing of plastics under these conditions can be safely regarded as environmental friendly and therefore plastic processing industry can be safely classified as "Safe Environment Industry".

Based on the facts, there is enough rationale to say, "Plastic Industry does not pose any adverse effect on the environment".

ENVIS
MANAGEMENT OF PLASTICS, POLYMER WASTES AND BIO-POLYMERS AND IMPACT OF PLASTICS ON THE ECO-SYSTEM
Volume 2 • Issue 4 • May-July 2004
For Internal Circulation only
INDIAN CENTRE FOR PLASTICS IN THE ENVIRONMENT
World Bank-aided Programme on "Environmental Management Capacity Building Technical Assistance Project" and Sponsored by Ministry of Environment and Forests, Government of India.

Ragpickers with van

ICPE on Plastics Recycling & Waste Management – Experience in Mumbai Wards and Eco-Sensitive Hill Station, Matheran

T. K. Bandopadhyay, *Technical Manager, ICPE*

Waste Management

Segregation of recyclable waste at source

In all parts of the country, people by and large do salvage reusable or saleable material from waste and sell it for a price, e.g., newspaper, glass bottles, empty tins, plastic bags, old clothes etc., and to that extent such reusable/recyclable waste material is not thrown out for disposal. However, a lot of recyclable dry waste such as waste paper, plastic, broken glass, metal, packaging material, etc., is not segregated and is thrown on the streets along with domestic/trade/institutional waste. Such waste is picked up to some extent by poor rag pickers for their livelihood. At times they empty the dustbins and spread the contents around for effective sorting and collection. By throwing such recyclable material on the streets or into a common dustbin, the quality of recyclable material deteriorates as it gets soiled by wet waste, which often contains contaminated and hazardous wastes.

Households and establishments, who throw such waste on the streets or in the municipal bins unsegregated, thus do not seriously practise segregation of recyclable waste at source. At least 15% of the total waste can conveniently be segregated at source for recycling, which is being thrown on the streets in absence of the practice of segregation of waste at source. Part of this waste is picked up by rag-pickers in a soiled condition and sold to middle men at a low price, who in turn pass on the material to the recycling industry at a higher price after cleaning or segregation and the waste that remains uncollected finds its way to the dumping grounds.

"Land filling" Practices

By and large, crude dumping of waste is done in the country without following the principles of sanitary land filling. As negligible segregation of waste at source takes place, all waste including hospital infectious waste generally finds its way to the disposal site. Quite often industrial hazardous waste is also deposited at dump sites meant for domestic waste.

The waste deposited at the dump site is generally neither spread nor compacted on a regular basis. It is also not covered with inert material. Thus, very unhygienic conditions prevail on the dump sites.

Segregation of Recyclable Waste

It is essential to save the recyclable waste material from going to the waste processing and disposal sites and using up landfill space. Salvaging it at source for recycling could make profitable use of such mate-

Dry waste at housing colonies

rial. This will save national resource and also save the cost and efforts to dispose of such waste. This can be done by forming a habit of keeping recyclable waste material separate from food waste and other bio-degradable wastes, in a separate bag or bin at the source of waste generation, by having a two-bin system for storage of waste at homes, shops and establishments where the domestic food waste (cooked and uncooked) goes into the Municipal system and recyclable waste can be handed over to the waste collectors (rag-pickers) at the doorstep.

The following measures may be taken by the local bodies towards the segregation of recyclable waste:

The local bodies may mobilize NGOs or co-operatives to take up the work of organizing street rag-pickers and convert them to door-step "waste collectors" by motivating them to stop picking up soiled and contaminated solid waste from the streets, bins or disposal sites and instead improve their lot by collecting recyclable clean material from the doorstep on daily basis. The local bodies may, considering the important role of rag pickers in reducing the waste and the cost to the local body in transportation of such waste, even consider extending financial help to NGOs and co-operatives in providing some tools and equipment to the rag pickers for efficient performance of their work in the informal sector.

The local bodies may actively associate resident associations, trade & industry associations, CBOs and NGOs in creating awareness among the people to segregate recyclable material at source and hand it over to a designated identified waste collector. The local body may give priority to the source segregation of recyclable waste by shops and establishments and later concentrate on segregation at the household level.

Loading of dry waste in Municipality van

The upgraded rag pickers on becoming doorstep waste-collectors may be given an identity card by the NGOs organizing them, so that they may have acceptability in society. The local body may notify such an arrangement made by the NGOs and advise the people to cooperate.

This arrangement could be made on "no payment on either side basis" or people may negotiate payment to such waste collectors for the doorstep service provided to sustain their efforts.

(Based on the recommendations made by the Committee constituted by the Hon'ble. Supreme Court of India, in 1999.)

Dry waste being carried for loading into Municipality van

Municipality van with dry waste on way to segregation area

ICPE Initiative:

ICPE engaged itself to implement the recommendations of the committee, and associated itself with some NGOs and the local bodies in helping the collection, segregation and diverting the segregated dry waste to recycling process and thus stopping their way to the landfills. Experimental Waste Management System was initiated at some wards of Mumbai following the above guideline.

Waste Management System at Brihan Mumbai Municipal Corporation:

In Mumbai, constant effort is being made to separate the dry and wet waste at the source itself, so that the dry wastes could be further segregated into different types of wastes and could be sent for recycling, resulting in lesser load to the landfill, sites.

There is an increasing activity among various Local Self Government Councils to treat the wet waste also through vermiculture or similar process, to generate compost, which can be used as fertilizer.

Segregation of dry waste

11. AVAILABLE TECHNOLOGY AND CASE STUDIES IN EACH OF THE PREFERRED ALTERNATIVES

The preferred alternatives from the available technologies are -

A. Recycling (consisting of making Plastic Granules to be moulded into goods thereafter)

B. In the Construction of Tar roads.

C. Conversion into Petroleum (Refuse Derived fuel, or RDF)

D. Disposal in Cement Manufacturing Kilns.

A. RECYCLING

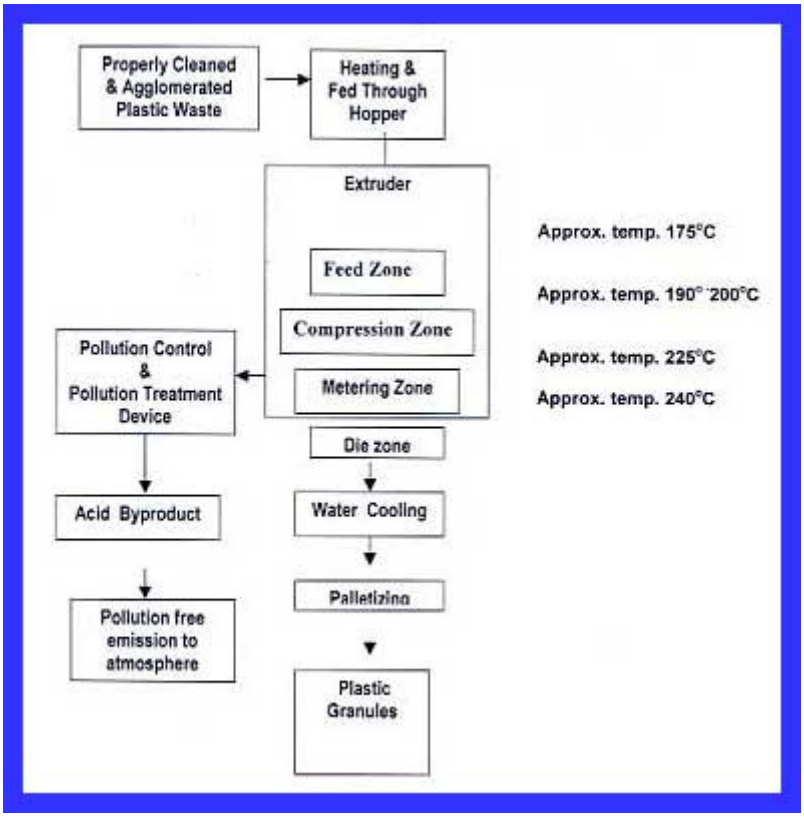
A. Technology - Plastics Recycling:

[31]Recycling of plastics through environmentally sound manner (Newly Developed Machine):

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:

[31] From CPCB website

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



B. Implementation:

Case Study 1:

Implementation by MCGM and MMRDA

MCGM has done considerable work in SWM and it continues to implement to the best of its abilities the laws made and various schemes floated by it from time to time in partnership with ALMs, some social organizations, NGOs, and private bodies such as "ENVIS", described in earlier part of this report

Some of the initiatives of the MCGM and MMRDA are best depicted by these advertisements:

ALM Newsletter / वार्ता - प्रगत परिसर व्यवस्थापन June 2001

प्रगत परिसर योजना

मुंबईच्या सुजाण नागरिकांसाठी महापालिकेची बहुउद्देशीय योजना

पार्श्वभूमी :

प्रगत परिसर व्यवस्थापन योजनेच्या प्रायोगिक तत्वावर सुरु केलेल्या योजनांच्या यशामुळे दिनांक २३-११-१९९७ ला योजनेस प्रशासनाने तत्वत: मान्यता दिल्यानंतर खऱ्या अर्थाने दिनांक १-७-१९९८ रोजी विशेष कार्य अधिकारी व सल्लागार यांच्या नेमणूकीने ही योजना गतिमान झाली व जुलै, १९९८ साली जेमतेम १० च्या आसपास असणारी प्रगत परिसर व्यवस्थापनाची संख्या आज ५७५ वर जाऊन पोहोचली असून २६० ठिकाणी व्हर्मिकल्चर सुरु असून, बऱ्याच ठिकाणी खत काढून वापरायला सुरुवात झाली आहे. महापौर निवासातून १,३०० गोणी खत काढण्यात आले व तेथील बागेसाठी त्याचा वापर करण्यात आला. अनमोल सोसायटीत एक लहान ट्रक खत काढण्यात आले व त्याचा वापर त्यांच्या बगीच्यासाठी करण्यात आला. सेंट्रल गव्हर्नमेंट सोसायटी, वडाळा, पाच गार्डन, वडाळा, डायमंड गार्डन, चेंबूर व विभागातील रोपवाटीका येथील खताचा उपयोग त्याच ठिकाणी करण्यात आला. स्वामी मुक्तानंद शाळा, अंधेरी येथील खताची विक्री करुन ती रक्कम मुलांच्या फंडात जमा केली. तेथील लोक स्वच्छ व सुंदर मुंबईचा अनुभव घेत आहेत.

एक आढावा

जनजागृती :

१. नागरिकांना योजनेबाबत माहिती देण्यासाठी दर रविवारी सुटीच्या दिवशी निरनिराळ्या सोसायट्यांमधून सभांचे आयोजन करण्यात आले व सरासरी ३ सभा (रविवार, सार्वजनिक सुट्टी व दुसऱ्या आणि चौथ्या शनिवारी) घेण्यात येऊन जनजागृती करण्यात आली. आतापर्यंत ६२५ च्या वर अशा सभा घेण्यात आल्या आहेत.

२. लहान मुलांमध्ये याची माहिती व्हावी व ही स्वच्छतेची सवय अंगी बाणावी म्हणून शाळांमध्ये सभा घेण्यात आल्या. काही शाळांमध्ये खत प्रकल्प रावविण्यात आले. ह्या योजनांना शाळांकडून उत्तम प्रतिसाद मिळाला आहे व मिळत आहे. (चिता कॅम्प शाळा, चेंबूर, मुक्तानंद शाळा, अंधेरी, आर्य विद्यामंदीर, अंधेरी (पश्चिम).

३. रोटरी क्लब, लायन्स क्लब, नौसेना, मुंबई पोर्ट ट्रस्ट, मध्यवर्ती सरकारी संस्था, महिला मंडळ यांच्याकडूनपण अशा प्रकारच्या सभा आयोजित करण्यात आल्या. (नौसेना विहार, नौसेना भांडार, घाटकोपर व नौसेना निवास संकुल, भांडुप हे याचे उत्तम उदाहरण आहे).

४. मा. अतिरिक्त आयुक्तांनी पण उच्चस्तरीय होणाऱ्या सभांमध्ये योजनेचे महत्व अनेकवेळा पटवून दिले असून त्याचा फायदा होत असल्याचे दिसून येत आहे.

ब) महापालिका प्रशासन

१. प्रगत परिसर व्यवस्थापन प्रभागात "प्रशासन तुमच्या दारी" या तत्वावर महापालिका प्रशासनाचा प्रतिनिधी, विभाग अधिकारी निश्चित करतील तो, तेथील प्रगत परिसर समितीच्या प्रतिनिधीशी संपर्क ठेवील.

महापालिकेने अंगिकारलेल्या नवीन पध्दतीनुसार एका नगरसेवकाच्या प्रभागात एक कनिष्ठ अभियंता व एक कनिष्ठ अवेक्षक त्या भागातील प्रगत परिसर व्यवस्थापनाच्या नागरी समस्येसाठी जबाबदार असतील. काही विशिष्ट बाबी उदा. अतिक्रमण, पाणी परवाने बाबतच्या समस्या ते संबंधित खात्याकडे पाठवून त्यांचा पाठपुरावा करतील.

२. संबंधित संपर्क अधिकारी किमान १० दिवसांत एकदातरी भेट देतील व त्या ठिकाणी ठेवलेल्या नोंदवहीत योग्य त्याप्रकारे नोंद करतील व नोंदवही अद्ययावत ठेवतील.

३. संपर्क अधिकारी व सहकारी समिती जबाबदार असलेल्या समस्यांबाबत तशी नोंदवहीत नोंद करतील व समितीकडून योग्या तो प्रतिसाद/कार्यवाही न झाल्यास महापालिका नियमान्वये त्याबाबत कार्यवाही करण्यात येईल.

४. महापालिका प्रशासनास योग्य ते सहकार्य देणाऱ्या समितीच्या प्रभागात नागरी समस्यांबाबत प्राथमिकता देवून कार्यवाही करण्यात येईल. त्या समस्यांचे थोडक्यात खालीलप्रमाणे वर्गीकरण केले आहे :— १) कचरा व विभागातील स्वच्छता, २) पाणी खाते, ३) भूमिगत गटारे व पर्जन्य जलवाहिन्या, ४) सौंदर्यीकरण, ५) खत प्रकल्प, ६) फेरीवाले, भिकारी व अतिक्रमण, ७) रस्त्याची निगा, ८) भटकी जनावरे, ९) कीटक नाशक, १०) वाहतूक.

५. विभाग अधिकारी महिन्यातून एकदा, सहाय्यक अभियंता (परिरक्षण) व सहाय्यक मुख्य पर्यवेक्षक १५ दिवसांतून एकदा प्रभागास भेट देवून कामाची पाहणी करतील व तशी नोंद नोंदवहीत करतील.

६. प्रगत परिसर व्यवस्थापन प्रभागात नागरी सेवांची कामे करताना समितीला त्याप्रमाणे सूचना दिल्यास तेथील नागरीकांचे सहकार्य मिळेल व नागरिकांची होणारी गैरसोय कमी प्रमाणात होईल.

७. महानगर गॅस, बी.एस.ई.एस. बेस्ट, टेलिफोन निगम, पाणी खाते यांनी खोदलेल्या चऱ्या त्वरित भरण्याबाबतची कार्यवाही (किमान तात्पुरत्या स्वरुपात) प्रशासनामार्फत करावयाची आहे. याबाबत "गोडल अधिकारी" यांनी पुढाकार घ्यावयाचा आहे.

८. प्रशासनाने लग्न मंडप व इतर सार्वजनिक कार्यक्रमाच्या ठिकाणाहून ओला कचरा परस्पर उचलण्याची कार्यवाही करावी. वाटल्यास याबाबत अतिरिक्त शुल्क संबंधितांकडून वसूल करावे.

९. प्रगत परिसर व्यवस्थापन परिसराचे दोन्ही बाजूस फलक लावण्यास प्रशासन हरकत घेणार नाही. या फलकामुळे प्रगत परिसर व्यवस्थापनाचा संदेश अधिकाधिक नागरिकांपर्यंत पोहोचण्यास मदत होणार आहे. स्थानिक समिती आवश्यक ते सहकार्य देत नसेल तर प्रशासनाने योग्य ती कार्यवाही करावी.

१०. प्रशासनाने वाहतूक बेटे, रस्त्यावरील मोकळी जागा व आवश्यकतेनुसार व मागणीनुसार इतर जागी नियमानुसार सौंदर्यीकरण करण्यास प्रोत्साहन द्यावयाचे आहे.

११. प्रशासनाने विभाग स्तरावर प्रगत परिसर योजनेच्या माहितीसाठी साहित्य ठेवावे व जनजागृतीसाठी व कर्मचाऱ्यांना प्रशिक्षणाची सोय उपलब्ध करावयाची आहे.

१२. या योजनेच्या जनजागृतीसाठी आवश्यकतेनुसार अशासकीय संस्थांचे सहकार्य प्रशासनाने घेवून व्यापक स्तरावर प्रसिध्दी द्यावयाची आहे.

१३. प्रगत परिसर व्यवस्थापनाच्या वाढत्या व्यापानुसार योजना गतीमान करण्यासाठी प्रशासनाने खालील उपाययोजना नव्याने अंमलात आणली आहे.

अ) प्रगत परिसर व्यवस्थापनाच्या कार्यामध्ये गती आणण्यासाठी विभाग पातळीवर समन्वय समितीची सभा महिन्याच्या दुसऱ्या शनिवारी सकाळी १०-०० वाजता विभाग कार्यालयात घेण्यात येते.

ब) प्रगत परिसर व्यवस्थापनाच्या कामामध्ये समन्वय साधण्यासाठी व नियंत्रण करण्यासाठी मुख्यालय पातळीवर सुकाणु समितीची स्थापना करण्यात आली आहे. समितीची सभा प्रत्येक महिन्याच्या चौथ्या शनिवारी मुख्यालयात घेण्यात येते.

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सही/-
अजितकुमार जैन
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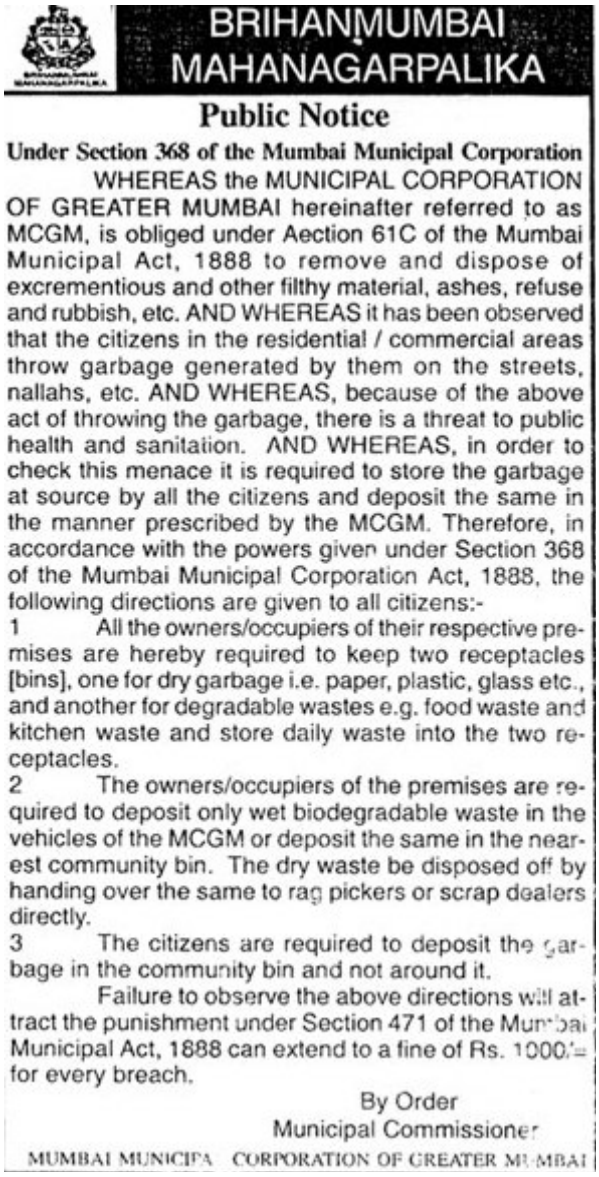
Published by D. B. Shivjatak P.R.O. for Municipal Corporation of Greater Mumbai. Editor : Sharad Kumar



BRIHANMUMBAI MAHANAGARPALIKA

Public Notice

Under Section 368 of the Mumbai Municipal Corporation

WHEREAS the MUNICIPAL CORPORATION OF GREATER MUMBAI hereinafter referred to as MCGM, is obliged under Aection 61C of the Mumbai Municipal Act, 1888 to remove and dispose of excrementious and other filthy material, ashes, refuse and rubbish, etc. AND WHEREAS it has been observed that the citizens in the residential / commercial areas throw garbage generated by them on the streets, nallahs, etc. AND WHEREAS, because of the above act of throwing the garbage, there is a threat to public health and sanitation. AND WHEREAS, in order to check this menace it is required to store the garbage at source by all the citizens and deposit the same in the manner prescribed by the MCGM. Therefore, in accordance with the powers given under Section 368 of the Mumbai Municipal Corporation Act, 1888, the following directions are given to all citizens:-

1 All the owners/occupiers of their respective premises are hereby required to keep two receptacles [bins], one for dry garbage i.e. paper, plastic, glass etc., and another for degradable wastes e.g. food waste and kitchen waste and store daily waste into the two receptacles.

2 The owners/occupiers of the premises are required to deposit only wet biodegradable waste in the vehicles of the MCGM or deposit the same in the nearest community bin. The dry waste be disposed off by handing over the same to rag pickers or scrap dealers directly.

3 The citizens are required to deposit the garbage in the community bin and not around it.

Failure to observe the above directions will attract the punishment under Section 471 of the Mumbai Municipal Act, 1888 can extend to a fine of Rs. 1000/- for every breach.

By Order
Municipal Commissioner

MUMBAI MUNICIPA CORPORATION OF GREATER MUMBAI

SEGREGATION & YOU
CITY'S WASTE DUMPS
ARE OVERFLOWING
Every day
Mumbai produces
6000 tonnes of garbage.
In 2 years time,
there will be no place
to dump all this .
One tonne = 1000 kilos.
Every household
produces approximately
2 kilos of waste every
day. If you recycle,
you cut it down by 50%.
If you practise
vermiculture,
you produce no waste
ACT NOW FOR BETTER FUTURE

Comment by Eco Friend and Company:
Dry Waste collection by the MCGM in the years 2003 to 2008 under the ICPE-NGO-BMC Project is given in the data sheet reproduced below:

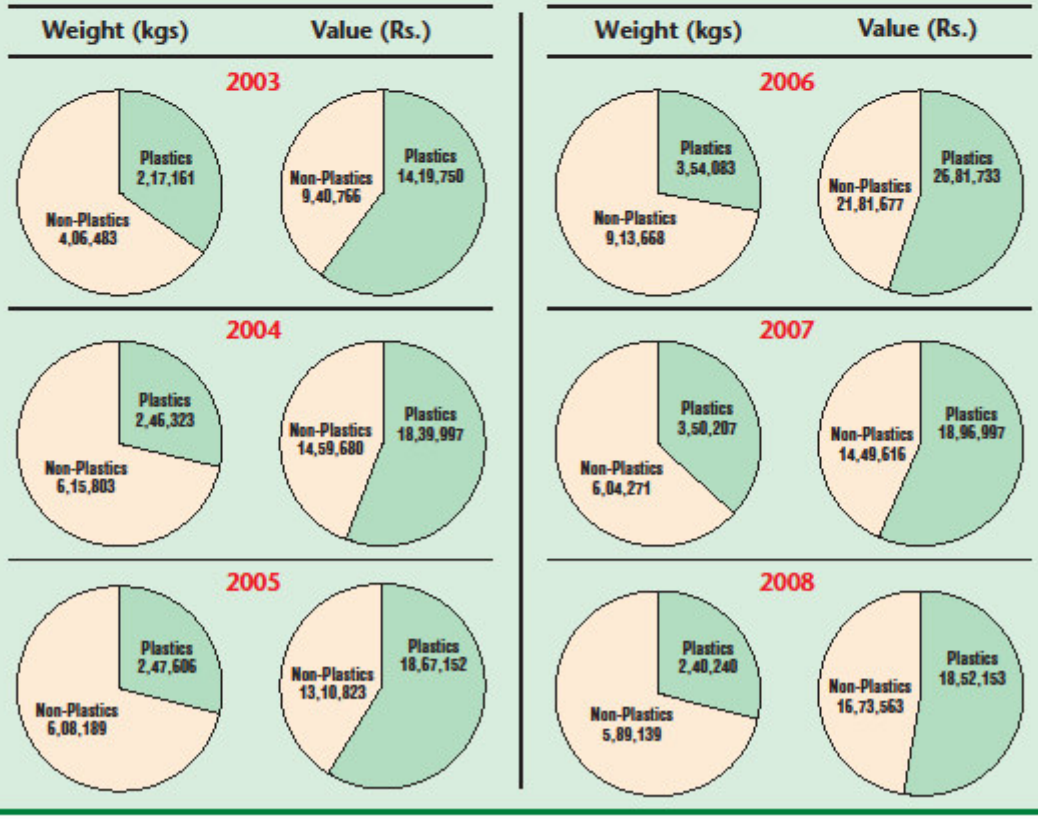
DATA SHEET

Solid Waste Management (Segregation) Projects in Mumbai Wards




Dry Waste collection figures of select Mumbai Wards under ICPE – NGO – BMC Project for the calendar year 2008 are given below. There are about 80 waste pickers engaged in the project. Close to 1000 MTs of dry waste, which included about 250 MTs of plastics waste was collected right from the source of waste generation in selected areas of 6 Wards of Mumbai Corporation by about 80 waste pickers, earning about Rs. 46.22 lacs among themselves. Average earning per waste picker was about Rs. 4,800/- per month.

	Weight (kgs)			Value (Rs.)		
	Plastics	Non-Plastics	Total	Plastics	Non-Plastics	Total
2007 Jan.-Dec.	3,50,207	6,04,271	9,54,478	18,96,997	14,49,616	33,46,613
2008 Jan.-Dec.	2,40,240	5,89,139	8,29,379	18,52,153	16,73,563	35,25,716
Total Mixed Dry Waste = 2,78,915 kgs and Value is Rs. 10,97,236/						



MMRDA to find best waste options

Pre-empting burgeoning issues with debris dumping once city's population increases, the implementing agency is working with NEERI for better management

Manthan K Mehta
WEH

By 2060, the population of the Mumbai Metropolitan Region will increase from 2.3 crores to 10.5 crores. With this increase, the quantity of solid waste will also swell from the present 11, 000 to 50, 613 tonnes per day. Identifying landfill sites to dispose this waste has been a major issue for all the civic bodies of Mumbai Metropolitan Region (MMR).

As a solution to this, MMRDA has decided to set up common dumping sites, where solid waste from the entire MMR can be dumped.

Says M R Shah, former Chief Engineer with BMC's Solid Waste Management Department, "We have identified five sites – Bhiwandi, Shilpatam, Ulhasnagar, Ambernath and Taloja for our project. We are planning to appoint NEERI (National Environmental Engineering Research Institute) as a consultant for the project for two years." Presently, Shah is the principal advisor to MMRDA's 'Solid Waste Management Cell'.

PRITI MISTRY

Now that Gorai dumping ground has been closed, other landfill sites need to be found

TWM BEAT RETREAT
INFRASTRUCTURE

Initially, NEERI will assist MMRDA to put in place administrative, regulatory as well as financial set up for the regional landfill sites. This project also takes into account the growth to be witnessed in the next 50 years in the MMR region. Adds Shah, "As of now it is difficult to locate land to create dumping grounds for bigger cities such as Mumbai and Thane, which do have the technical know-how to deal with the waste. On the other hand, areas that do have the land don't have expertise. Regional landfill site will be a win-win situation for both, as the waste taken at these spots will be dealt in a scientific manner."

Already, MMRDA has set aside Rs 30 crores in this year's budget for this project.

Informs Shah, "The land will have to be acquired from the government as well as non-governmental entities. We have appointed a special land acquisition officer for this purpose. Moreover, the process to acquire government land has already begun. Now, MMRDA intends to run the regional landfill site on a professional basis. We will strive to create a healthy business model, so that the sites can work as independently in an effective manner."

manthan.mehta@timesgroup.com

Case Study 2 :

Recycling by Private Organizations

Meanwhile, the work of Plastic Waste (a significant part of Dry waste) Collection, Segregation and recycling by hundreds of Private Organizations continued in Mumbai:

It is seen that almost in parallel with the work done officially by the MCGM with the help of ALMs, NGOs and rag pickers in Mumbai, thousands of rag picker women, children and men (staying near the dumping ground and in fact some staying inside them in unauthorized zopadpattis) are collecting Dry Recyclable wastes from the streets and dumping grounds 24 hours a day by turns, and selling them every day to Scrap dealers through local collectors known as "kantawalas" who have no establishments of their own, except a for few weighing balances and perhaps a tempo. These Kantawalas collect the waste from the rag pickers on daily basis, pay them on the spot, and transport the waste to big scrap dealers who have Godowns and facilities and workers for further segregation of the waste as needed. These scrap dealers in turn sell the waste to Recyclers, be it for glass, metal or plastic.

In Mumbai, there is no place for segregation of waste and washing and drying which is necessary for some sections of the plastic waste. Moreover, the question of treating such effluent remains. Such wastes are therefore regularly picked up from the MCMM dumping grounds by recyclers from Malegaon, Ankleshwar, etc., for washing and drying and for further processing.

In the case of Plastic wastes, segregation of the waste in various kinds of plastics is done at the scrap dealers', and sent to different recyclers specializing in different kinds of plastic recycling and having facilities and machinery accordingly. The recyclers convert the waste into granules. Some recyclers run different campaigns for the manufacture of plastic granules of different qualities depending upon the quality of plastic waste available from time to time. These granules are then sold to manufacturers of different items such as recycled plastic mugs, shoes, soles for sandals, carry bags, "tarpauline" sheets etc. They have the machines / moulds for making such items. Some manufacturers having more sophisticated machines convert the granules into chairs, tables, Poles for fencing, etc.

There is a huge market for such recycled goods not only in Mumbai, but throughout India. A section of Society, notably poor and lower middle class people find these items cheap and useful. This section can hardly afford the same goods made from virgin plastic.

Thus there is a complete chain of people from the rag picker to the kantawalas to the scrap dealer stocks the waste and employs worker for the segregation, to the recyclers who make granules and to the recycler who makes goods from the granules, to the shopkeepers and finally to the consumer, and each link in the chain is happy. Also, this activity happens with the help of the obliging small transporters who find gainful employment and earn a living almost on day to day basis.

People in the above business for a number of years know each other, develop a bond and are there to extend financial help in case of emergency such as in case of hospitalization, death and even in marriages. Rag pickers find this particularly useful in their otherwise insecure life.

The recyclers are supposed to take license from the Pollution Control Board, for which permissions from a host of Government bodies such as the Fire Brigade, Municipality, etc are necessary. Recyclers generally find it very difficult to get such permissions, and therefore establish their business at a convenient place unauthorisedly. Needing help from each other and protection, labour force, transporters, etc., they form a cluster. Several such clusters have come up in Bhandup, Kurla, Dharavi, etc. The Recyclers normally come from uneducated class of the Society and generally work their way up and are able to make a comfortable living.

In a way, existence of the recycling business in plastics helps also the higher ups in Society hierarchy, as they can continue to use goods made from Plastic with abandon, and throw the waste packaging material and unwanted plastic items into the waste, to be picked up by the rag pickers. Such people can also be included in the chain, as well as the manufacturers of various kinds of Plastics and of goods from Plastic.

Plastic Recycling Industry can therefore be said to be Consumer Driven Industry and plays a big part in today's Economy.

There is a strong and urgent need to give status it deserves to the recycling industry, as it provides employment to a vast number of people particularly in India, right from a rag picker to big Manufacturers of Plastic and the people it provides employment opportunities to. This point will be discussed later in this report.

B. IN THE CONSTRUCTION OF ROADS

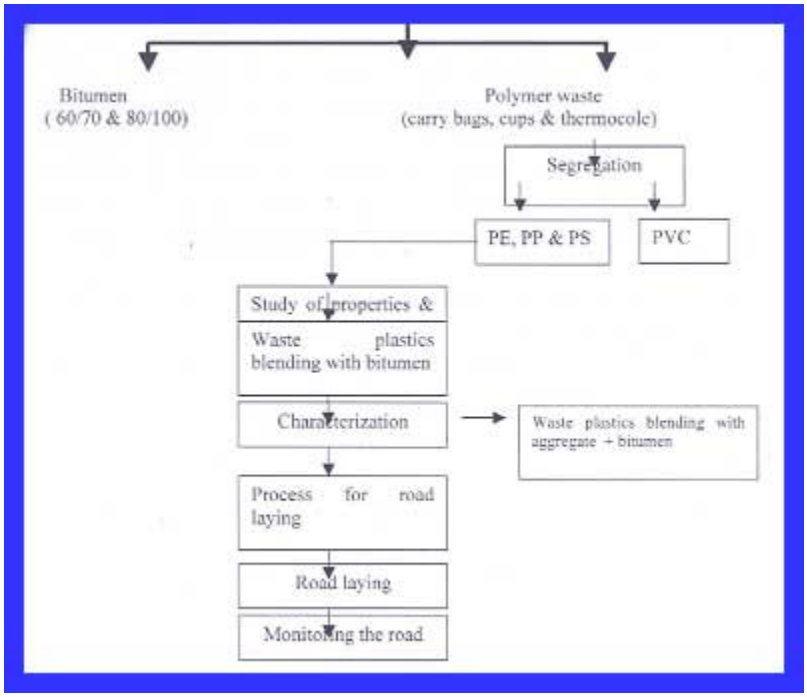
A. Technology -

[32]Process of Road laying using polymer- aggregate – Bitumen mix

In many countries, plastic waste is used in the construction of roads, PVC scrap is made into traffic barriers, lane dividers and other non-human contact applications. The plastic waste (bags, cups, Thermocole) made out of PE, PP, & PS are separated, cleaned if needed and shredded to small pieces (passing through 4.35mm sieve) The aggregate (granite) is heated to 170^{o}C in the Mini hot Mix Plant and the shredded plastic waste is added, it gets softened and coated over the aggregate. Immediately the hot Bitumen (160^{o}C) is added and mixed well. As the polymer and the bitumen are is the molten state (liquid state) they get mixed and the blend is formed at surface of the aggregate. The mixture

[32] [REF: http://en.wikipedia.org/wiki/Plastic_recycling]

is transferred to the road and the road is laid. This technique is extended to Central Mixing Plant too.



B. Implementation

Case Study 1:

[33]Civic body lays plastic-fortified road in Dadar

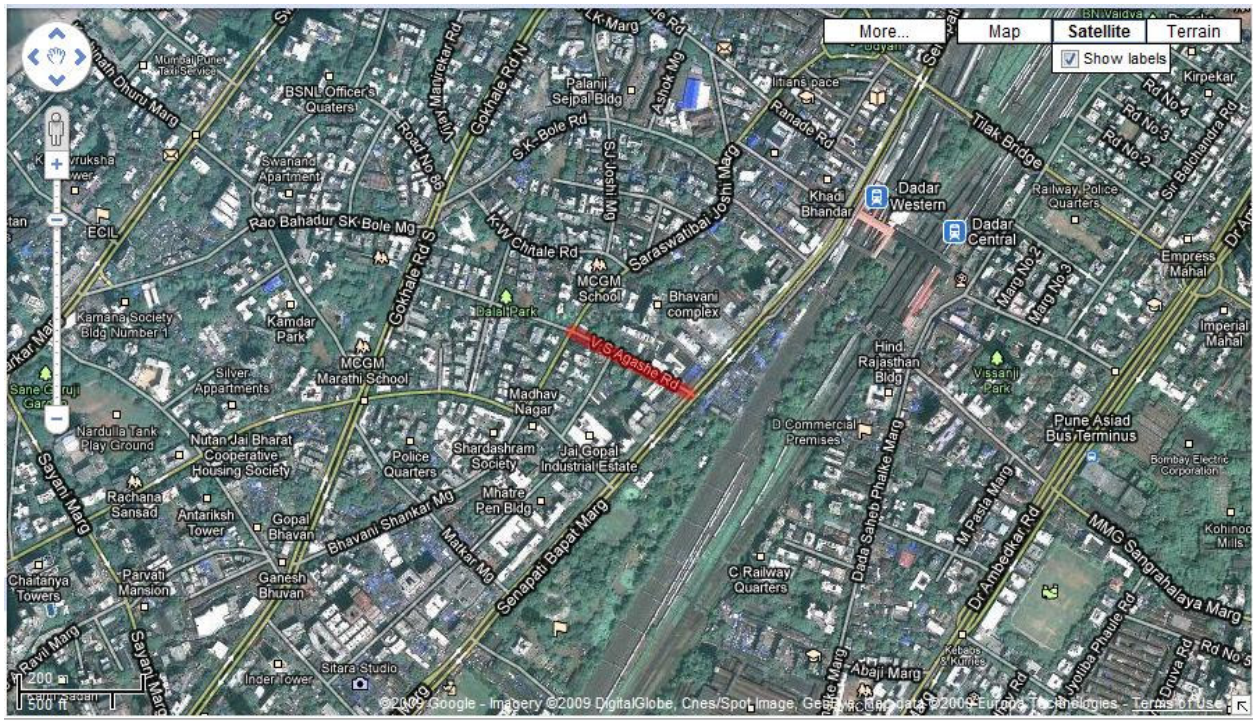
Dhanya Nair Posted: Aug 10, 2008 at 0150 hrs IST

Mumbai, August 9: Finding an ecological solution to reuse polythene and plastic waste, the Brihanmumbai Municipal Corporation laid a 100-metre stretch of road at Dadar using plastic and asphalt. This stretch on Prof V S Agashe Road near the Kohinoor Technical Institute in Dadar was laid by the civic body's Road department with the help of the Indian Centre for Plastics in the Environment (ICPE) . The BMC will test its sustainability for a year and then decide whether to lay an entire stretch of road using waste plastic.

"We have used waste plastic and asphalt for laying this stretch of the road. Virgin plastic is not a feasible option as it is not totally adaptable with asphalt," said T K Bandopadhyay, technical manager, ICPE. Adjoining the plastic road, the BMC has also laid another 100-metre road using normal asphalt to compare and evaluate the sustainability of both the roads.

[33] 'http://promo.expressindia.com

To lay the 100-metre plastic road, 16 per cent plastic waste was added to 15 per cent bitumen. Plastic waste costs around Rs 12 per kg. The BMC provided one tone of bitumen. “The cost of laying the road was Rs 56,000,” said C B Pendse, sub-engineer, Road department. The ICPE had approached the BMC to use the plastic for laying roads in January 2005. “The BMC wanted to see how this technology works. We have laid the 10-metre stretch in New Prabhadevi Road on a trial basis. This stretch could withstand the 24/7 deluge. The mayor was impressed and the proposal got a shot in the arm,” said Bandopadhyay.



“We wanted to see if the plastic and asphalt could blend well. After the success of the trial, we decided to go ahead with laying of a 100-metre stretch. The trial confirmed that any micron size plastic could be used after pulverizing it properly. We thought of using waste plastic for a good purpose,” said Pendse.
Authorities at Chennai and Bangalore had already used waste plastic in the construction of asphalt roads. Six years ago, such a project was successfully completed in Bangalore. In 2005, the Thiagarajar College of Engineering had constructed plastic roads in Madurai. “We consulted R Vasudevan who led the project for laying plastic road,” he added.

In 2005, the Central Pollution Control Board (CPCB), after studying the plastic reuse technology, permitted to use plastic in the construction of roads. Now, the ICPE along with the Gujarat State Plastics Manufacturers’ Association and Plastindia Foundation are working with the Gujarat government’s road and building department which has sanctioned laying of a 10 km stretch of asphalt road using waste plastic.

Case Study 2 :

[34]Waste Plastic in Construction of Tar Roads

A Report by KK Plastic Waste Management Pvt. Ltd, Bangalore

Managing Plastic Waste

In spite of the Environment Protection Act, the plastic waste seems to be a growing menace. As environmentalists, all over the world, caution against plastic waste, Bangalore seems to be feeding up on the same. Plastic bags are thrown about everywhere in the city and can be found in excess at dumps and disposal vats. This scenario throws up more questions especially when seen in the light of the Environment Protection Act. Apart from that, the ruling that the Karnataka State Pollution Control Board (KSPCB) passed in 2002 banned wedding venues from using plastic. But the rules have not gone beyond paper and Bangalore is still suffering.

Thin plastic is definitely a worry in the city. "Thin and thick plastic have no major distinction, thick plastic is 20 microns or more than the thin variety", states Ahmed Khan of KK Plastic Waste Management. Consumers still prefer thick plastic over the thin ones as they are sturdy in nature. "Plastic usually takes many years to degrade which means thick plastic poses lesser threat to the environment", adds Khan who emphasizes that because the degradation is spread over years it is lesser evil to the environment. Thin plastic on the other hand degrades rapidly to produce harmful carcinogens like dioxins and furons.

In its plastic waste management efforts, KK Plastic Waste Management along with the BBMP is currently working on recycling plastic and using them on road projects. Their efforts have covered 1,000 km of Bangalore's roads in waste plastic. The waste management procures 4 to 5 tones of waste plastic everyday from the city that generates 35 tones of plastic everyday. "It is alarming but our waste management program makes sure all the plastic goes into making roads. BBMP purchases plastic waste from KK management and uses the plastic along with other materials to tar roads in the city. Anybody from a rag- picker to a housewife can contribute in not only making the city beautiful but also plastic free" states Khan.

The environmental future of Bangalore city is in your own hands. "It is not that plastic should not be used. It is just that people should make an attempt to use plastic intelligently", declares Khan. So, the next time you want to make a difference to the environment around you, contact:

Bangalore to have Plastic Roads!

Plastic garbage in India's hi-tech city will literally end up on its streets when the Bangalore Mahanagara Palike (BMP) begins laying over 500km of road, using bitumen mixed with recycled plastic. The BMP's contractors would employ a proven environment friendly technology developed by a private firm, which uses recycled plastic in the bitumen mixture for roads. "We will begin the process of laying roads blended with recycled plastic in May once the BCC

[34] http://www. kkplasticroads.com

Standing Committee gives the go ahead. The committee is awaiting the lapse of the model code of conduct," BMP Engineer in-chief Rame Gowda told PTI.

The Bangalore-based K K Plastic Waste Management Ltd (KKPWM) developed the technology that turns plastic waste into a polyblend to be used in laying roads. "We need around two tones of plastic for every kilometre of road. With the plastic, the cost of the road will increase marginally but is compensated by its durability and eco friendly properties," KKPWM Managing Director Ahmed Khan said. About 8% of recycled plastic is added to the bitumen mixture to lay roads, which are durable and strong even two years after they are laid. The Delhi-based Central Road Research Institute has validated the technology, Khan said. A field test report by the Bangalore University revealed that the polymer blend increases the fatigue life and strength of road by three times. Rame Gowda said the BMP lays about 1,000km of roads annually and it could extend the use of plastic blend bitumen eventually to all its roads. The city generates over 300 to 400 tones of plastic waste every month, Khan said adding that once the process starts, the city could be a model for other places in the country. He declined to explain the process behind the patented technology, which he and his brother, Rasool Khan, took over five years to develop with the assistance of a chemical engineer friend.

Plastic-blended roads now the norm

If there is a silver lining to Bangalore's infrastructural woes, it may be this. Plastic-blended roads have become the standard, and are here to stay. Whenever we see roads being laid anywhere, we see concrete or tar with bulldozers and big mixers. As some of you will be aware, Bangalore now has plastic-blended roads, which have been proven to be stronger, smoother and less bumpier. In fact, all the new road constructions happening in the city (including the contested road-widening project), will be using plastic, according to the BBMP. But what are these plastic roads all about? I had the same question in my mind when I heard of it. How can a waste material we see in our dustbins everyday be used to make roads? If concrete roads generate potholes how can a road with plastic survive?

Enter Ahmad Khan

While we were all throwing our plastic waste in the bins without pondering on where it was going, a plastic bag manufacturer was finding ways to dispose this waste in the most harmless manner. Ahmed Khan, 56, who received the Real Hero Award in April 2008, organized by CNN-IBN and the Dhirubhai Ambani Corp, runs a plastic manufacturing company KK Polyflex that made plastic bags. He felt a social obligation for manufacturing a non bio-degradable product.

"When my younger brother Rasool Khan and I were thinking for a solution to reduce the harm caused by our manufactured products, we realized that bitumen and plastic both belong to the petroleum family and both are non bio-degradable. I started thinking of ways to use them together and judicially," says Khan as he goes down the memory lane. Bitumen is used for road construction. But when bitumen alone is used, the road tends to wear out in some time, and the road starts mixing with the soil. At the same time, plastic, once melted becomes extremely hard in just ten minutes. Khan further remembers: "We thought why not mix both plastic and bitumen. We then tried mixing both. Later

we experimented by putting the mixture in some small potholes in Jayanagar, unofficially for two years from 1998 to 2000. To our surprise the results of these experiments were positive."

After the successful smaller experiments, there was need to know if this process was safe enough to be used in the city. Thus Khan approached RV College of Engineering, Bangalore and the Central Road Research Institute, New Delhi (CRRI) wherein some of the professors helped him conduct the research. Khan recalls his anxiety to know the results, "It took two years for them to complete the research. To justify the reports the same technology was tried on a small structure of 500 metres. The report was released in the year 2002 thereby approving the technology. This was an official report by the University of Bangalore."

The next major task was to get this technology approved to be used on Bangalore roads. The same year the report was released, Khan approached the then Chief Minister S M Krishna. After evaluation of the report, Krishna called for a meeting with his officers and Khan and his brother were asked to give a presentation of their proposal. "The Chief Minister was impressed by our presentation and gave directions to the municipal corporation for our pilot project, which was to lay roads of 40kms. Later those roads were closely monitored and till today they have not worn out," says Khan proudly.

The new technology saw an official inauguration of the Rajarajeshwari Arch road by S M Krishna, later in the year 2002, it was after that grand inauguration that K K Plastic Waste Management Private Ltd got their name and therein began their journey to fame. But it did not stop there, a lot more research was needed to prove the safety and environment friendliness of this technology. Khan later went ahead to the Council of Scientific and Industrial Research (CSIR), New Delhi for further research, which he sponsored. The report of this was out in November 2002. And he then got his first order from the BBMP (then called BMP) for 230 kms of roads in Bangalore.

Plenty of plastic available, collection efficiency needed

The next big hurdle was to get plastic for the construction. Though it was in abundance to get it was not easy. Thus the next big target for Khan were people who would supply him with plastic. Thus he contacted the push cart garbage collectors and some rag pickers for help and gave them an offer more than what they were getting. He offered them Rs.7 to Rs.8 per kg to the rag pickers which was more than what the rag pickers usually got. So the word spread amongst the rag pickers and more and more came in number. "Each rag picker can bring 20 to 25 kgs of plastic each per day," he claims.

According to his personal research on the plastic waste of the city he says that Bangalore produces 10,000 tons of plastic waste in a year. The city has 45,000 Km of roads which will consume 9,000 tones of plastic. Thus most of the plastic can be used. But right now the BBMP is using only 2,000 tones of plastic which is way less than the optimum capacity.

Initially the BBMP had set up some collection points but unfortunately these points are not working now. "There were collection points in all the divisions of

the corporation but now only five of them are working and that too not so well. There needs to be an organized approach for any project. This is a very viable project provided it should work to its optimum capacity. But the BBMP is not enthusiastic enough to do so," says Khan disappointedly. A K Gopalswamy, Engineer-in-Chief, BBMP says that this technology is used a lot by the Municipality. "We are using it as much as we can. We are going to use it on all the coming constructions including the road widening project that we have undertaken. We have made it compulsory for at least all the major players to use the blended plastic in all the roads. I think this the most we can do."

A plastic blended road does not need any repair for five to six years at least according to the BBMP. Khan believes that these roads would stay intact for 10 years minimum. Till today, none of the plastic blended roads in the city have seen any problems. Gopalswamy agrees that the roads are very cost worthy and are the best option presently to answer the road problems as well as plastic disposal issue.

Notable Plastic Roads in Bangalore:

- **K H Road**
- **BTS 7th Main Road (outside Shantinagar Bus stand)**
- **J C Nagar Main (TV Tower) Road**
  Bellary Road (Mekhri Circle)
- **Shankar Math Road (Shankarapuram)**
- **Kanakapura Road**

But Khan is looking ahead to spread his business. Presently the BBMP buys the final product at Rs.27 per kg which is later provided to the contractors to be used in roads. "Right now we are not getting any profits, it is still in the 'no profit no loss' stage," he says. "We are planning to expand our business and are looking forward for venture capitalists who would invest in our technology. Reliance Industries Ltd has already approached us for the same." He is also getting offers from Gujarat, Goa, Maharashtra and Chattisgarh governments.

The making of a Plastic Road

How does the plastic make it into the road? The process starts when rag pickers take their collection to the office of K K Plastic waste management on Kanakpura Road. There it is cleaned, segregated by different grades of plastic, then made into a fine powder and taken to the site of construction. On the site the powdered plastic is then mixed with bitumen in a hot mixer and the mixture is laid on the road.

This technology can be done by two processes, one is dry and the other is a wet process. "We are currently using the dry process of making a fine powder of the cleaned plastic and mixing with bitumen (plastic and bitumen are mixed in equal proportions) and then on the site of construction this is mixed with the aggregates and put on the road. In the wet process bitumen and plastic mixture is

mixed with tar only. But that requires a lot of investment. And we are planning to do that as our next step," explains Khan. The setting of the bigger plant for the wet processing will cost around Rs.5 to 6 crores, according to Khan.

While Khan finds his way out for a profitable business, Bangalore seems to have found a ray of hope for its persistent problem of bad roads. After the road widening project is over most probably we will have for us better roads and not just wider ones. Great narrative of Mr. Khan's experiments and research leading to the discovery of a better road-topping material, reusing non-degradable waste to boot! I wonder if similar techniques are in use elsewhere in road-building.
Also, are there no tradeoffs in using plastic? I guess it was just the economics of the process that prevented such materials from being used. A problem solved by our excessive use of non-degradable plastic, resulting in cheap availability of the raw material.

Food For thought

- Use plastic and save forest
- Use plastic and save environment
- Use plastic and generate employment
- Use plastic and increase the life of the road
- Use plastic and strengthen national economy
- Use plastic and make roads of international standard

‘Bane converted to Boon’

- Effective disposal of plastic waste has always been a challenge.
- The primary reason for ineffective disposal of plastic waste has been due to the absence of large scale usage of used plastic.
- Research by KKPWM and the subsequent development of KKPB has opened an avenue for collection and usage of this plastic waste for large scale production of a compound which can be used in the construction of roads.
- This therefore makes waste plastic a ‘valuable’ raw material and converts the plastic waste from a ‘bane’ to a ‘boon’.

Environment benefits

- Today, plastic waste treatment is largely hazardous to the environment as most of the plastic is burnt resulting is toxic gases being released in the environment.
- By effectively managing the collection, separation and processing of plastic waste, the environmental damages can be limited by eliminating the waste from our streets.
- We can have international standard roads and pavements which are litter free

MSWM (Municipal Solid Waste Management)

- Households and other units wrap all garbage into plastic bags and dispose them. The non-biodegradable plastic bags acts like a covering on the garbage preventing it from being converted into compost.

- 4-5 gms of plastic locks within itself up to 5 kilos of garbage. This can be avoided if the plastic is segregated at the local garbage dump itself.
- All other components in the MSW like iron, wood, building materials, glass etc are picked up as they fetch money for the rag pickers. With the KKPWM initiative this will change and plastic will also be picked up from the initial source itself, resulting in plastic free MSW.
- At present only 20% of the MSW is converted into compost. This can be considerably increased to 80-85% and more by systematically managing the plastic waste.

Farming Community

- One of the foremost areas that would directly benefit is agriculture.
- At present only 20% of MSW is converted into compost. This can be converted to 80-85% once the plastic from the MSW is segregated.
- Farmers can directly purchase from MSWM if plastic separated.
- Over dependence on chemicals and fertilizers affects the fertility of the land.

National Economy

- Cumulative benefits to the National Economy –Environmental –Employment generation –Agricultural efficiency
- When life of a road is doubled, then the savings that accrue to the national exchequer are in thousands of crores.
- Lab tests and real time tests have revealed that the life expectancy of a plastic polymer road as compared to a normal road is at least 100% more.
- Segregating the plastic from the MSW at the municipal yard involves application of resources, the cost of which runs into crores of rupees. A substantial amount of this can be saved.
- The Central Government's annual allocation of funds towards roads and highways is approx. 35 thousand crores.
- With nationwide implementation of this project i.e. with the longevity of the roads doubled, the savings to the national exchequer would be a whopping 15-20 thousand crores!!
- Lab tests and real time tests have revealed that the life expectancy of a plastic polymer road as compared to a normal road is at least 100% more
- In addition to the savings accrued at the central level, every state Municipal Solid Waste Management would save crores of rupees by eliminating the plastic segregation process at its yards.

C. CONVERSION INTO PETROLEUM (REFUSE DERIVED FUEL, OR RDF)

A. Technology

[35]Principles involved

All plastics are polymers manufactured from the petroleum lighter ends like propylene, mostly containing carbon and hydrogen and few other elements like chlorine, nitrogen etc. polymers are made up of small molecules called as monomers which combine and form single large molecule called polymer.
When this long chain of monomers breaks at certain points or when lower molecular weight fractions are formed this is termed as degradation of polymer. This is the reverse of polymerization. In the process of conversion of waste plastic into fuels random De-Polymerization is carried out in a specially designed Reactor in the absence of oxygen and in the presence of a proprietary catalyst. The maximum reaction temperature is 350 deg C. The plastics are converted completely into value added fuel products.

Catalytic Cracking

A team of students at Velammal Engineering College has discovered a method of producing quality petrol from one of the most problematic pollutants of modern times - non-biodegradable plastic. A final year project led mechanical engineering students Sridhar, Jaikar Sathish, V. Lakshmanan and Guru Prasad through several experiments with a `secret catalyst' that prevented plastic from melting into a mass when heated, and instead generated petroleum products - petrol, diesel and kerosene. Waste polythene and polypropylene - consisting mainly of discarded bags and biomedical waste - are subjected to `catalytic cracking' or breaking down the carbon chain. The correct ratio of the catalyst and the plastic materials are taken in the reaction flask to get greater yield. When heated at 400 degrees Celsius, the plastic yields a distillate crude. Fractional re-distillation yields a type of petrol at between 100 to 120 degrees C and kerosene at between 150 to 180 degree C. Finally, the process leaves diesel as residue. In about two hours, the students were able to generate around 2 liters of crude from 2.5 kg of plastic waste and through distillation one liter of petrol and half a liter each of kerosene and diesel. The cost works out to roughly Rs. 22 for petrol and Rs. 26 each for diesel and kerosene. Sridhar says by heating plastic in the absence of oxygen, toxic dioxin emissions are also avoided, making the fuel eco-friendly. Even the left over paraffin mass (approximately 500 gm) can be made into candles. The fuel, developed by the team, has been certified by the Indian Oil Corporation's Regional Laboratory at Korukkupet. Compared to regular petrol, this plastic-derived fuel has a marginally higher octane level; pollution emission was within stipulated limits. Sridhar says the fuel's mileage could be higher than the 40 km per liter he got on his 20-year-old scooter. The students have already obtained a patent for the process and have applied for a full patent. The Indian Institute of Technology (IIT) has agreed to quality test the products. The students were guided in their project by the College Principal C. Rathnasabapathy, and professors, D. Sivaraj and K. R. Senthil Kumar.

[35] From STEPS

B. Implementation

Case Study 1:

Plastic to Diesel

[36]Comments by Ozmotech – Australia & Europe

Approximately 20% of the waste in modern landfills is non-degradable plastic. **Ozmotech** have created a solution to convert this waste into diesel fuel. Their patented process uses liquefaction, pyrolysis and catalytic breakdown to render 1kg of waste plastic into 950ml of oil or Green Fuel. This contains the same energy content as conventional diesels, but with "significantly reduced emissions levels". Existing diesel engines are said to run fully effectively on these fuels with no engine modification. It works best with PP, PE and PS plastics but can also manage ABS, PA, PUR and EVA but is not so keen on PVC or PET.

We've had a few Willy Wonka type machines out to save-the-world recently (Two Machines and Startech.) Not wanting to lose the momentum, here is yet another. Apparently 20% of the waste in our modern landills is non-degradable plastic. The Ozmotech solution is to convert this into diesel fuel. Their patented process uses liquefaction, pyrolysis and catalytic breakdown to render 1kg of waste plastic into 950ml of oil or Green Fuel. This contains the same energy content as conventional diesels, but with "significantly reduced emissions levels". Existing diesel engines are said to run fully effectively on these fuels with no engine modification. It works best with PP, PE and PS plastics. Can also manage ABS, PA, PUR and EVA but is not so keen on PVC or PET. Yet another reason to avoid PVC! Their websites are a mine of information - go digging. ::Ozmotech Australia and ::Ozmoenergy Europe [by WM]

Case Study 2 :

[37]Alka Zadgaonkar wrings plastic waste for profit.

Alka's is the world's first continuous process for all manner of waste plastics.

It is strange to hear Alka Zadgaonkar say, "Plastics are useful to our lives. We can't deny that."

Were she a spokeswomen for the dishonest, self-serving plastic industry lobby, that statement would be understandable. Were she a legislator we could say she was evading the issue. Her statement will likely infuriate many of us agonizing over the plastic litter all around us.

But hold your breath. Alka loves plastics for an exciting reason; she is the inventor of a process that has the potential to clear our environment of plastic

[36] Share January 26, 2005
http://www.addthis.com/bookmark.php
[37] From Good News India Magazine - Alka Zadgaonkar wrings plastic waste for profit

waste, create a million jobs in waste management, add useful, profitable products to our economy and make India a technology leader in taming plastics. Her work is breathtaking good news for this planet's environment.

Pie on the table:

We are not talking of a pie in the sky idea that is still in the laboratory. Alka and her husband Umesh, are buying in 5 tones of plastic waste everyday in Nagpur at prices attractive to rag pickers. They are wringing fuel oil out of that unsightly pile and selling it to industries in the Butibori Industrial Estate, on Wardha Road out of Nagpur. Production from their plant, Unique Plastic Waste Management & Research Co Pvt. Ltd is sold out for the next year.

They are making money right now, and are about to scale up and buy in 25 tones of plastic waste a day. That production too is booked. As Nagpur generates only 35 TPD of plastic waste, they will shortly run out of raw material to grow bigger. So, a plant based on their technology may soon be playing in your town, at a factory near you.

All your questions:

Too good to be true? Let us at once address some of the questions that are already popping up in your mind. Zadgaonkar's is not a demo plant running on some government grant or subsidy. They took a commercial loan from the State Bank of India in 2005 and have already begun paying back. In fact, the government let them down and Zadgaonkars decided to flex the great Indian entrepreneurial muscle. [On that, more later.]

The process invented and patented by Alka Zadgaonkar is capable of accepting all tribes and castes of plastic waste as input: carry bags, broken buckets and chairs, PVC pipes, CDs, computer keyboards and other eWaste, the horrible, aluminized crinkly bags of the kind that pack crisps, expanded polystyrene [the abominable 'thermocole'], PET bottles- are these and others are all given equal opportunity to contribute to Zadgaonkars' profits. No sorting or picking is done. No preparatory cleaning is necessary either, except shredding that helps economic transport of bulky waste. All solids and metal fines settle down in the melting process or are converted to ash.

Chlorinated plastics like PVC are particularly hazardous to burn because they emit dioxins. In the Alka Zadgaonkar process, the entire shredded mixture is melted at a low temperature and led to a de-gasification stage. Here chlorine is led away to harmlessly bubble through water, producing hydrochlorous acid.

Comment by Eco Friend and Company:
Alka Zadgaonkar has since sold the plant to Asian Electronics, Navi Mumbai. It is reported that the Company is having problems in running the plant.

Case Study 3 :

a. [38]Mumbai - Global eye on start-up converting garbage into fuel

Hindustan Times Thursday, January 17, 2008

T. Raghavendra Rao, director, Sustainable Technologies and Environmental Projects (STEPS) filed for a global patent last year for his technique of converting waste — think plastic, sewage, slaughterhouse waste, hospital waste, petroleum byproducts — into liquid fuel and gas. And it's easy on the environment, for the process does not emit heat-trapping gases that contribute to global warming.

Rao, a former oil industry expert, thinks 'waste is wonderful, it's a resource.' "Mumbai's waste generated daily should be recycled daily too,'' Rao emphasised. "We aim to come to the market with a globally acceptable system to recycle plastic, electronic and organic waste in 24 hours.''

The technology is winning rave reviews.

"We would like to see this powerful innovation commercialized around the world, not just Texas,'' James Vance, business development manager of the global commercialization group, IC2 Institute, told HT from the University of Texas. "We believe it should be able to convert most, and perhaps all types of hydrocarbon-based waste to fuel."

Vance added that IC2, which provides innovators from emerging economies commercialization expertise, has received more interest in this technology than any innovation it has examined. The technology yields 1.1 litres of fuel from one kilo of plastic bags, and 1.2 litres fuel from one kilo of polyethylene sacks used for packaging, all at a cost of Rs 11-12 per litre. One kilo of plastic coating on wires yields 600 ml of fuel. Mumbai's municipal corporation does aim to earn carbon credits from capping the Gorai dump and generating electricity from its methane emissions. But at Rao's plant in Vasai, on Mumbai's northern fringe, his staff is testing a quicker method. Plastic is converted into vapour and passed through cartridges containing a catalyst or a chemical to breakdown the molecules into liquid fuel and gas. The plant is self-energized, on gas generated from the waste conversion process.

b.[39]From ECONOMIC TIMES February 08

Here's how garbage is recycled into money

4 Feb, 2008, 1530 hrs IST, Sachin Dave, TNN

Picture this. Donating a dustbin full of garbage everyday could get you free gas in your kitchen or free electricity, forever. Sounds far-fetched? It's possible if

[38] Reshma Patil Hindustan Times e-mail Author
[39] http://economictimes.indiatimes.com/rssarticleshow/msid-2753914,prtpage-1.cms 2/14/2008

your housing society buys one of the waste management technologies available in the market, which transforms your garbage into fuel (liquid and gas) or electricity. Says Alka Zadgaonkar, founder of Nagpur-based Unique Waste Plastic Management and Research Company (UWPMRC), “Yes this could be a reality today if the government’s permission is taken by the residents. The technology of converting waste to fuel or electricity has huge potential as it solves two problems simultaneously—of waste management and the fuel crisis.” Industry experts estimate that India produces waste equivalent to fuel or energy that could fetch $100 billion annually. UWPMRC currently produces 5,000 litre of fuel from plastic waste collected by rag pickers in Nagpur and sells it to industrial units in Butibori, outside the city. A year ago, Suresh Shah of Asian Electronics in Navi Mumbai bought 75% in this company for Rs 80 crore.

Meanwhile, Sustainable Technologies & Environmental Projects (STEPS), a Mumbai-based company, has also developed a technology that can thermally convert various materials like vegetable oil, animal fat, and petroleum by-products into liquid, gas and solid fuel. “With this technology, any hydrocarbon, such as plastic, bio-medical waste, slaughterhouse waste, petroleum sludge or wax can be thermally converted into liquid or gas fuel and a powder carbon residue. The liquid fuel can then be refined into different fractions or used ‘as is’ in engines and generators,” says Raghavendra Rao T, director, STEPS.

The petroleum gas can be fed back into the system to power the process and the carbon residue or coke powder can be recovered and sold. The process is based on adding a catalyst to the feedstock and then raising the temperature through several stages to approximately 420 degrees Celsius. As the temperature rises, the materials are vaporised, drawn off and condensed into fuel. Finally at 420 degrees Celsius, any remaining material is converted into carbon powder. Says Rao, “

Negotiations for twelve of our machines are in final stages, and two of the buyers are in India. Presently only industrial units are going for the technology but in the future housing societies could pool in money and adopt it.” Each machine costs around Rs 10 crore, but the company is developing a method where the machines will cost less and be more affordable for homes.

There have already been proposals made to the finance ministry for excise duty exemption on waste management technologies. Harshad Gandhi, secretary, Developmental & Eco-Friendly Enterprises (DECENT) a not-for-profit company, recently in his letter to the finance minister, says, “ Waste handling agencies have not been able to keep pace with the growing urban municipal solid waste, which is currently estimated at 1,15,000 tonnes per day in India.”
Here's how garbage is recycled into money- ET Cetera-News By Industry-News-The Eco...

He also asks that a concession be given on equipment required for waste management and excise be reduced from the present 16% to nil. According to government figures Mumbai alone generates 8,000 tonnes of waste every day, of which 5% is plastic waste. “ About 52% of the waste generated is organic waste and can also be converted into compost with the help of machines like the Organic Waste Converter (OWC). This could not only solve the problem of availability of dumping grounds in cities like Mumbai and New Delhi but also reduce transportation costs if every housing society invests in this technology,”

adds Gandhi. According to an estimate, around Rs 3,000 crore is spent every year by municipal bodies in the metros on collection and disposal of garbage. "The Brihanmumbai Municipal Corporation (BMC) spends about Rs 800 crore every year in transportation of waste from homes to dumping grounds. Only if the government fixes one organic waste converter in every society this cost could be reduced at one go," says Mohan Jawdekar, vice president of the environment and biotech division at Excel Industries, a Rs 800 crore company which manufactures organic waste converters.

The OWC is presently used by hotels and hospitals and priced at Rs 4 lakh. And it can convert organic waste into manure, which if sold even at one or two rupees per kg, can not only help governments save millions spent on transportation of garbage but also earn revenue from the sale of manure. Notably, two companies—Sai Renewable Power and GK Bio-Energy—are using the technology to generate electricity from waste. Sai Renewable Power, based in Hyderabad, generates power after combustion of empty bunches from palm trees and residue of palm fruits. These are rich in volatile substances and are used as a fuel for the boiler in the plant. The Rs 1,376 lakh project, funded partly by IREDA, generates 3MW of power from 100 tonnes of palm oil industry waste every day. GK Bio-Energy, a Namakkal (Tamil Nadu) based company, generates power from poultry droppings. It collects the droppings of about a million birds from nearby poultry farms to generate power. The technology is based on the Biogas Induced Mixing Arrangement (BIMA) technology developed and commercialised by Entec, an Austrian company.

Explains Anurag Garg, assistant professor at IIT Mumbai, "According to our research about 20% of the total municipal solid waste consists of plastic, which is a hydrocarbon and can be converted into fuel or energy. Presently not many companies have come into the market with their products but this field has great potential."

Many small companies are now tying with large oil companies for promotion of their products. Recently Asian Electronics entered into a joint venture with a major Indian petroleum company. "We have signed an MOU with the oil company and would be marketing our products with them and could also use some of their residue (heavy oil) as raw material for our process. But otherwise also we can market our products through them," says Shah refusing to divulge the name of the petroleum company. Asian Electronics plans to come out with a fuel, which could be used as a substitute for diesel and will be cheaper too. "In the near future you could see many petroleum mammoths tying up with small companies either for the technology or the products. And we expect that it would be a business worth billions," says Rao.

Industry experts also point out that technologies developed in India hold huge potential abroad. Says Zadgaonkar, "We are in talks with an Oman-based company and a USA-based company have also showed keen interest. Companies in the West are attracted to our technology as it gives them carbon credits."

c. From India Today - 14 July 08

Entrepreneurs are increasingly seeking ways to turn rubbish into value. Mumbai startup, Sustainable Technologies and Environmental Projects (STEPS), set up in June 2007 by T. Raghavendra Rao, uses a thermal catalytic conversion method called 'polycrack' to convert plastic and organic waste like kitchen, animal and agro refuse into petroleum fuels like gas, liquid fuel or a combination of both. A kg of polypropylene plastic feedstock yields 1.2 liter of liquid fuel that can be used to power electrical generators, or 150g of LPG, at a conversion cost of Rs 11 per liter.

Although the industry has a record of failure, Rao is undeterred. He argues that the technology is "far superior to traditional recyclers, which require clean plastics or involve high costs". With rising oil prices, he may just have timed it right. Profits may still elude, but optimism and innovation are in plentiful supply.

If the chemical engineering department of Jadavpur University, Kolkata, is collaborating with Moromi, an NGO, to extract dyes from waste flowers for use in the textile industry as well as for bio-fertilisers, Rajendra Gandhi, MD of the Mumbai-based Rs 110-crore Gujarat Reclaim and Rubber Products has been successfully recycling old rubber from tyres since the '70s. With natural rubber in short supply, tyre companies, ranging from Goodyear, Michelin and Bridgestone abroad to Apollo and JK Tyres in India, mix 5-6 per cent reclaimed rubber in car tyres, whereas bicycle tyres contain about 40 per cent. Says Gandhi, **"It is no longer enough to manage waste and minimise the environmental impact of its treatment. Waste must be used as a resource."** Yet, rising manpower costs are forcing many of these players to rethink their strategies. The garbage warriors must plod on through millions of dustbins before they can have a good, clean run.

D. DISPOSAL OF PLASTIC WASTE THROUGH CO-PROCESSING IN CEMENT KILNS

A. Technology[40] :

Use of the waste as Alternative fuel

a. [41]from flsmidth

The clinker burning process is an excellent means of processing waste compared to a normal incineration plant:

a. The heat content of the waste is fully recuperated
b. The consumption of fossil fuel is reduced
c. The CO_2 emission to the atmosphere is reduced, corresponding to the amount of fossil fuel replaced by the waste
d. There is no secondary waste product to deposit afterwards
e. A modern kiln system works as a big scrubber, all acid gasses being neutralized by the lime in the system
f. Reduction of fuel costs
g. Environmental benefits
h. Saving of fossil fuel resources

Replacement of raw materials

Many types of waste materials can be used to replace smaller or bigger amounts of the traditional raw materials. The use of fly ash from power stations is well known but *any* waste material containing the principal elements of cement – Ca, Si, Al and Fe – are potential substitution materials.
Examples of materials also used today are spent catalysts (Al-source) and foundry sand (Si-source).

b. [42]From HOLCIM

Executive summary

Different types of wastes have been successfully co-processed as alternative fuels and raw materials (AFR) in cement kilns in Europe, Japan, USA, Canada, and Australia since the beginning of the 1980s.
These Guidelines are meant to gather the lessons of that experience and offer it particularly to developing countries that need to improve approaches to waste management. Some developing countries will need capacity building help before launching AFR programs.

The Guidelines, meant for all of the cement industry and all of its stakeholders, result from a public-private partnership between GTZ (the German Corporation for International Cooperation) and the cement company Holcim Ltd. The findings and recommendations are based on experiences from industrialized and

[40] Eco Echoes - Oct Dec 2008 issue of Quarterly published by ICPE
[41] From www.flsmidth.com (Up-to-date addresses of worldwide subsidiaries and sales offices are available from our website INDIA Fuller India Limited Capital Towers 180, Kodambakkam High Road Nungambakkam Chennai E-mail: fil@fullerindia.co.in)
[42] HOLCIM is the parent company of M/s ACC. From Alternative Fuel research division, ACC, Thane : Guidelines on co-processing waste materials in cement production

developing countries, as well as from the public and private sectors. They are also based on other initiatives of bilateral and multilateral organizations to improve waste management at national and local levels, as well as attempts by the cement industry to reduce environmental degradation resulting from cement production. They reflect international laws and conventions. The use of AFR can decrease the environmental impacts of wastes, safely dispose of hazardous wastes, decrease CO2 emissions, decrease waste handling costs, and save money in the cement industry. It will help in achieving the targets set in Agenda 21 of the "Earth Summit" in Rio de Janeiro (1992), the Johannesburg Declaration on Sustainable Development (2002), and the Millennium Development Goals.

However, there are some basic rules and principles that should be observed. AFR use should respect the waste hierarchy, be integrated into waste management programs, and not hamper waste reduction efforts. It should never be used if it might increase harmful emissions or impacts to human health. Companies using AFR should have a long, excellent track record of using conventional fuels and raw materials. Co-processing should not harm the quality of the cement produced.

Countries considering co-processing need appropriate legislative and regulatory frameworks. National laws should define the basic principles under which processing take place, and define the requirements and standards for co-processing. Regulators and operators should conduct baseline tests with conventional fuels and materials, so they can compare AFR results to these.
Some wastes should never be co-processed; these range from unsorted municipal garbage and certain hospital wastes to explosives and radioactive waste. Other wastes will need preprocessing before they can be used, and approaches to AFR use should take account of the need to effectively regulate and manage these pre-processing plants.

Following certain basic rules assures that the use of AFR does not change the emissions of a cement kiln stake. These include feeding alternative fuels into the most suitable zones of the kiln, feeding materials that contain a lot of volatile matter to the high temperature zone only, and avoiding materials that contain pollutants kilns cannot retain, such as mercury. Emissions must be monitored, some only once a year and others continuously. Environmental impact assessments (EIA) should be done to confirm compliance with environmental standards; risk assessments can identify any weaknesses in the system, and material flux and energy flow analyses help to optimize the use of resources.
Cement plant operators must know the origins and paths of AFR before accepting any for use, and all should be tested before use. Transport of wastes and AFR must comply with regulations.

Plants must have developed, implemented, and communicated to employees adequate spill response and emergency plans. For start-up, shut-down and conditions in between, strategies for dealing with AFR must be documented and available to plant operators. Plants need well-planned and functioning quality control systems, as well as monitoring and auditing protocols. Risks can be minimized by properly locating plants in terms of environmental setting, proximity to populations and settlements, and the impact of logistics and transport. Plants will require good infrastructure in terms of technical solutions for vapors, odors, dust, infiltration into ground or surface waters, and fire protection. All aspects of using AFR must be well documented, as

documentation and information are the basis for openness and transparency about health and safety measures, inside and outside the plant.

Management and employees must be trained with regard to handling and processing of AFR. Hazardous operations training for new workers and subcontractors should be completed before starting with co-processing. Periodic re-certification should be done for employees and subcontractors. Include induction training for all visitors and third parties. Understanding risks and how to mitigate them are keys to training. Training of authorities is the basis for building credibility. Introducing AFR requires open communications with all stakeholders. Provide all the information stakeholders need to allow them to understand the purposes of co-processing, the context, the functions of parties involved, and decision-making procedures. Admitting mistakes is part of transparency, leading to corrective actions. Be credible and consistent, cultivating a spirit of open dialogue and respect for differing cultures.

As populations increase in the developing world, so do waste management problems, and so does the need for more cement and concrete for housing and the infrastructure of development. The properly managed use of wastes as fuels and raw materials in cement kilns can help manage wastes while contributing to the sustainable development of our common world.

Note : ACC have issued in Sept 09 revised guidelines for sending of Waste Samples for trial

B. Implementation:

Case Study:

Analysis of trials taken by ICPE at ACC

Benefits of plastics have been acknowledged by one and all in the modern world. Various Issues and Myths on Safety and Toxicity of plastics have been addressed adequately and the Realities have been brought out. It was realised that the issue of Solid Waste Management including Plastics Waste Management needed real attention to find out an amicable solution.
While local / civic authorities are trying to find out the solution, ICPE attempted to find out an environment friendly and scientific solution to a segment of plastics waste, which otherwise is found uncollected by waste pickers from the MSW stream creating a waste management problem. ICPE along with ACC Ltd. have established for the first time in India that All Plastics Waste could be Co-processed safely in Cement Kilns in Indian conditions. This, we believe, is a pioneering attempt in India in the direction of finding a disposal solution of low-end plastics waste. A detailed report has been brought out in this issue of the Newsletter.

Disposal of Plastics Waste through Co-processing in Cement Kiln is a known and accepted process of Municipal Solid Waste Management in many developed countries. Details of the process have now been brought out along with test results of the trials conducted – for the first time in India, in an ICPE sponsored project at the cement plant of the leading cement manufacturer of the country – ACC Ltd.

The new technologies and economics have come to play an important role in plastics recycling. Recycling principally refers to Recovery, which is divided into Material Recycling and Energy Recovery. Material Recycling is again divided into Mechanical and Feedstock Recycling. The choice between Mechanical Recycling, Feedstock Recycling or Energy Recovery depends on the types of plastics waste and the relative ease / difficulty in total or partial segregation from other plastics and / or other waste materials. Mechanical recycling includes a wide variety of processing techniques and a broad range of processing methods. Pure grade production scrap may only have to be reground and reprocessed, mixed plastics have to be mechanically separated and, if contaminated, also adequately washed and cleaned. All these steps increase the cost depending on the degree of contamination. To avoid the extra work involving extra cost and other numerous problems, proper segregation of wastes at source gives us a great ease in operation in recycling the wastes.

After collection of the portions that can be recycled by mechanical recycling, there remain numerous very small, heavily contaminated articles, multi layered composites or cross-linked products, which are mostly unattended and are allowed to remain in the waste stream causing solid waste problem. The best way of reutilizing these portions is to properly incinerate them instead of dumping them diffusely on landfills. This recovers their calorific values and at the same time disposes of the waste in a scientific manner without causing any environmental hazards. Many developed / developing countries are disposing these otherwise unattended plastics waste in the Municipal solid waste stream through co-processing in Cement Kilns (Energy Recovery) and using in Blast Furnaces of Steel Industries (Feedstock Recycling) in a scientific and environmental friendly method. Conversion of all types of mixed plastics waste into Industrial Fuel (another example of Feedstock Recycling) is also a recent development.

Though both processes (Co-processing in Cement Kiln and Conversion to Industrial Fuel) can handle all types of plastics including laminated / multilayer plastics, without any segregation and without thorough cleaning of the waste, fresh investment is required for the Fuel Conversion route while some modifications in the Feed Section are required for the existing Cement Kilns in case of Co-processing. However, in India the method of disposal of plastics waste in Cement Kilns (or in blast furnaces) are not practiced as yet. ICPE initiated a project along with the leading manufacturers of cement in the country, ACC Limited to find out the possibilities of disposing plastics waste through co-processing in the cement kilns in Indian conditions. The project had active support from Central Pollution Control Board (CPCB). With the active cooperation and formal clearance from Madhya Pradesh Pollution Control Board (MPPCB) to conduct a trial of co-processing plastics waste in the Kaymore Plant near Katni, MP of ACC, a systematic trial was conducted during 29th-31st March, 2008 to record any possible environmental implication associated with the process.

Trial details

Different types of plastics waste were used in the trial including – Polyethylene (LDPE / HDPE / LLDPE), Polypropylene (Homo and Copolymer), Polystyrene (GPPS and HIPS), Polyethylene Terephthalate (PET), Acrylonitrile

Butadiene Styrene (ABS), Nylon, Polyacetal, Polybutylene Terephthalate (PBT), etc. PVC was excluded from the initial trial stage as the cement kiln was not equipped to handle the situation which may arise due to the possible formation of HCl or chlorine. The emission samples prior to co-processing, during co-processing and post co-processing were collected by SGS Laboratories – who are approved by CPCB for conducting such tests. The samples were tested as per the international testing protocol on the subject matter in the SGS Laboratory facilities at India and Belgium.

Parameters monitored during each phase of the co-processing trial:

• Dioxins & Furans • TOC • HCl • HF • Hg and other Heavy Metals • Particulate • CO2 • CO • NOx • SO2 • Oxygen and Moisture

Chapter 11 - Table 1: Summary: Emission Monitoring Results

Parameters	Pre Co-processing During Co-processing	Units	Post Co-processing	Stack emission during trial
Dioxins & Furans	mg/TEQ/Nm3	0.004	0.0033	0.0029
TOC mg	Mg	5.5	7.36	6.01
HCl	mg/ Nm3	ND	ND	ND
HF	mg/ Nm3	ND	ND	ND
SO2	mg/ Nm3	77	27.75	12
SPM	mg/ Nm3	44.9	48.6	48.9
CO	mg/ Nm3	446	780	313
CO2	Vol - %	17.8	17.6	17.8
Nox	mg/ Nm3	651	600.5	614
Mercury	mg/ Nm3	0.014	0.046	0.006
Metals (except Cd & TI)	mg/ Nm3	0.047	0.041	0.037
Cd & TI	mg/ Nm3	0.002	0.004	0.004

Discussion of the result

It is observed that the emission levels of various gaseous substances including Dioxins and Furans, TOC, Heavy Metals, SPM, CO_2, SO_2 and NOx, etc., either came down or remained within the acceptable norms. The plastics waste used for the trial consisted of both Commodity Plastics like PE, PP, PS and Performance / Engineering Plastics like PET, ABS, Nylon, PBT, Polyacetal etc. These plastic materials represent about 99% of the plastics end products used for daily routine or special applications (PVC was not included in the study due to the reason as stated earlier). All packaging applications including laminated / multilayer pouches contain combination of some of the plastic materials used in the trial. The result indicates that disposal / co-processing of all types of plastics waste in cement kiln in Indian condition is an environmentally safe operation.

The volume of Plastics Waste used for the trial

The volume used for the trial could replace only about 1.5% of the fossil fuel (coal) normally used in the cement kiln. For increasing this volume to a level of 5-10%, the Cement Plant has to modify its input material conveying system by introducing Air Ducts instead of Open Belt Conveyor. However at the trial volume rate, the 170 odd cement kilns of India can co-process about 2.4 million tons of plastics waste in a year – much above the total plastics waste generated in the country. Hence it is sufficient enough for the Indian cement kilns to co-process the plastics waste at trial volume to begin with. In the future when Indian plastics consumption will increase, the Indian Cement Plants can replace even 50% of its coal consumption by co-processing plastics waste, like developed country Germany does it in its cement kilns.

Scope for Further Implementation

Madhya Pradesh Pollution Control Board has already accorded its consent to all the cement plants in the State to co-process plastics waste in their plants. It is learnt that CPCB has also asked all the Pollution Control Boards in the country to implement the system in their respective States. This will pave way for civic authorities in various cities and towns in the country to find an effective alternative and scientific method of disposal of low end plastics waste in more than 170 cement kilns in the country in an environment friendly way and thus be able to solve the plastics waste management problem in a real big way. ICPE, in cooperation with ACC Ltd. has been able to demonstrate that plastics waste in India can be scientifically disposed off by co-processing in Cement Kiln in an environmentally safe method. The issue of collection and delivery of the plastics waste to the cement kilns has to be resolved by the Civic and State Government Authorities. This is expected to benefit the cement industries also as well.

12. VISITS MADE BY ECO FRIEND AND CO. TEAM

The team responsible for making this report during the short time available at its disposal made a number of visits to the offices of the MCGM, Dumping Grounds at Deonar and Mulund, to the recyclers of Plastic waste, took trials on the plastic waste segregated from the MSW, and interviewed a number of people engaged in the business.

Following is a summary of the visits :

Date 12 Sept 09

Venue : MCGM's MSW Dumping Site, Deonar

Person visited – Mr Praveen Sawant (Junior Overseer)
Information collected by - M/s Prakash Deshpande, Ramesh Patil, Akash Rao, DJ Deshmukh, Ms. Nrupura Bhagwat

The team was asked to take permission for entering the Dumping Site. Some general information was given to the team by Mr. Sawant.

Date 15 Sept 09

Venue 1: MCGM's Dumping Site, Deonar

Persons visited - Mr Sabley (Supervisor, MCGB) , Mr Chavan (Overseer)
Information collected by - M/s Akash Rao, DJ Deshmukh, Ms Nrupura Bhagwat

The Dumping ground is in existence for a number of years (since 1927)
Wastes brought to Deonar from all over Mumbai from various wards and from Transfer Stations at Mahalaxmi & Kurla.
Total Area of Deonar Site - 117 HA (partly encroached upon by slum dwellers)
Municipal Solid Wastes are brought round the clock in about 2000 trips by Dumpers & similar vehicles.

The Wastes are dumped in the area in a systematic manner (8 loops are formed in the area for this purpose) and leveled almost immediately by JCB machines.
Once the area covered by a loop is leveled, the waste is allowed to settle down, and dumping on this loop is started again and leveled. Many tiers of the waste have been formed in this way over the number of years.
Rag-pickers take out the recyclable materials from the wastes right from the moment a Dumper enters the area, and take out the wastes before the leveling operation is completed.

There are about 2000 such rag pickers, many staying in slums adjoining the un-walled dumping ground, and some inside the dumping ground itself. The wastes picked up for recycling are – metal, wood, glass, plastic, Thermocole, Rag-pickers sell the wastes to nearby scrap-dealers on daily basis at different rates. They earn less during the monsoon because the wastes are wet. Sometimes there are fires due to trapped methane leaking out, and sometimes due to Rag-pickers who burn some part of the wastes in order to recover saleable metal parts (and Thermocole inside drums to extract carbon) at the site causing problems to residents of nearby localities, especially during the summer season. After 26 July 2005, the dumpers brought dead animals (about 2000 to 2500 buffaloes, 4500 sheep, etc which had to be buried in the dumping ground) along with plastic, spoiled medicines / food, cotton beds, house hold furniture and other wastes (which were all cleaned up by the rag-pickers within a week)

It has been rumored that the Site being handed over to Excel Industries, Mumbai from 1st October 2009 for managing the operations partly to extract the trapped Methane Gas, (to be used for an Electrical Power Plant to be set up in a 50 acre area at the site by Reliance Industries), and partly to make Compost / Manure while continuing to accept wastes from the MCGM area.

1. Out of 117 hectares, encroachment is found on 15-20 hectare area.

2. Workload -

- There are 3 shifts for working. In 1st & 2nd shift around 450-500 vehicles unload waste. In 3rd shift around 150-200 vehicles unload waste.
- There are 3 transfer stations- Mahalaxmi, Kurla, Andheri West (lagoon). where small vehicles, which moves about in the wards for collection of waste, transfer the waste in dumpers – where the waste is compacted – these dumpers transport the waste to the dump site. But some small vehicles from the area near dumping ground unload the waste directly instead of transferring in dumpers.
- In the months of April / May / June –more vehicles unload waste since drainage cleaning is done before rains.

3. Bio degradable waste composting project was initiated but could not run for a long period.

4. Pattern of unloading wastes –
The waste is dumped in loops. There are 8 loops. Once the vehicle comes on dump site, the sellable waste is lifted by the waste pickers.
The remaining waste is available. Once the loop is closed down, again after amount 2 months, the loop incomes operative as waste vehicles is reduced due to decomposition of bio-degradable waste sample area gets available for further waste unloading. If received, even the height of the loop increased. E.g. - At retain place the height of waste dumped has reached as much as the forth story of a building.

5. Approx 2000 waste pickers visit Deonar dumping ground daily. Waste pickers lift waste from- common dustbin, vehicles, transfer stations to dumping grounds.

At the end when we requested them to have a look at the dump site and see how the actual work is carried out and to get samples of waste from different areas, they asked us to take permission from Mr. Tawase, Deputy Chief Engineer, SWM, MCGB, Pantnagar, Ghatkopar.

Venue 2 – MCGM's Solid Waste Department Office, Pantnagar, Ghatkopar

Person visited - Mr Tawase (Dy. C.E. Solid Wastes, MCGM)
Information collected by – M/s Akash Rao, DJ Deshmukh

Transfer stations at Gorai and the Varsova Lagoon have been closed down and a green cover has been provided by the MCGB. Mr Tawase confirmed that the Deonar site will be handed over to Excel Industries from October 2009 for Partial Closure, during which accumulated wastes under the land will be transferred into a scientifically designed landfill having separate arrangements for taking out leachate and methane gas (which can be used for electrical power generation) The other Dumping Ground existing at Mulund and a new one coming up at Kanjurmarg will also be handed over to a private operator on similar basis. 2000 tpd of the MSW at Deonar will be sent to Kanjurmarg for processing in a Bio-reactor *(Check)*

Of the 1600 tpd MSW sent to Mulund, 500 / 600 tpd will be used for Bio-Methantion, and the balance 1000 tpd will be sent to Kanjurmarg.

Thus, out of the compliance criterion comprising of six activities (Collection, Segregation, Storage, Transportation, Processing and Disposal) [specified under Schedule –II - rules 6(1) and (3), 7(1)] for Management of Municipal Solid Wastes the MSW Rules 2000, the last two are being transferred in part to Private Operators by the MCGM.

Mr Tawase was given an application in writing for visiting the Mulund Dumping Site. He arranged for the visit for the following day with Mr Pant.

Date 17 Sept 09

Venue : A. MCGM's Dumping Site, Mulund

Person visited - Mr Pant (Solid Wastes Dept, MCGM, Pantnagar, Ghatkopar)
Information collected by - M/s Akash Rao, DJ Deshmukh, Ms Nrupura Bhagwat

Different samples of waste collected with the help of a rag-picker at the site. The person was also asked questions regarding the waste. .

*Information regarding Mulund Dumping Site:
Area: 55 hectares. Has 4-5 loops (*information of loops from Deonar dump site visit*). Approximately 2000 tons of dry and wet waste is received per day, and approximately 1000 tons of debries /silt through 361 waste collection vehicles. The waste is collected from different wards of Mumbai. Approximately 40,000 tons of waste is received at Mulund dump site per year. This includes nearly 1000 tons of waste extra per day in the months of April- September. The wastes are weighed and records are maintained on computer, 24 hour a day.

*Interviewed a waste picker on the site, details of which are as follows:

What are the wastes types picked by the waste pickers?
Puttha, glass & plastic bottles, plastic containers, paper waste, aluminium, iron, tube, tyre, LDPE, cloth.

Is rubber sellable?
No.

How many hours they work to pick the waste?
Each person works for 7-8 hours.

What is their income?
Approximately Rs.100/- per person per day.

Is LDPE plastic waste picked by all waste pickers?
The waste pickers from Malegaon come in trucks, pick the LDPE plastic waste and sell the same in Malegaon (for washing, drying which cannot be carried out in Mumbai for want of space)

What is the amount of waste collected by them? What income does it fetch?
Around 4-5 waste pickers sell 2.5 tons of waste in one and a half month which would be loaded in trucks and sent to Malegaon. The waste fetches Rs. 6/Kg which would have been Rs. 3/Kg in Mumbai.

Do the waste pickers segregate the waste in different categories?
The waste is not segregated. It is sold in mix form at the rate of Rs.8-10/Kg.

Waste are the rates of different wastes?
Copper- Rs.50 to 60 per Kg, Aluminium- Rs.30 to 35 per Kg, Plastic- Rs.3 to 4 per Kg (dry), Plastic - Rs.1 to 1.5 per Kg (wet).

What happens of the waste once it is picked by the waste picker?
The waste is sold to the scrap dealers.

Does the scrap dealer come to the Dumping Site to collect the waste?
Some scrap dealers come to the Dumping Site to purchase waste and some waste pickers have to go to the scrap dealers every day to sell their waste.

How much LDPE plastic waste is collected by a waste picker in a day?
Approximately 50 to 60Kg (if wet) OR approximately 10 to 15Kg (if dry).

Is the waste washed before selling to the scrap dealer?
Waste is not washed.

What is done with rubber waste?
It is not sellable.

What is done with thermocole waste?
Termocole is burned in drums on the dump site and the compacted form is sold at Govandi (no idea what happens to it later)

Are metal pipe pieces sellable?
Yes. Pipes with thread fetch less money compared to the pipes without thread.

What is done with the cigarette packets?
Single cigarette packet is not sellable, but if it is available in bulk quantity, it is purchased by the waste paper dealers.

A] Recyclable Material	B] Non Recyclable Material
Plastic Water Glass	Sim Cards
Colgate wrapper	Land Pouches
Bulb	Gutkha Pouches
Powder	Marie Biscuit Wrappers
Glass	Empty Tooth paste Tubes
Bangles	PVC
Wood	Plywood
Pen Refills	Decorative Gelatin
Ice-cream cup	Transparent Plastic Cover
Cigarette Packets	Computer Floppies
G.I. Pipes	Broken sandals (rubber)
Hacksaw Blades	Use & throw Thermocol plates
Broken Phone Instruments	
Electric Wires / cables	
Paper	
Aluminum Foil	
Cold drink bottle caps	
Tops of tins	

Venue B. Enviro Care Labs Pvt. Ltd., Thane

Attended by Ms. Nrupura Bhagwat, mr. Akash Rao and Mr. Deshmukh. Met Dr. Nilesh S. Amritkar- Director Laboratories. This meet was regarding the analysis of the plastic waste samples, collected from the Mulund Dumping Site of MCGM. Dr Amritkar informed that the analysis parameters depend upon the end use. The samples given for analysis should be in segregated form or else they will have to get it segregated from some other agency. Sample size should be 500gm. The number of samples will depend upon the types of plastics (one sample for each plastic type) The sample can be clean or soiled. For plastics from MSW, other than general tests, tests of heavy metals tests for copper, nickel, iron, zinc, lead can also be carried out. For the end use of plastics in Cement Kilns, what parameters are required, need to be studied.
ACC later confirmed that the analysis will be done at their end.

Information from other cement companies regarding their plans for use of Plastic waste in their Kilns could not be obtained.

Venue : C. Eco Logistic's Bio-Medical Division office at Pawane , Navi Mumbai, for waste samples' segregation, quantification and photographs.

List of material collected from Mulund Dumping Site:
Details of Photographs taken for following samples-

1. MSW Fresh :
   a. Recyclable materials
   b. Non Recyclable materials
2. MSW-
   Partially Decomposed (x) :
   Actual material – weight of bag weight = 2.9 - 0.2 = 2.7 kg
3. MSW- Fresh materials (y) = 2.5 kg
4. MSW- Recyclable materials removed (z) = 1.25 kg
5. Waste segregated from partially decomposed materials (m)
6. Waste segregated from partially fresh materials (n)
7. Waste segregated from partially recyclable materials (o)

Table 2: For Plastic waste

Name	Weight(kg)
Plastic materials from partially decomposed materials (p)	0.7
Plastic materials from partially Fresh materials (q)	1.05
Plastic materials from partially recyclable materials (r)	0.1

Table 3: For other recyclable waste

Name	Weight(kg)
Other recyclable materials from partially decomposed materials(s)	0.35
Other recyclable materials from partially Fresh materials(t)	0.05
Other recyclable materials from partially recyclable materials(u)	0.1

Sample for analysis : p + q + r = 0.5 kg

Date 22 Sept 09

Venue–MCGM's Solid Waste Department Office, Pantnagar, Ghatkopar

Person visited - Mr Tawase (Dy. C.E. Solid Wastes, MCGM)
Information collected by – Mr DJ Deshmukh, Ms Nrupura Bhagwat

A Typical Analysis of MSW (All India basis) is given -

Organic Fraction (Bio Mass)	: 35 %
Woody Mass	: 15 %
Paper	: 5 %
Rags, Textiles	: 5 %
Rubber, etc	: 4. 85 %
Plastics	: 0. 05 % (?)
Glass	: 0.05 % (?)
Metal	: 0.05 % (?)
Stone	: 20 %
Sand / Earth	: 15 %
Bulk Density	: 0.4 to 0.6
Gross Calorific Value	: 800 K Cal / Kg

Wastes from various wards of the MCGM are collected at the Refuge Transfer Stations & Dumping Sites by various types of vehicles* as given below :

Mahalaxmi Refuge Transfer Station	: Wards A, B, C, D , E & F
Kurla RTS	: Wards F (N), G (N), L, H, K(E)
Varsova Lagoon RTS	: Wards K(W)
Gorai RTS	: Wards R(S), R(N)
Chembur (Deonar) Dumping Ground	: Wards M(E), M(W)
Mulund Dumping Ground	: *(Check)*

*Vehicles – Large Compactors, Mini Compactors, Small Body vehicles, etc.

Quantities of MSW :
Deonar : 5600 MTD - 4500 MTD of refuge & 1100 MTD of Silt & Debris
Mulund : 1600 MTD - 600 MTD of refuge & 1000 MTD of Silt & Debris
Total : 7200 MTD – 5100 MTD of refuge & 2100 MTD of Silt & Debris

Date 22nd & 23rd September 09

Telephonic calls to KK Plastic, Bangalore regarding use of plastic waste in the construction of roads.

Person called - Mr Rasool Khan (Director) of KK Plastic
Information collected by – Mr D J Deshmukh
KK Plastics are in road construction using Plastic Waste for the last 8 years
KK Plastic buys MSW from Bangalore Municipality @ Rs 6 / kg
Has entered into MOU for construction of roads using plastics segregated from the MSW

The Segregated Plastic is used in the road construction by a patented process.

Use of plastics in road construction –
Reduces use of bitumen
Doubles road life (postpones relaying of the roads)
Plastics collected from roads reduces congestion of city drains
Wastes removed from Dumping Grounds saves valuable dumping space
Biodegradable wastes segregated from wastes can be used for composting
Above step further leads to saving of subsidy on imported chemical fertilizers
Compost fertilizer improves quality of food produced & maintains soil quality
Segregation activity generates employment opportunities, thus, the tangible and intangible benefits can fetch Rs 11.5 from Re 1 invested.

Only other (better) way is to segregate plastics (dry wastes) from wet wastes at source apartment wise, and collect on door to door basis, for which huge efforts will be required. Has a limited business in Bangalore – about 1 to 1.5 Crores / year - Low volumes. Three other parties have failed in Delhi (trials on Hariyana border) Would like to expand business – if possible in Mumbai / all over India. Expects to separate 30-40 tpd recyclable plastic out of estimated 100 tpd of Plastics from 8000 TPD MSW in Mumbai. No washing is required during / after segregation. A machine is used to avoid use of water. Requires nearly 2 te of waste plastics to construct 1 km of road. A 3.5 M wide road costs Rs 6 Lakhs for doing a 25 mm thick relaying. Funds from the JNURM can be made available for this activity. Mumbai can set an example to be copied by the other Metros. Has so far met VIPs such as Mr Jairam Ramesh, Mr Vilasrao Deshmukh, M/s Murli & Milind Deora, Mukesh Ambani and the CPCB chairman in this connection.

Date 23rd September 09

Venue - Bhandup Complex

Persons visited – Mr Hanumanbhai, Pareshbhai & Mr Agarwal (Recyclers of Plastic Wastes)
Information collected by – Mr Akash Rao, DJ Deshmukh, Ms Nrupura Bhagwat

It is possible to re-cycle all types of plastics, one way or other.
LDPE, HDPE, HM, PVC, etc are being recycled successfully and economically in Mumbai. There are 110 Plastic recycling units at Bhandup alone.
Plastic from MSW from the Dumping sites is not being used for recycling in Mumbai, as it requires washing and drying which entails a large working area. For this reason, recyclable materials, mostly plastics, are taken from Mumbai dumping sites to Malegaon for recycling.
Plastic from MSW is similarly being recycled near Pune, Nashik and in Gujarat.
Plastic from MSW is bought at Rs 2 to 3 per kg, and for half this price in monsoon.
Trial on plastics collected from Dumping sites can be given on a limited scale.
Photograph of soles for sandals, made from recycled plastic was taken from a nearby plastic recycling unit.

See : Interview of Mr Hanumanbhai on Video

Date 25th September 09 :

Venue–MCGM's Solid Wastes Department, Near Crowford Market, Mumbai

Persons visited – M/s Nitin D. Mankar (C. E., Solid Waste Mgmt, MCGM),
Mr Rajwadekar (Ex Engineer, SWM- Refuge)
Mr Subhash Patil (OSD) ALM
Mr Anand Jagtap (OSD) Slum Sanitation Programme (MSDP)

Information collected by – Mr D J Deshmukh

A. From Mr Rajwadekar –

A. Estimated Quantities of MSW in Mumbai – 6500 tpd of refuge and 2000 tpd of Silt & Debris. The Generator is supposed to make arrangements for disposal of the Silt & Debris

B. As per the survey done by 'Infrastructure Leasing and Finance' Company, 0.75 % of the waste is expected from the wastes, in which 30 % wastes are Dry wastes.

After Supreme Court Order in 2004 on Management of MSW as per the Rules 2000 :

Brick Masonary type open wastes collection stations are being phased out.

For collection of the refuge, different types & sizes of waste collection bins have been ordered placing at various locations in Mumbai. All are as per EN standard, and the capacities are 1.1 Cu M (4 wheelers) 240 liter and 120 liter (both 2 wheelers) Life expectancy being 6 months, double the quantity has been ordered, so as to cover one year's requirement of all the housing societies in Mumbai. Part of the funds have come from the Corporators' fund and the rest from the MCGM.

Various size and types of vehicles (6 te, 2.5 te, 1 te and even smaller Tata tempos, Dumpers, Dumper placer vehicles) are used for transportation of the wastes to the dumping grounds. Similarly, Stationary compactors are also placed at sites having a large amount of waste. Lifting of the wastes is done in all the three shifts. Sanitary Landfill has been done at Gorai and carbon Credit of Rs 26 Crores has already been received. Total CC of Rs 73 Crores is expected by 2013.

Deonar Dumping site will be shortly closed partly by Sanitary Landfill and will be used for composting by a private party. CC is expected even there. Mulund Landfill will also be closed partially, allowing for Bio-Methanation. This will require segregation of plastic waste at the site to some extent. Here, 500 tpd of MSW will be used for Bio-methanation. Dumping site at Kanjurmarg will have the facility for processing of 3000 tpd of MSW in the Bio-reactor and 1000 tpd for composting.

On Plastic Waste Collection and Disposal :

C. From Mr Subhash Patil -

(On recycling of Plastic waste found in MSW)
For the Dry wastes sorted out by rag pickers, collection centers are opened at 17 places in various wards of Mumbai. More will be opened depending upon the availability of space. Some of the prominent collection centers are- Near Cooper Hospital, Andheri, Opposite Telephone Exchange, Bandra and at Sindhi Colony, Chembur. These centers are being managed by NGOs such as Force Forum, Stree Mukti Sanghatana, NGOs pay the rag pickers at fixed rates for different types of dry wastes brought by them. NGOs sell the wastes to Scrap Dealers who in turn send the wastes to recyclers.

(On Reuse of Plastic waste found in MSW)
A few years back, the Solid Waste Department, the Road Department of MCGM, and Dr R Vasudevan, a Consultant from Madurai were roped in by the ICPE to make roads using shredded plastic segregated from the MSW. These trials were taken on Agashe Road, Dadar, Indian Express Lane, Lalbag, New Prabhadevi road, opposite the 'Samana' Press, etc. The Road Dept has a pre-mix plant at Worli (near Satyam – Shivam theatre) The above method is useful both to the Road Department in reducing the costs of bitumen spent and improving the life of the roads, and to the SW Department in reducing the quantity of the wastes to be handled by them. Pothole during monsoon can also be filled effectively by using hot bitumen mixed with shredded plastic.

(On solving problems created by plastic wastes)
The BMC has made several steps to tackle the problem –

"Advance Locality Management" scheme since 1996 to take care of the wastes from Housing Society Buildings. This is a non-funding scheme aimed at middle class localities.

" Dattak Vasti Yojana" scheme launched in 2001 was used extensively after 26th July 2005 to educate slum-dwellers on the problem of drains getting chocked by waste polythene bags thrown into the streets, and 90 % of the slums covered under this scheme are free from this problem in 2009. This scheme today has 518 Community Based Organizations formed of local residents and the BMC pays Rs 700 per 1000 population to these CBOs to maintain cleanliness in their area.. This scheme is more popular than the ALMs and is found more effective.
Jan-Jagruti Yojana was launched in the year 2008 against indiscriminate use of Plastic.

D. From Mr Anand Jagtap -

The menace of plastic waste can be contained if the recycling process is channeled properly, as is the case with sale and recycling of paper waste. Private persons have opened collection centres for paper and other types of dry wastes at every nook and corner in the city, and in many cases they collect the waste from house to house, paying money on the spot - same is not the case with plastic waste.

It is a "social" process.
In the unorganized plastic recycling industry, there is an established chain of persons / agencies of rag picker - "kantawala" - scrap dealer - plastic recycler –

manufacturer of goods from recycled plastic. Especially the rag pickers get credit / loan, from the kantawalas in times of need and in lean season such as monsoon when waste plastic collection is low.

"SEWA" in Gujarat is doing much better work in this field, in an organized way. Mahindra & Mahindra, Kandivali had sponsored a good network 2 years ago, of persons / agencies buying garbage once a week, separating the dry waste, ending it to the recyclers, etc but the good work stopped once the link in the chain broke. Some good schemes for waste recycling are in operation in Brazil, the Philippines, Kairo, etc

Date 26th September 09 :

Venue – Office of STEPS, Vasai
(M/s STEPS are engaged in development work for Refuse Derived Fuel for the past several years and have a pilot plant at Vasai for this purpose)

Persons met – M/s Raghavendra Rao (Director, STEPS)
Mr Nitin Bondal (Director, STEPS)
Information collected by- M/s Akash Rao, DJ Deshmukh, Ms Nrupura Bhagwat

M/s STEPS (Sustainable Technologies & Environmental Projects Pvt. Ltd.) are carrying out research work in the field of extracting oil from plastic wastes, be it coming from MSW, hospital, wrap-film packaging, or even domestic plastic / electronic goods. The waste is shredded and conveyed through a hopper into an extruder where it is melted. The vapours from the top of the extruder are passed through a catalyst and condensed into liquid which can be used as a fuel. The uncondensed gas can be burnt just as LPG, and the solid residue from the extruder can be used as fuel by converting into pellets or, simply as a garden soil enrichment agent. Thus the entire waste can be utilized 100 %.

M/s STEP have put up a pilot plant in Vasai and have developed a catalyst after years of work, and now they want to apply for patent.

Their work, Mr Raghavendra Rao said, is similar to that of Ms Zadgaonkars' in Nagpur, but developing the right kind of catalyst, is the key to make it a profitable business.

Date 29th September 09 :

Venue : A. Plastic Recycling Unit at Bhandup Complex for Trials of Plastic Recycling

Persons met – M/s Hanumanbhai (Proprietor of a Plastic Waste Recycling Unit SUN-SHINE PLASTICS)
Information collected by– M/s Akash Rao, DJ Deshmukh, Ms Nrupura Bhagwat

Plastic Waste similar to that found in MSW was brought from a Scrap dealer in Kurla. A horizontal "Zatak "machine (3 to 5 HP) was used to remove attached

dust, earthen waste from the plastic waste. This machine threw out from its side opening, each individual piece of the plastic waste after rigorously thrashing it inside to remove and collect at the bottom any attached dust / dirt; Washing and drying of the waste is therefore not necessary. The cleaned waste was put into a high speed "Aglo Mixer" (35 HP) which can accept all qualities of plastic for directly shredding and grinding the waste. This machine avoids the need to agglomerate the waste into a lump form. The ground waste was then fed into the extruder (25 HP) in hot condition to pass the waste through a set of heaters (10 to 12 HP) and mesh to convert it into round ribbons / wires which are further cut continuously to get plastic 'granules'

The whole process is carried out in minutes, is continuous and an 80 kg / hr extruder, working in 3 shifts can give an output of 1 tpd. These granules are then sold to recyclers, who convert the granules into useful articles such as sandals, shoes, carry bags, jerry cans, tarpaulin sheets etc. There are 110 machines in Bhandup alone, which are running to make soles for sandals. Straps are made elsewhere. The 60 to 65 kg capacity bags in which the waste plastics are brought cost Rs 8 to 10 each, are themselves used over and over again (7 to 8 times), until they get torn. They are then re-processed in a similar manner to get granules.

The mesh needs to be removed for cleaning from every 5 minutes to every 8 to 10 hrs, depending upon the impurities in the waste, and the cutter blades need to be sharpened after cutting about 7 to 8 tons of waste material. The investment for a 1 tpd plant comprising all the above machines, exhaust fan, lighting etc is about Rs 2 Lakhs. While the cheapest extruder costs Rs 1.5 lakhs, better quality machines cost from 10 to 15 Lakhs, but have lesser breakdowns, lower maintenance costs. Similarly, better the input (raw material), better the output, and better the selling price. There are about 77 different quality plastics and almost all can be recycled according to Mr Agarwal, who owns a few plastic recycling plants in Bhandup. A labour working in a plastic recycling plant may earn Rs 4000 per month. Total Processing Cost may come up to Rs 6 per kg of the Finished Product. Besides Mumbai, the granules are sent to recyclers in Kanpur, Indore, Chennai. Net profits can be from Rs 2 to Rs 6 per kg of granules from various qualities of the waste. **Prices of both Raw Materials and the Finished Product fluctuate widely depending upon demand – supply position, and the price of virgin materials which themselves depend upon international prices of crude oil.**

Prevailing prices of some of the raw materials and processing costs (both per kg) are –

Plastic waste from MSW bought directly from Dumping site – Rs 8 to Rs 10,
Above Plastic waste bought from Wholesale Scrap Dealer – Rs 13 to Rs 14,
Processing cost for the above material - Rs 6,
Waste, Multilayer with LD Polystyrene lined "Gutka" packs - Rs 8 to 10,
Pet Bottles – Rs 15 to 17,
Glucose bottles, Good Quality (imported) Packing Material (from Airlines, Ships) – Rs 55,
Shredding / cutting cost for the above - Rs 2 to 3,
Washing & Drying costs, including water, detergents & labour - Rs 3.5 to Rs 4,
Recovered Aluminium from waste plastics – Rs 70 to 80,
Granules from Aluminium lined Plastics – Rs 35 to 40.

Though unorganized, the plastic recycling industry provides enormous job opportunities to the rag picker, the Kantawala, the scrap dealer, the recycling machine manufacturer, the recyclers themselves, and the transporter. The buyers of recycled plastic goods are happy too because the goods are cheap. Meanwhile, manufacturers and consumers of goods made from virgin Plastic are happy too, as they can continue to manufacture & use the goods without worrying about the disposal of the plastic wastes. The Government too should .be happy because the problem of handling and disposal of the plastic waste is solved to a large extent. With plastic waste recycling, it is a win-win situation for all, and banning plastic is definitely *not* the solution. On the other hand, the Government can think of providing the recyclers the infrastructure and also if possible, incentives which are at present available to the organized industry.

See Exhibit : Video of the Trial

Venue : B. Plastic Recycling Unit at Bhandup Complex

Persons met – Mr Jadishbhai (Manufacturer of goods from Virgin & Recycled Plastic Granules) MrJagadishbhai, who makes plastic carry bags for Big Bazaar & other malls in Mumbai, also makes bags and other articles from granules obtained from recycled plastic, was interviewed. His emphasis was that the authorities should not ban Plastics, but should encourage recycling as it provides employment opportunities to many.

Venue : C. MSW Dumping Site at Mulund

Persons met – Mr Salim, Rag-picker, staying in one of the huts on the premises for several years and supporting his family in Karnataka. There is a heavy rush of vehicles bringing in MSW from various wards in Mumbai.

See : Interview of Mr Salim on Video.

Date 1st October 2009 :

Venue –Mukti Sanghatana (SMS) , Chembur
Persons visited – Mrs. Sunita Patil
Information collected by – Mr DJ Deshmukh, Ms Nrupura Bhagwat

Venue : A. SMS Office at Chembur

a. SMS is one of the NGOs, started about 10 years ago for the welfare of uneducated women whose husbands are not able to run the family responsibly. These women become rag-pickers and sell the wares to 'Kantawalas' (the dealers in recyclable items found in MSW) Though the rag-pickers get just enough money for their daily needs, it is not sufficient for fulfilling their social needs such as entertaining guests, marriages, and medicines hospitalization, etc. The Kantawalas help them by providing loans, but the interest rates are so high (25 to 30 %) that the women are not able to pay back the loan and fall under a debt trap. Their daughters are not able to continue their education, and are married off at an early age.

b. SMS has by now total member strength of about 2500 members in Mumbai (from Sion to Mulund in the Central & Harbour railway suburbs) nearly 500 in Thane and 250 in Navi Mumbai, all in groups of 10 to 11 each.

c. The MCGM launched the "Suvarna Jayanti Shahari Rojgar Yojana" (Golden Jubilee Co-operative Employment Scheme) in 1997 under which a "Bachat Gat"(small group of 10 to 11) formed by rag pickers who are encouraged to save and each group, after minimum 6 months of their coming into existence, is given a non-returnable loan of Rs 1000 / - in their Bank Account and other incentives in cash or kind to help them stand on their feet , educate their children, save money and get loans at nominal (2 %) rates of interest from their own bank account, etc. This scheme is implemented for the members by the MCGM through NGOs such as SMS, who work for social causes. [Two other NGOs working in this field are "AKAR" Mumbai (since last 3 to 4 years), and "FORCE" (since last 5 to 6 years)]

SMS has about 150 to 175 such groups attached to them (1500 to 1800 members, staying in areas adjacent to the dumping ground at Deonar, such as Govandi, Chembur and Ghatkopar)

Five Collection Centres for garbage (MSW) are opened by the MCGM under the Golden Jubilee Co-operative Employment Scheme at Colaba, Wadala, Chembur (East & West) and Mulund. One of them at Chembur (East) is run by SMS. ICPE does part of the funding (salary for the staff)

Rag pickers deposit the collected wastes at such centres or give the wastes to the tempos provided by the MCGM for sending to the Collection centres, and are paid at fixed rates which may vary from time to time or season to season (from Rs 4.50 to Rs 21 per kg – see attached sheet for the month of June 2009) depending upon the type quality of the waste. In Chembur (East) Collection centre, 21 women sell the wastes collected by them (50 to 60 Kg each) Recyclable wastes are sold to manufacturers and scrap dealers. Monthly report is sent to ICPE who does the monitoring. (See attached report showing quantities of Plastic and Non-Plastic wastes Collection by rag pickers from Ward Nos. A, T, F (North) M (E & W) & S and Payments made to them from Jan – Aug 2009)

In addition to giving them payment for the wastes, SMS gives the rag pickers nutritious snacks in the afternoon (no tea) , sometimes advance amounts, yearly bonus @ 4%, a 3 monthly health check-up and loans at 2 % rate of interest as mentioned above.

Apart from the rag pickers selling their wastes to these collection centers, many rag pickers choose to sell them on their own directly to scrap dealers because they are nearby and are known to them for long.

Since 2004, the MCGM has further helped deserving women by forming a 'Parisar Bhagini Vikas Sangh' and has 16 such and other 10 cooperative groups who are given the work of Cleaning, Gardening , Setting up Bio- Gas Plants in certain areas]

Mrs. Sunita Patil handed over two documents – one showing the rates offered in June 2009 to the rag-pickers for different items types of wastes found in MSW,

and the other showing the monthly quantity of Plastic waste obtained from the rag pickers in various areas (wards) of Mumbai from January to August 2009.

Venue : B. SMS Dry Wastes Collection Centre–Chembur (E)

a. This is one centre which is provided with a covered space by the MCGM.

b. 23 women working regularly for collection of the wastes on behalf of SMS, 2 women do the sorting and another 2 do the office work.
c. Collected wastes are brought by the women directly, or sent through the MCGM.- appointed tempos, in which case, the women come and collect their money from the centre.

d. Six different types of wastes are segregated and sold at the centre.
[shoes/ sandals(in sacks), Card-board / Paper, Glass, Aluminium Foil …..]

Scrap dealers / smaller Kantawalas come to the centre and take away the wastes in tempos.

See : Photographs & Video taken at the centre.

Other Social Organizations working for women in this area

1. The RBI employees Union independently helps by adopting about 250 to 300 school / college going girls in their education, training in nursing, etc.

2. L & T runs a free of cost Health Camp and OPD at Govandi daily for 2 hrs;

3. BARC has given training in gardening, composting, etc to about 700 to 800 women.

Date 5th October 2009 :

Venue– ICPE, Olympus House, Raghunath Dadaji Street, Fort, Mumbai

Person visited – Mr T K Bandopadhyay (Sr Technical manager)
Information collected by – Mr DJ Deshmukh, Ms Nrupura Bhagwat

A. On the Use of Plastics :

Use of Plastics is maximum in the Developed Countries – up to 80 Kg / person / year. Corresponding figures (per person per year) as per statistics available for 2007 are - World average – 22 to 25 Kg , China – 30 Kg, India – 6 Kg

B. On Disposal of MSW in a Cement Manufacturing Kiln :

ICPE had organized the trial of MSW in Cement Kiln at Katni plant of ACC Ltd. Laboratory tests charges & Collection and Transportation costs were paid for by the ICPE. No particular restrictions on the quality of the MSW by ACC; however, PVC to be avoided, (though there is no danger of dioxins formation at the high temperature occurring in the kiln,) the quantity of PVC in the waste

should the kept at the minimum un-avoidable as Chlorine in PVC is corrosive (and the kiln lining may be affected). Nearly 200 Tes of the waste was transported from Mumbai for the trial. The waste was packed in suitably sized, water tight polyethylene bags (not woven, which might leak out liquids in the unhygienic waste and harm the workmen loading the bags on the 350-400 mm wide conveyor for charging into the kiln. Preferably bags made from recycled plastic should be used)

30 to 40 Tes of the waste was used in the one-day trial.
As most of the 200-odd Cement Plats in India are located away from the metros, where the generation of the MSW is high (and similar quantities of MSW are not available in smaller cities nearby), cost of transportation of the wastes to the cement manufacturing kilns will be high. Also, there is the difficulty of segregating the right quality of the waste, testing and packing it in smaller bags in the metros, where sufficient space is not available and the labour is more expensive, versus the problem of spillage of the wastes during transit if transported unpacked. Finding another use for / disposal of the wastes not found suitable for use in the kilns in the latter case, is another difficulty. Permissions from the Pollution Control Boards for the transport of the waste from one State to another is time-consuming under the present laws.

C. On Plastic Wastes in the construction of tar roads:

ICPE was involved in the above trials taken in various areas of Mumbai, along with MCGM's Solid Wastes Department, Road Department and the Consultant Dr R Vasudevan from Madurai. Although it is claimed that up to 15 % of the weight of bitumen can be replaced by the plastic waste for construction of tar roads, in actual practice, only 12 to 13 % can be used since the nylon present in the laminated plastics found in the MSW has a melting point of 250 deg C as against 170 to 180 deg C of bitumen. If the nylon does not melt, it may show up as an aberration on the road surface.

E. On Disposal of Plastic waste by converting it into fuel :

The experiments carried out by Mrs. Zadgaonkar are noteworthy. The process requires large quantities of Plastic wastes, which are difficult to obtain on regular basis. The price one has to pay for the plastic waste today is not competitive if one has to produce fuel for commercial use (such as in vehicles)

F. On Recycling of Plastic waste :

Ban on the use of plastics is not the solution to the problem of plastic waste.

The principle of three Rs – Reduce, Reuse, Recycle is best applicable to plastics. Recycling of Plastic waste is (economically) always better than its disposal.

Segregation (of Plastics from other wastes) is a must for recycling. It is best if the Plastic, along with the other dry waste is segregated at source. BIS Standards, (made as per the Burman committee recommendation) should be followed by the recyclers. Facilities, such as Common Effluent Treatment Plant

should be created for recyclers. Incentives such as Tax exemptions should be given to the plastic recycling industry to lure big businessmen / investors into the business. ICPE has used boards made from recycled multi-layer laminated plastic (hence water-proof) which is made in Navi-Mumbai, in their office in place of Ply-wood. The material is heavier, and its cost is equivalent to that of water-proof quality Plywood. Thus recycling of plastics can save precious wood and is therefore eco-friendly.

Mr Bandopadhyay handed out leaflets on each of the above methods of recycling / disposal of Plastic wastes, and a CD on the experiment done by ICPE in the construction of road using granules made from Plastic waste.

13. FINDING A PRACTICALLY FEASIBLE AND ECONOMICALLY VIABLE SOLUTION TO THE PROBLEM OF DISPOSAL OF PLASTIC WASTE

From the foregoing, it will be seen that -

1. There is a good law for Management and Handling of Municipal Solid Waste.
2. There are good laws and Standards fro the Recycling of Plastics.
3. Technologies are available for handling of the MSW & the Plastic Wastes.
4. There are people who are willing to do the work.
5. Finances can now be made available from various sources, especially from the Centre

An analysis of the number of reasons given out by the authorities for poor implementation of the laws regarding MSW and the Plastic Waste mentioned earlier in this report, will show that they fall in the following broad categories –

1. Lack of public awareness, education, discipline and motivation.
2. Lack of systems for segregation of wastes at source and their collection
3. Lack of suitable land in the municipal area for dumping the waste
4. Lack of (awareness of) proper technology and availability of trained people
5. Lack of Finance
6. Lack of will and inadequate manpower in the Municipalities & the PCBs

The ONE most important and common sense matter that stands out very clearly from the matter presented so far in this report is that for a good SWM, *SEGRAGATION AT SOURCE* is a much desired starting point.

Indeed, segregation of waste at source into Dry and Wet wastes is the best and most economical option, as it will lead to reduction in total costs, because -
1. The quality of civic life will improve, with no garbage getting onto the streets causing filth and health problems as happened in Surat in 1994.
2. The cost of keeping the city clean by sweeping etc., will go down.
3. The quantum of the wet waste going to dumping grounds will come down resulting in savings in transportation costs.
4. The wet waste treatment processes of vermi-composting, bio-methanation, etc., will become entirely feasible, economical and even profitable when done on large scale.
5. The disposal costs will go down as the quantity of waste for disposal will be reduced drastically.
6. The quality of material available for reuse and recycling will also be better and the recycling costs will also go down with improvement in quality of goods produced.

One of the first recommendations of this report is that efforts for ensuring *SEGRAGATION AT SOURCE* should be given top priority by the Municipality.

1. Segregation should be made applicable to all household waste, waste from hotels, slaughter houses, shops, offices and commercial establishments, et al.

2. Segregated waste from each of the above should be taken to either Dumping Ground (Wet waste) or to a Collection Centre established by the Municipality in each of the wards of the city (Dry waste)

3. Silt and Debris would not normally need segregation and can be taken directly to the Dumping Site.

SEGRAGATION AT SOURCE of household waste generation into DRY (recyclable) and WET (compostable) waste will result in the following advantages –

For the Wet Wastes –

1. The land required for dumping will be reduced to 60 % (i.e., for Wet waste only)
2. Transportation costs will be reduced (for transportation of Wet waste and Debris & Silt)
3. Littering on the streets and multiple handling of the waste will be avoided.
4. Debris and Silt can be utilized for the building of Scientifically designed dumping pits.
5. The processing of the Wet waste will be qualitatively much better.
6. Energy recovery leading to economic benefits will be derived from the processed wet waste.

For the Dry Wastes –

1. It will be much easier to segregate each component of the dry waste for recycling.
2. Separate components from the waste can be sent to separate areas for processing.
3. Transportation costs will be reduced.

Thus, processing of both Wet and Dry wastes will be easier, cleaner, and economical.

It must be noted that complete segregation at source and separate transportation is a must. All the benefits of segregation will be lost if the segregated wastes were to get mixed again at any point afterwards. Hence they must be collected and transported separately.

It is to be expected that it complete (100 %) segregation may not happen at source until people get used to it, but the quantum of one waste in the other will be much less than it is now, and some segregation will probably be necessary at the end point. This can probably be managed without much difficulty.

As mentioned earlier in Chapter VI, technologies available for recycling / disposal of Waste Plastics are:
1. Recycling, consisting of making Plastic Granules to be moulded into goods thereafter.
2. In the Construction of Tar roads.
3. Conversion into Petroleum (Refuse Derived fuel, or RDF)
4. Disposal in Cement Manufacturing Kilns.
5. Disposal in Blast furnaces
6. Energy Recovery and /or Generation of Power in Incinerators
7. Plasma Pyrolysis in which the waste is broken down into the basic elements
8. Disintegrating plastics by processing into the basic Chemicals which are harmless.
9. Disposing off the waste by using some bacteria.

Segregation of the wastes is much desirable if not a must, for most of the above technologies to be effective and efficient.

Segregation of wastes at source however is not being practiced in India.

There are pockets in Mumbai, Thane and Pune, where segregation at source is gaining ground, and people are experiencing the benefits of cleaner surroundings.

Segregation of wastes at source therefore must be given top priority by the MCGM and other Municipalities in Maharashtra.

This can best be done by giving wide publicity to the benefits obtained by the citizens, educating the school going children and increasing awareness in public by distributing leaflets, giving wide and continued publicity through the print and electronic media, holding demonstrations, providing facilities, land, incentives and awards etc, in areas across the cities.

Involvement of the people, NGOs and the Municipal workmen and authorities at all levels is a must, as shown by numerous examples in Mumbai.

A workable system of imposing fines to the errant must also be put in place.

Finally, all efforts would be lost if the system for collection of the waste and its final disposal is also not good enough to ensure that the segregated Dry & Wet wastes do not get mixed again.

Until the time the system of segregation of waste at source becomes an accepted part of life of its citizens, the MCGM and other Municipalities must continue to use other options for disposal of the wastes, including the management of the recyclable waste.

These technology options for waste plastic are discussed below:

1. Disposal by Plasma Pyrolysis is perhaps the best option, as it reduces the quantity of the waste to almost nothing; however, it is the costliest and energy intensive process, still not fully developed to make it economically viable, hence not possible to implement for waste disposal in India.

2. Even if un-segregated, MSW can be burnt in Incinerators for Energy Recovery and / or Generation of Power, if it has a good calorific Value. Incineration of the MSW as practiced in the developed countries can not still be an option in India because –

A. Per capita consumption of Plastics is much lower in India compared to the developed countries. The percentage of Plastic in the MSW, and therefore its Calorific value is therefore lower in India, making incineration impossible without using auxiliary fuel.
B. Most of the Plastic in the MSW is already taken out by rag pickers in India before it is collected by the municipalities from the streets and even after it reaches the Dumping grounds.
C. Incinerators are Capital Intensive, require large space and the process is fraught with many other safety health and environment related problems. For these reasons incinerators have to be located away from the city. Although the percentage of waste is brought down considerably, making scientific dumping more economical, the running and transportation costs are high and transportation of the entire waste to a centralized facility for incineration creates avoidable pollution in the city.

3. Disposal in Blast Furnaces has not been tried in India yet. Use of waste Plastic, having Hydrogen and Carbon along with coal as reducing agent to manufacture pig iron in Blast Furnaces , has the obvious benefit of reduction in quantity of Coal, leading further to availing of Carbon Credits. Steel manufacturing companies in Germany and Japan are using this technology.

4. Disposal of a limited quantity (1.5 to 2 %) of the Raw Material used for Cement Manufacturing) Plastic waste in Cement Manufacturing Kilns has been first tried by ACC in the year 2008. The experiment was highly successful, making the CPCB to recommend the use of this technology for disposal of Waste Plastic in Cement Manufacturing plants throughout India.

This technology, described in detail in other part of this report, has an advantage that the waste gets completely and permanently locked into cement, which itself is used in Civil Engineering Constructions lasting for decades.
However, problems associated with use of this technology on a wider scale are –
i. Some sort of segregation is envisaged.
ii. Each lot will need to be tested for minimum quality requirements prescribed by the Industry to maintain quality of cement being produced. It may be difficult to maintain the quality of the waste every time for a long time.
iii. The waste needs to be collected and packed into small bags for charging into the kilns. This will increase the cost of collection of the waste.
iv. Most of the cement Plants in India are old, and do not have the necessary arrangement (conveyor belts, openings in the kilns) for charging of the waste. Some modifications may be necessary, or new cement plants will have to be built with provision for the waste charging.
v. Cement plants in India are located far away from the Metros and cities, making the transportation costs prohibitive.
vi The Cement company may charge the supplier for the waste, if the waste does not have a minimum Calorific Value prescribed by some as a requirement of the waste quality, along with some other requirements, which the supplier may not be in apposition to control such as the moisture content, Chlorine and Sulphur, presence of metal / hazardous substances. In other words, the waste may have to

be segregated to conform to the requirements of the Cement company, making it an uneconomical option.
vii The effect of PVC if as a constituent of the waste in the formation of Dioxins and Furans is yet to be established in India, but according to ACC, the waste is charged and processed at such a high temperature, that there is no possibility of the carcinogenic gases being produced.

Disposal of Waste in any case, by any technology should be undertaken only if reuse and recycling is not possible.

The waste at dumping grounds therefore can be used for this purpose, as most of the recyclable waste in the MSW would have been removed by the rag pickers before and as it comes into the dumping Ground.

The activity of carrying out the segregation of the waste suitable for use in Cement manufacturing kilns, its testing and subsequent packing into small bags can be carried out by the Municipality with own persons if possible or it can be outsourced by inviting tenders.

For the MCGM, the nearest plant of ACC being in Chandrapur, sending the waste to other manufacturers having cement manufacturing plants nearby Mumbai, would be the better option as it will mean lesser transportation costs. If such a plant is located in Gujarat nearby, the permission for inter-state transfer of the waste will have to be given.

From the foregoing, this option appears to be expensive. However efforts can be made by the MCGM to explore the possibility.

This leaves us with the next three technology options.

The technology for conversion of the waste plastic into petroleum products by heating the waste in presence of a catalyst to not a very high temperature of 450 degrees C, appears promising, but it is in experimental stage and will take some time to be established both as a technical and economical option on large scale.

There are no recyclers in India who have big plants to use this technology except two or three. The machines available are right now for Industry and they are costly. There have already been proposals made to the finance ministry for excise duty exemption on waste management technologies.

The use of waste plastic for making of bitumen roads has been proven beyond doubt. It can very well be used by the Municipalities; however, it entails conversion of the waste into granules, and the municipalities will have to enter into contracts with private players, of which are not many in this field. However, a beginning has been made in several areas in Mumbai, and contracts for this activity of supplying and utilizing recycled plastic along with the Road department should be given by the MCGM. Initiative is all that is required on part of the MCGM to make this a success story.

The last option of recycling the waste plastic, by converting the waste into Plastic Granules to be processed for making of moulded goods thereafter, is the most preferred option. The reasons are –
1. It is already being done in a big way in Mumbai, partly with MCGM's help.

2. It provides employment opportunities to all sections of the society.
3. Technology required is simple and already proven.
4. It will reduce the dumping costs, as plastic wastes would have been removed
5. It will help better processing of the wet wastes at the dumping grounds.
6. If done in an organized manner to utilize its full potential, it will lead to better living conditions in the city.

It is to be noted that newspapers and magazines (i.e., paper waste) hardly finds its way into the streets. This is because each household is able to sell the waste to "raddiwalas" of whom there are plenty, and though the price obtained is not very lucrative, there is a satisfaction among the members of the public that something has been received from the waste. Similar situation would prevail if the people are able to get some returns from the plastic waste. This would happen if the Municipalities encourage segregation at source, and the Recyclers are able to pay the rag pickers a reasonably good amount for their efforts. This in turn, is possible only if the recyclers are able to do their business

Efforts must be made by the MCGM to use this tool in improving its own functioning.

In addition to expanding the good work already being done with the cooperation of ALM and the NGOs, MCGM must find out ways to involve the recyclers or at least help them in the following manner :

1. Provide areas for setting up their business in each of the three divisions of the city, or in the MIDC areas inside or just outside of the city (in the MMRDA region) to set up their business preferably as a cluster.
2. Provide Electricity, Water and Common waste treatment facilities if not available.
3. Make it easier for them to obtain Recycler's license by using a single window concept.
4. Provide incentives such as tax concessions, extra facilities for their employees, etc.
5. Provide help from the Central and State Governments in matters of Excise, Tax, etc.
6. Make the business more lucrative and clean so as to attract bigger industrialists to the business.

LET US REMEMBER THAT MUMBAI CANNOT HOPE TO BECOME A WORLD CLASS CITY UNLESS THE PROBLEM OF DISPOSAL OF THE MUNICIPAL SOLID WASTES INCLUDING THE PLASTIC WASTES IS SUCCESSFULLY DEALT WITH.

14. ANNEXURES

ANNEXURE A.

"Integrated Solid Waste Management Programme for Mumbai and similar fast growing cities "

[43]Save Bombay Committee

Save Bombay Committee (SBC) has since 1973 been taking up issues of social and environmental concern and developing with active citizen participation practical and sustainable solutions.

SBC has been instrumental in trying to give suggestions and programs in cleaning the filth and stink created due to the ever increasing quantities of the MSW in Mumbai with an area of 434 sq. km., and an ever exploding population.

In 1994, SBC in collaboration with leading environmental and consumer groups took up an in-depth study of the issue of solid waste management and in 1996, came out with their Integrated Solid Waste Management Programme (ISWMP), a unique, logical, concrete and sustainable solution for cleaning Mumbai and similar, fast growing metros and cities in India and even abroad.
The ISWMP, based on citizen perceptions and civic demands, suggests the "cradle to grave" approach and the 3R principle of Reduce, Reuse and Recycle and takes into account the ecological and economical aspects.

The ISWMP provides an opportunity for live partnership between the government and the people. The SBC worked out models of partnerships between the authority and citizens and helped the Municipal Corporation of Greater Mumbai (MCGM) as a consultant for three years in finalising work plans for creating and sustaining partnerships involving citizens in improving conditions in their areas. The MCGM designated the partnerships as Advanced Locality Management (ALM). The Government of India has laid down norms for handling Municipal waste, medical waste, and toxic industrial waste on the basis of ISWMP.

Materials and Methods suggested by the ISWMP

Mumbai, with a population of 16 million inhabiting in an area of around 434 square km, generates 12000 tons plus of solid waste a day. MCGM statutorily obligated to abate nuisance and pollution within its boundary is required to handle solid waste generated daily to maintain minimum level of public health in this city with a population density of 27,000 persons per square km, the highest in the world for any human settlement.

[43]Integrated Solid Waste Management Programme – A sustained and perennial solution
PRIYA SALVI, KISAN MEHTA AND DILIP SANKARREDDY, Save Bombay Committee, India

The Solid Waste Management Department of the MCGM lifts the waste from crowded habitats and hauls to four dumping grounds, two of which have recently been closed. Incidence of cardio-vascular disease is very high in areas up to 2 km radius of the dumping yards. About 25% of Mumbai's residents stay in slums around this area. About 3.5 billion INR, which is about 15% of the MCGM's annual revenue income, is spent on the operations of the Solid Waste Management (SWM) Department.

The SBC study showed that Mumbai's solid waste comprises predominantly of 3 components: biodegradable organic or wet waste, recyclable or dry waste and rejected building materials or inert waste in the ratio of 55:10:35 respectively. Every component needs entirely different and component specific treatment to create "zero garbage" condition. The debris is generated not on a day-to-day basis and therefore its management is not a problem for residents.

The ISWMP recommends segregation of waste on the basis of three major components at the point of generation to be taken up by the generator. The recyclable component is further segregated in paper, plastic, rags, glass etc. The emphasis in the ISWMP is on treating each and every component of the solid waste while leaving nothing as discards. The ISWMP recommends treating each and every component of this solid waste especially the wet and the dry component so that it is brought back for reuse directly or after recycling by the community.

Organic waste can be returned to the soil as soil conditioner/ manure through vermi-culture.

Practically every item of dry or recyclable component can be brought back to reuse directly or after recycling. Instead of throwing away as waste, the dry component originally made from finite natural resources creating serious environmental pollution, it can be diverted to the market for reuse. Every society has a substantial population of rag pickers, Rag pickers the poorest of the poor in the community form about 3% of Mumbai's population and are always on hunt for activities that can provide food for sustenance. They pick up the dry components from the waste bins and dumping yards. Residents can actually hand over segregated dry components directly to rag pickers for diverting to the market for recycling.

Rejected building material, the third major component, is inert. Municipal bodies can deposit it in a designated site to create a hill in 10 to 25 years to be covered with soil conditioner retrieved from wet waste. This hillock can then be landscaped with greenery to create for the community a loveable picnic spot in the otherwise monotonous city.

Employment opportunities provided by the ISWMP to the lowest strata of the society

Most of the rag-pickers in cities are developing world are migrants from rural areas. They face two challenges: surviving poverty and living with respectability. Working independently, they do not gain the respectability they deserve. Many view them with suspicion. Often, they scavenge for recyclable waste in Municipal dumps. But becoming part of ISWMP gives them a sense of

identity as they can now collect wastes from individual households. This sense of respectability is a major incentive for the rag-pickers to participate in ISWMP.

Results and Discussions on the ISWMP

The SBC presented the ISWMP to the MCGM and residents simultaneously. The Municipal Commissioner announced in public that the MCGM would implement the ISWMP in stages with resident support. Residents saw in the ISWMP an opportunity to bring about cleanliness in their neighbourhoods. They formed resident associations to set up neighbourhood vermi culture facilities. Rag pickers readily helped residents in managing their own waste within their premises and got in return recyclable component of waste from residents. Recyclable waste was diverted to market for reuse and recycling.

The MCGM set up vermi culture facilities within the dumping grounds with the help of rag pickers to handle waste from bulk generators like markets places and similar such sources.

For the first time, a hope that solid waste can be managed environmentally was generated amongst the residents. The SBC approached the State of Maharashtra, of which Mumbai is the capital and the Central Government to direct all municipalities to devise waste management practices on the lines recommended in the ISWMP. The Central Government laid down norms for managing solid waste on environmentally acceptable lines. Municipalities are slowly discarding their erstwhile practices of dumping waste to sustainable practices. Leading industries and large business houses are taking up the ISWMP for handling their waste.

Conclusion

In a nutshell the ISWMP ensures the following benefits:

- Reduction in the quantum of waste
- Creation of jobs for the poorest of the poor
- Creation of zero waste condition in communities through 100% reutilization of the “waste”
- Conservation of finite natural resources
- Protection of environment
- Sustained clean surroundings
- Improvement in the quality of life through better health conditions

ANNEXURE B.

"New Practices of Waste Management, Mumbai"

[44]School of Planning, CEPT University, Ahmedabad

In their aforesaid project undertaken by three students of the School of Planning in the year 2005, some important issues were dealt with in detail -

The report throws light upon the conditions obtaining in Mumbai with regard to SWM and the system in operation, which is valid with little changes even today. Some issues are presented below, along with relevant data from the project report:

Background

Mumbai is the largest metropolis of India, with a population of 16.37 million in 2001 within its urban agglomeration area (Mumbai Urban Agglomeration – MUA). In the Municipal Corporation of Greater Mumbai (MCGM - or in the Marathi form, Brihanmumbai Mahanagar Palika, or BMC) area, the population was 11.92 millions in 2001. Mumbai is the capital of Maharashtra State and the financial capital of the country. MCGM area is divided into two major geographic divisions. One is the island city, which is a strip of 24 sq km and the other is the suburban area, north of the island city. Mahim creek separates the two, a creek that is getting gradually filled up because of indiscriminate land developments by the builders as well as planning agencies. River Mithi running north-south in the suburbs is discharging its waters in this creek, whose path has been also blocked by such development activities. The island city and suburbs together form the Greater Mumbai (or Brihan Mumbai) with an area of 437.71 sq km. The islands are in the form of a peninsula with the former Central Business District (CBD) at the southern extremity. The new CBD, the Bandra-Kurla complex is at the centre of the city, just north of the Mahim creek on the land developed through reclamation by Mumbai Metropolitan Regional Development Authority (MMRDA). Greater Mumbai is considered as one district and has been divided into six zones and 24 wards to facilitate the administration of the Municipal Corporation. Each of the wards has a ward committee through which ward level development activities and maintenance of the facilities is carried out. Ward level budgets are also available in the city (Mukhopadhyay 2005). The SWM is a ward level activity, undertaken through the ward office.

Historically, the city district has one of the highest concentrations of people in the country, its densities as high as 46,000 persons per km2 in Mumbai and 20,000 persons per sq km in suburban Mumbai (SWM Dept. 2004). This can be comparable to that of Kolkata, which is 24,760 persons per sq km, but much higher than that of New Delhi (4,909 persons per sq km) and that of Bangalore (2,979 persons per sq km) (Based on population census, 2001). It is commonly

[44] SP Working Paper Series Working Paper No. 35 December 2005
New Practices of Waste Management - Case of Mumbai

stated that more than half of the Mumbai's population lives in slums. The population density in some of the slum enclaves can reach as high as 400,000 persons per sq km (Mumbai pages, 1997). The slums are considered as vulnerable settlements because of their location. Under the Mumbai Municipal Corporation Act of 1988, it is the mandatory duty of the Corporation to maintain the area falling under its jurisdiction in clean and hygienic conditions in order to ensure a good and healthy environment.

Following are the obligatory duties of the Municipal Corporation under section 61 (A), 61(C) and 61 (N) of the Mumbai Municipal Corporation Act of 1988:

- Cleaning of public streets
- Collection of solid wastes including temporary storage
- Removal and transportation of solid wastes
- Disposal of solid wastes
- Disposal of dead bodies of animals
- Construction, maintenance and cleansing of urinals and public sanitary conveniences.

The Municipal Solid Waste Rules, 2000 framed by the Government of India (GoI) makes it mandatory for the storage of garbage at the source and its synchronized collection at the doorstep. The MCGM has already declared the segregation and storage of garbage at source mandatory. The per capita generation of wastes in Mumbai is about 630 gm. per person per day (MCGM 2004). The quantity of municipal solid waste generated within Greater Mumbai is 7,800 MT per day5. There is higher share of the island city in the total garbage generated than its proportionate share in total population because, the island city, being major employment centre, gets a large proportion of floating population, in the day time. The solid waste is in the form of regular garbage from households, debris, silt removed from the drains, *nallas*, cow dung and waste matter removed from gullies between the houses.

On the whole, 4,500 MT (57.68 per cent) of waste in the whole of the city is biodegradable in nature; another 500 MT (6.41 per cent) is the dry waste consisting of paper and cardboards, plastics, metals, glass, etc. another 2,500 MT (32 per cent) is the debris and silt and 25 MT is biomedical waste (MCGM 2004).

Chapter 14 -Table 1: Garbage Generation by Geographic Locations, Mumbai

Division Garbage Generation#	Density (persons per sq km)*	Population (%)		MT per day %	Garbage Density (MT/ sq.Km)
Island City	49,163	27.92	3700	48	53.85
Western Suburbs	24,605	42.77	2500	32	12.07
Eastern Suburbs	10,410	29.31	1600	20	10.17
Total	` 26,722	100	7800	100	16.8

Source: TERI data as in MCGM website: http://www.demographia.com/db-mumbaiward91.htm

Chapter 14 - Table 2 : Physical Characteristics of MSW by Region (% weight)

Category	Island City	Eastern Suburb	Western Suburb
Biodegradable	42.29	35.72	39.52
Paper and cardboard	6.16	10.93	6.61
Plastics	4.23	4.87	5.47
Metals (ferrous)	0.85	0.65	1.42
Glass	1.28	0.87	3.48
Sand and fine earth (Inert)	18.09	26.76	23.46
Bio resistant	4.15	11.81	11.07
Others	23	20.25	20.04

Source: Modi et al (2002: 35).

A part of the recyclable waste generated, is sold by the households themselves and part of it is picked up by the rag-pickers and waste-pickers to earn their own living.

Chapter 14 -Table 3 : Constituents of Recyclable Wastes at Source & Disposal Sites

Zone	Paper		Plastics		Glass	
Source	Source	DS	Source	DS	Source	DS
Island City	6.16	5.38	4.23	4.1	1.48	1.3
Eastern Suburb	10.93	7.08	4.87	3.54	2.07	1.02
Western Suburb	6.61	3.98	5.47	3.85	4.23	3.64

Source: SWM Department, MCGM (1994).

Present Waste Management System

Street Sweeping and Collection of Wastes

In Mumbai, there is manual sweeping of all the public roads on a day-to-day basis. In selected areas such as the arterial roads and the main station roads, sweeping is carried out during the night hours. The total length of streets in Mumbai is 1,800 km. To successfully cover the entire length, the area is divided into 'beats'. The beat area is about 4,000-5,000 sq. m. for the city area and 8,000-10,000 sq. m. for the suburban areas. A pair of sweepers is assigned a single beat. The activity is carried out from 6:30 a.m. to 1:30 p.m. The pair uses one handcart and 2 containers and brooms. There are around 4,200 beats for entire Greater Mumbai and about 8,400 staff for this activity alone. Wastes thus collected are deposited in nearby community dustbin containers, which are provided by the MCGM. A very high volume of floating population and daily commuters, with almost 65 lakh people travelling daily is a cause for road littering (Jain 2004). In many areas of the city, streets are in ill-maintained

conditions due to lack of timely street sweeping and there is clogging of surface water drains due to solid waste dumped into it. The percentage of roads cleaned 6 days a week is 77 per cent and only major roads are cleaned 7 days a week (SWM Cell 2003). The problem in Mumbai is further aggravated due to a high density and large proportion of slum population. The slum and pavement dwellers do not have access to proper services and hence dispose their waste in the public spaces like roads, drains or railway tracks. Hawkers contribute to littering of roads.

Collection and Temporary Storage of Solid Waste

In view of the MSW Rules of 2004, the MCGM has issued notices u/s 368 of MMC Act. The notice talks about public awareness programmes for understanding the importance of waste segregation at source. For effective implementation, MCGM has also proposed to charge fines. It has also proposed to propagate the concept of "Advance Locality Management" (ALM) scheme, which is at present being implemented by a population of 3.27 million throughout the city (Jain 2004). We would discuss the ALM scheme in details later on. The MCGM, from time to time, carries out campaigns through newspapers, instructing the citizens/ institutions to collect their own garbage and store the same in bins to be kept at the gates from where the municipal vehicles would pick them up mechanically at specified time. The citizens and the institutions are also instructed that the municipal authorities would not enter individual premises for the purpose of garbage collection and lifting. The municipal authorities have also notified the citizens that the dry and wet waste has to be stored separately, and that the wet waste would be collected daily and the dry waste would be collected once or twice a week, depending on the amount generated. Composting of wet waste on the premises would be encouraged under the ALM scheme.

Disposal of Municipal Solid Wastes

Disposal through Dumping

With increasing urbanization, land available for dumping and creation of landfill sites for disposal of waste is becoming unavailable. There are only 4 landfill sites in the MCGM area, whose expected lifespan remains only 5 years. The Corporation disposes waste through landfill or land dumping method. At present there are 4 dumping sites in operation. (Chincholi Dumping site has since been closed) Waste is brought here from various locations throughout the city as well as from the TSs at Mahalaxmi and Kurla. Refuse and debris are levelled at these sites by means of bulldozers and landfill compactors. The land filling carried out here is open dump tipping.

Increasing population of the city has forced people to settle near the dumping grounds. Densely inhabited areas now surround the landfill sites. This has led to a situation where the residents have starting making complaints of environmental pollution caused due to burning of garbage and foul odour.

Chapter 14 -Table 4 : Amount of Waste Disposed at Dumping Sites

	Location Area (hectares)	Quantity of MSW received (Maximum) (TPD)
Deonar	111	6,826
Mulund	25.3	598
Gorai	14.5	2,200
Total	**150.8**	**9,624**

Source: MCGM, Dec. 2004

Land being scarce in Mumbai, the Corporation is looking for means for disposal of garbage through manufacture of organic manure and electric power. The various methods adopted for the disposal of municipal solid wastes in Mumbai are composting, biomethanation of wet garbage, vermi-composting and recycling of dry waste, done by rag pickers. These methods are being now adopted by a number of decentralized units under various organizations working in coordination with MCGM, thus forming an effective public private partnership.

Two more landfill sites have been proposed: at Kanjurmarg of 82 Ha and at Mulund of 40 Ha (SWM Cell, AIILSG, 2003). Of all the four waste disposal sites, Deonar receives 70 per cent of the total waste generated (Table 4), as this is the largest of all the three dumping sites with an area of 111 ha. All the dumping grounds are nearly 30-40 km north of South Mumbai, which is generating 48 per cent of the total waste of the city. As a result, transportation costs of waste are quite high. These sites need to be upgraded and the waste appropriately treated as it has been estimated that they will last for only another 5 years (SWM Cell, AIILSG 2004).

Recycled Waste in the Informal Sector

As in all Indian Cities, even in Mumbai, there are door-to-door waste collectors, street and dumpsite rag pickers, the middlemen or the roaming waste dealers and the waste recycling workers involved in recycling part of the solid waste generated. But, a significant part of this waste is disposed off for recycling at the household level itself. This recycling material reaches the middlemen involved in the recycling trade from where it reaches the processing and manufacturing units - small to large-scale. Middlemen accept every type of waste as long as it has market value in the waste recycling sector. Those employed in collection of such recycling materials are uneducated and unskilled labour (Modi et al 2002). Those engaged in particularly rag picking and sorting of waste at the garbage collection points are the most unskilled and the poorest and many among them are women and children. A survey of 2000 women conducted by Stree Mukti Sangathan (SMS), an organisation that has organised and trained the rag picker women, in 1998, found that, in Mumbai, rag picking is a caste and gender based activity, with 85 per cent of them being women, 5 per cent being children and 10 per cent being men, and most of them were from dalit landless labour families coming from drought-prone areas of Maharashtra. The age groups of rag-picking women vary from 7 years to 70 years. They are forced into rag picking

because of their poverty, illiteracy (98% being illiterate) and because they have no alternative skills. Rag pickers suffer serious health hazards resulting from unhygienic work conditions. They carry heavy loads and have no form of transportation. Rag pickers are unaware of their rights as citizens; hence the society as well as the middlemen in garbage management take advantage of their helplessness and exploit them, further de-generating their position.

According to MCGM, there are about 50,000 to 60,000 street and dump site rag pickers in Mumbai city, of which 60 per cent are women, 20 per cent are men and 20 per cent are children (Modi et al 2002). Further, door-to-door waste collectors and recycling workers total 80,000 to 100,000 in the whole city (Modi et al 2002). Therefore, there is already a large section of workforce in the entire recycling sector in Mumbai, part of whom could be trained to collect SWM. This is what SMS has done, as we would see later on.

Issues in Solid Waste Management in Mumbai

New Efforts in Waste Management

Looking into the drawbacks relating to the solid waste management that the city is facing at present and also anticipating the future problems, local NGOs along with the MCGM have taken up certain new initiatives in order to control the waste management problem.

Three new initiatives
(i) The Advance Locality Management,
(ii) The Slum Adoption Programme
(iii) The Parisar Vikas programme by the Stree Mukti Sanghatana (SMS)
are discussed in this article.

Advanced Locality Management (ALM)Programme

Scale of project

The scheme started in July 1997 with only one locality as its participant. Later the number of societies registered in ALM scheme crossed 1000 (Modi et al 2002). Presently there are almost 375 societies (Jain 2000) registered in different areas in Mumbai catering to 3.27 million population. But, according to another source (Table 7), there are 578 ALMs in the whole cityThe main target of the ALM system is the individual households and most of these are middle to high income households.

Institutional Framework

The ALM scheme began to spread and as its success was being felt by the MCGM, the MCGM appointed an Officer on Special Duty (OSD) for the purpose of educating people and creating awareness about the scheme. The OSD coordinated with the overall performance of the ALMs which was reviewed by the Additional Municipal Commissioner. Various NGOs who were already involved in work relating to local governance and groups of senior citizens involved in civic issues became a part of the ALM process. With the involvement of NGOs, Corporates also joined the process. The role of rag

pickers in the overall solid waste management in keeping the city clean emerged as a result of ALM movement and hence MCGM took a decision to support the activities of rag pickers by providing them with sheds, vehicles for dry transportation, open spaces and also helped them in linking with ALM and Co-operatives Housing, Corporate and Ward Office. The rag pickers were involved in the collection of dry recyclable waste directly from individual houses. MCGM started supporting NGOs like Stree Mukti Sangathana (SMS), Force and Akkar Mumbai to organize and train the rag pickers. As a result rag pickers became more organized, received fairer prices to their collection, and better health & insurance services, along with work provided by the NGOs. The private contractors in turn played a role in the collection, segregation and disposal of solid waste. The role of the beneficiaries is to segregate the waste at source and maintain vigilance on the spot to prevent littering. Besides this, they are also involved in creating awareness among the community for the propagation of the concept of source segregation along with importance of disposal of waste in the bins to avoid littering of roads and other public places. It can be observed that the institutional mechanism in the present case was formal with specific roles assigned to specific people. Since the initiative for the ALM movement came from the public who compelled the local authority i.e. MCGM to take necessary actions, there was no definite hierarchy in the management framework.

Financing mechanism

Each housing society registered under the ALM scheme contributes Re.1/- per day, to raise funds to support segregation of garbage at household level, sweeping and disposal of biodegradable waste through composting or vermi-composting. Accounts related to people's contribution are maintained by the housing societies themselves. It is estimated by the residents of Joshi Lane that the cost of Integrated Solid Waste Management by the residents is Rs. 8 per capita per month or Rs. 96 per annum (Jain 2004).

System of waste collection

The residents of the locality are the major players in waste management, being assisted by rag pickers, MCGM workers and the private operators together, depending on the area delineated to each service provider.

Technology Used

Under the scheme, it is mandatory for waste segregation is carried out by the household itself. The wet waste is processed through vermi-culture to form compost at individual or community vermi-composting units. Dry waste is collected by the rag-pickers and directly sold by them to the recycling units.

Innovation in Practice

An innovative approach in the management is the residents' initiative to RRR, i.e. Reduce-Reuse-Recycle. The waste is segregated at the source and recyclables are removed at the source itself to be taken away by the rag-pickers, which gives the rag pickers some income. The wet waste is taken directly for composting. This led to 'Zero Garbage' situation. This has eliminated the need for community dustbins. This scheme has considerably reduced the burden of

primary collection, transportation and disposal of waste which in turn has reduced the MCGM's expense on the waste disposal process amounting to Rs. 1.5 per kg of waste (Jain 2000). Thus, while the doorstep collection has added to the collection cost, it has been counterbalanced by reduction in waste quantity.
The other feature of the scheme is that the housing societies/ communities are asked to register themselves with the MCGM, as prerequisite to the ALM scheme. Weekly meetings and focus group discussions are held between the residents of an ALM society and the Ward Officer of MCGM, through which problems at local level are identified and then addressed. Awareness programs have also been conducted in the localities and in schools with the help of local NGOs and CBOs. Another special feature of this scheme is the appointment of an Officer on Special Duty (OSD) for educating and spreading awareness among people of other wards about the scheme.

Results achieved

The success of the ALM scheme in one community led to its widespread replication in other areas of the metro city. This has been possible because of the concerted efforts by the municipal authorities. MCGM through the appointment of the OSD has assisted in building awareness among the residents of different wards. With the success of the ALMs in SWM, the Municipal Commissioner delegated additional functions to them. These included beautification of the localities and maintenance of gardens, parks and roads. The ALM movement has been so successful that the citizen groups have not just taken up the responsibility of their immediate neighbourhoods but also have organized maintenance of open spaces like the Juhu Beach etc. at the ward level (Kundu 2005). Wherever the ALM societies are functioning successfully, their scope of work has increased to take up other activities such as tree plantation, prevention of encroachment on pavement and beautification of streets. The corporate houses have undertaken the responsibility of managing their road, sanitation and solid waste. Today there are a total of ten Corporates that are part of the ALM movement; one of them has even registered a trust called ‘ALM Trust’ which encourages vermi-composting. 261 vermi-composting units spread over six zones reduce approximately 20-25 MT of garbage per day from reaching the disposal site. It is estimated that about 25 per cent of the ALM are managing solid waste at the local level through vermi-composting and recycling of dry waste (Redkar 2005)**.**

People’s habit of throwing garbage on the roads has reduced with increase in segregation of wastes at household level. Dustbins from the main roads were removed, providing a cleaner look to the streets. The system has developed a platform where the urban local body and the citizens can work in consultation rather than confrontation with each other. Such interaction helped in developing people’s faith in the city’s governance. The ALM movement that started with the objective of cleanliness (Zero Garbage’) has gradually spread to other areas of people’s grievance regarding civic services like maintenance of road in the locality, improvement in water supply, check on unauthorized construction, and monitoring unauthorized hawking. It has provided a forum to the citizens for participating in SWM and in improving the city’s environment. To note is the fact that the ALMs are largely middle and high income based groups, whose interest is ‘Clean City’, at the exclusion of the poor. Hence, although many of the initiatives of the ALMs are recommendable, these have become organised

forums for the support for evictions of slum dwellers and the pavement dwellers from public space.

Slum Adoption Scheme

Genesis and Background

A study done by the Youth for Unity and Voluntary Action (YUVA) in 1998, which covered 100 communities in the slum pocket of Jogeshwari (East), found that while the residents were aware of the problems related to inadequate practices of household disposal of waste and systems of collection and transportation of garbage in the community, there was very little community involvement in solving the problem. It was also experienced by the MCGM that because of the heterogeneous population in the slums there was no sense of belongingness in the slums, which led to piling up of garbage and deteriorating health conditions of the dwellers.
As a result of the survey, it was realised that an attempt to motivate and involve the slum population in keeping the slums clean had to be made through offering some incentives for the purpose. It is in this background that the Slum Adoption Scheme (SAS) through community-based organizations and public participation was started by the MCGM.

Called the *Dattak Vasti Yojana*, which means Slum Adoption Scheme, this programme is meant to financially support slum communities to form garbage committees that would then hire workers to clean their areas.

Description of the Initiative

A Community Based Organisation (CBO) has been involved in work related to SWM in the Prem Nagar Slum Community since last one and a half years. The MCGM has provided necessary equipments for the purpose to the CBO and it also takes care of the salaries of the slum cleaners. The project has turned out to be successful.

Institutional Framework

The CBOs involved in the scheme require recommendation from their ward councilor and a registration with the charity commissioner office, to become eligible for SAS. This process formalises the CBO. The selection of the CBO is based on certain norms and it is appointed as an agency on behalf of the MCGM to keep the slum area clean. The CBO represents the people and implements primary services of the municipal authorities at the slum level.

System

The waste is collected from door-to-door. But, because the slums have narrow pathways and alleys, it is difficult to take in large vehicles inside the slum for collection of waste from a pocket. Hence, waste is collected through handcarts, tricycles, auto-rickshaws or other smaller modes that can move on the narrow paths, and then transferred to community bins. The community bins in turn are lifted by a dumper-placer / skip-loader vehicles or compactors, and carted away to the landfill. A system of keeping plastic containers in the passages for short

periods for doorstep collection of the waste has been also introduced in place of waste bin at household level, given that in many slums individual housing units are located cheek-by-jowl. The waste pickers employed to do the task in the adopted slums remove waste from such common containers thus placed.

Financing mechanism

The initial source of finance for the scheme is from the MCGM, who provides some annual amount for first three years, but the amount reducing gradually over the period. Then, the CBO is expected to raise Rs. 10/ per household for collection of segregated waste from house to house and for the maintenance of toilet blocks. The scheme has been so designed that by the end of the third year, the CBO would be self- sufficient in managing services related to waste management and sanitation at the primary level.

Results achieved

Through his programme, MCGM is reaching out to 253 slum pockets of a total of 1,959 recognized slums in the city of Mumbai. However, the CBOs service only small sections of the slum pockets handed to them. Hence, their efforts are not felt strongly in the overall scenario. Nonetheless, they are known and respected within the communities as supporters of a healthy and clean environment. The exposure of the CBOs to the ward system has made them formal organizations with registration and audited accounts. They have become more aware about the functioning of the ward system and hence are prepared to take on many more complicated and larger contracts of solid waste, mid-day meal and slum sanitation programmes. The project has also resulted in creating opportunities for the slum youth, women and rag pickers by giving them employment. The CBOs headed by women are more than 35 per cent of the total CBOs (Redkar 2005) and this has enabled women to participate in development processes that would eventually lead to their empowerment in the society.

Probable Conflicts and Sustainability Issues

The SAS is not without its own concerns and problems. One of the most glaring drawbacks of this programme is that the Slum Adoption Programme is meant only for the authorized slums. Due to this, the non-authorized slums of the city and pavement communities do not have any means for effectively dealing with their waste management and cleanliness issues. This is one more mechanism of creation of rift between the authorized and unauthorized slums.

On the economic front, it can be seen that as the CBOs serve only a small section of the areas allocated to them. Thus, the beneficiaries' contribution does not add up to any great amount. In fact, the total contribution adds up to just 8 per cent to 10 per cent of their total costs of keeping the slum clean. Hence the CBOs face a great difficulty in the operation and management of the cleanliness drive.

Up gradation of Governance System

The projects have also made an effort in an indirect manner to link the civil society groups to the governance system, bringing in a sense of ownership and increasing the transparency within its structure. Such kind of third party

monitoring has also helped to overcome the problems of the system and of mal-practices, if any. The negotiating position of the ALM societies as well as the CBOs has strengthened and they are able to use this in bargaining for better civic service deliveries from the MCGM.

Reduction in Costs

Lastly, participatory mechanism can reduce the cost of implementation of any scheme, as it can be seen where the MCGM is able to partner with the CBOs for solid waste management either through ALM or Slum Adoption Schemes.

Long way to Go

The experience from Mumbai shows that the city has still a long way to go in SWM, inspite of the initiatives described here. The size of the city is very large and the scale of these new initiatives is not so large as to cover the whole city. Deluge of July 26, 2005 has shown that the garbage collection has to still go a long way so that it does not clog the city drains in times of heavy rains and cause severe inundation of the city areas. Nonetheless, these new practices show the way, for addressing part of the problem of waste management in Mumbai City. [The research has been carried out under Shastri Applied Research Project (SHARP), 'Urban Governance and Environmental Management; Action Oriented Policies Studies on Waste Management in Jabalpur & Raipur'. We acknowledge financial support of Shastri Indo-Canadian Institute (SICI).]

ANNEXURE C.

"India Infrastructure Report 2006"

[45]SOLID WASTE MANAGEMENT by P. U. Asnani

Comment by Eco-Friend and Company : The subject of Solid Waste Management has been addressed innovatively and precisely in *India Infrastructure Report 2006 (Pp 160 to 189)* so much so that the contents are valid even today. Some portion of the report has already been quoted earlier. Some other aspects of the report on the subject of this report worth mentioning are reproduced below :

Reasons for Inadequacy and Inefficiency in Services :

Apathy of Municipal Authorities

Though municipal authorities have held the responsibility of managing solid waste from their inception over three centuries ago, the issue seldom got the attention it deserved. Elected representatives as well as the municipal authorities generally relegate the responsibility of managing municipal solid waste (MSW) to junior officials such as sanitary inspectors.

Systems and practices continue to be outdated and inefficient. No serious efforts are made to adapt latest methods and technologies of waste management, treatment and disposal. Though a large portion of the municipal budget is allotted for solid waste management, most of it is spent on the wages of sanitation workers whose productivity is very low. There are no clear plans to enhance their efficiency or improve working conditions through the provision of modern equipment and protective gear. Unionization of the workers, politicization of labour unions and the consequent indiscipline among the workforce are all results of bad working conditions and inept handling of labour issues.

Almost all the 3955 towns with population below 100,000 run SWM services rather unprofessionally. They depend on sanitary inspectors to manage solid waste with the help of sanitation workers. In many small towns, even qualified sanitary inspectors are not posted and services are left in the hands of unqualified supervisors.

The situation of cities with 100,000 plus population is somewhat better, though far from satisfactory. In these cities, generally there are health officers who head the SWM department. In some of the larger cities qualified engineers supervise SWM seeking technical inputs from doctors as well.

Absence of Community Participation

Community participation has a direct bearing on efficient SWM. Yet, the municipal authorities have failed to mobilize the community and educate citizens on the rudiments of handling waste and proper practices of storing it in

[45] SOLID WASTE MANAGEMENT P. U. Asnani
India Infrastructure Report 2006 Pg 160 to 189

their own bins at the household-, shop- and establishment-level. In the absence of a basic facility of collection of waste from source, citizens are prone to dumping waste on the streets, open spaces, drains, and water bodies in the vicinity creating insanitary conditions. Citizens assume that waste thrown on the streets would be picked up by the municipality through street sweeping. For the general public, which is quite indifferent towards garbage disposal etiquette, the onus of keeping the city clean is entirely on the ULBs. This mind set is primarily responsible for the unscientific systems of waste management in the country.

Drawbacks in Present SWM Services :

No Storage of Waste at Source

There is no practice of storing the waste at source in a scientifically segregated way. Citizens have not been educated to keep domestic, trade, and institutional bins for storage of waste at source and stop littering on the streets.

No System of Primary Collection from the Doorstep

There is no public system of primary collection from the source of waste generation. The waste discharged here and there is later collected by municipal sanitation workers through street sweeping, drain cleaning, etc. Street sweeping has, thus become the principal method of primary collection.

Irregular Street Sweeping

Even street sweeping is not carried out on a day-to-day basis in most cities and towns in India. Generally commercial roads and important streets are prioritized and rest of the streets are swept occasionally or not swept at all. Generally, no sweeping is done on Sundays and public holidays and a back log is created on the next working day.

The tools used for street sweeping are generally inefficient and out-dated. For instance, the broom with a short handle is still in use forcing sweepers to bend for hours resulting in fatigue and loss of productivity. Traditional handcarts/tricycles are used for collection, which do not synchronize with the secondary storage systems. Waste is deposited on the ground necessitating multiple handling.

There are no uniform yardsticks adopted for street sweeping. Though, some states/cities have prescribed work-norms, these are not very scientific. Most of the cities allocate work to sanitation workers on ad hoc basis. The work distribution ranges between 200 metres to 1000 metres of street sweeping each day. Some sanitation workers are found under worked while some over burdened.

Waste Storage Depots

As waste is collected through traditional handcarts/tricycles that can carry only a small quantity of waste at a time, there is a practice to set up depots for temporary storage of waste to facilitate transportation through motorized vehicles. Generally, open sites or round cement concrete bins, masonry bins or concrete structures are used for temporary bulk storage, which necessitates multiple handling of waste. Waste often spills over which is both unsightly as well as unhygienic.

Transportation of Waste

Transportation of waste from the waste storage depots to the disposal site is done through a variety of vehicles such as bullock carts, three-wheelers, tractors, and trucks. A few cities use modern hydraulic vehicles as well. Most of the transport vehicles are old and open. They are usually loaded manually. The fleet is generally inadequate and utilization inoptimal. Inefficient workshop facilities do not do much to support this old and rumbling squad of squalid vehicles. The traditional transportation system does not synchronize with the system of primary collection and secondary waste storage facilities and multiple manual handling of waste results.

Processing of Waste

Generally no processing of municipal solid waste is done in the country. Only a few cities have been practising decentralized or centralized composting on a limited scale using aerobic or anaerobic systems of composting. In some towns un-segregated waste is put into the pits and allowed to decay for more than six months and the semi-decomposed material is sold out as compost. In some large cities aerobic compost plants of 100 MT to 700 MT capacities are set up but they are functioning much below installed capacity. A few towns are practising vermi-composting on a limited scale.

Disposal of Waste

Disposal of waste is the most neglected area of SWM services and the current practices are grossly unscientific. Almost all municipal authorities deposit solid waste at a dump-yard situated within or outside the city haphazardly and do not bother to spread and cover the waste with inert material. These sites emanate foul smell and become breeding grounds for flies, rodent, and pests. Liquid seeping through the rotting organic waste called leachate pollutes underground water and poses a serious threat to health and environment.

Landfill sites also release landfill gas with 50 to 60 per cent methane by volume. Methane is 21 times more potent than carbon dioxide aggravating problems related to global warming. It is estimated by TERI that in 1997 India released about 7 million tonnes of methane into the atmosphere. This could increase to 39 million tonnes by 2047 if no efforts are made to reduce the emission through composting, recycling, etc.

Strategy to Implement MSW Rules 2000 :

Five years have passed since the notification of MSW Rules, 2000 and the time limit for the Implementation of the rules has run out in December 2003. Yet, there are cities, which have not initiated any measures at all. There are several which are still grappling with choice of technology and other

operational issues. Authorities need to take the implementing of the rules seriously and find ‘out of the box’ solutions. Days are not far when city governments may be hauled up by the courts and state pollution control boards (SPCBs) for non-compliance.

Given the lack of in-house capability of municipal authorities and paucity of financial resources, it is desirable to outsource certain services and resort to private sector / NGO participation in providing SWM services.

Private Sector Participation in SWM at Urban Local Body Level

Private sector participation (PSP) results in cost savings and improvement in efficiency and effectiveness in service delivery mainly due to financial and managerial autonomy and accountability in private sector operations. Besides, it brings in new investment and better technologies. In developed countries the private sector manages most of the SWM services.

In India, by and large, municipal authorities are providing solid waste management services departmentally. Resistance from labour unions and interpretations of labour laws, have discouraged city administrations from contracting out services to private operators. Of late, some experiments to privatize certain SWM services have demonstrated improvement in the level of services in a cost-effective manner.

The Supreme Court of India has cleared the doubts on legal implications under the Contract Labour (Regulation and Abolition) Act 1970 by its decision in Special C.A. No. 6009–6010 of 2001 in Steel Authority of India Limited and others versus National Union Water Front Workers and others in August 2001. This has paved the way for municipal authorities to contract out certain SWM services. Private sector participation has been attempted in door-to-door collection of waste, street sweeping, secondary storage of waste, transportation of waste, composting of waste or power generation from waste and final disposal of waste at the engineered landfill.

The present capacity of municipalities in India to manage the privatization process is, however, extremely limited. There is a need for developing in-house financial and managerial capability to award contracts to private sector and monitoring the services provided since the onus of ensuring proper service delivery and compliance of standards, remains with the local body.

Service Contracts

Contracts are generally given for door-to-door collection of waste in the morning hours with or without the equipment of the contractor. This activity is labour intensive and generally taken up by small contractors, residents welfare associations and associations of backward classes or NGOs at a low cost. Cities of Bangalore, Ahmedabad, Nagpur, Jaipur, North Dumdum, New Barrackpore (West Bengal), Gandhinagar, Vejalpur (Gujarat) are some examples.

Contract packages are made by municipal authorities keeping in mind the work to be done and the minimum wages payable under the law. The contractor is paid per month on the basis of the number of houses served.

Street sweeping

Street sweeping contracts are less common. They are generally given to cover un-served and newly developed areas. Payments are made per km area served or on the basis of unit area fixed for street sweeping.

Secondary storage and transportation

Municipal authorities enter into secondary storage and/or transportation contracts to avoid investing in vehicles and equipment and to avail of a more efficient system. In such an arrangement, the private firms provide containers

and/or vehicles with drivers as well as fuel. The onus of maintaining the fleet of vehicles also lies with them. Such contractors are either paid per trip to the treatment/disposal site or per tonne of waste transported (examples can be found in Ahmedabad, Surat, and Mumbai)

BOOT, BOO and DBO Contracts for Treatment and Disposal of Waste

Generally, municipal authorities in our towns and cities are not equipped to handle treatment and disposal of waste, which are highly technical operations. Private sector participation is thus preferred and is gradually picking up in the country. Build, Own, Operate and Transfer (BOOT) and Build, Own and Operate (BOT) are the most popular models of concession agreements in vogue in the country. Cities such as Kolkata, Hyderabad, Vijayawada, Ahmedabad, Trivandrum, and Thane are examples of such contracts for the construction of compost plants or waste to energy plants.

Privatisation of Disposal of Waste

In case of disposal of waste, there are no examples of private sector participation in India as no such plants existed thus far. However, the concept of paying tipping fees is gaining acceptance with a beginning made by the Municipal Corporation of Bangalore. The BMP (Bangalore Mahanagar Palike) is using an integrated treatment and disposal facility for the treatment and disposal of 1000 tonnes of waste per day.

Based upon technology and investment requirements, various profiles of contracting with private firms are emerging. Mega cities namely Delhi, Mumbai, Bangalore, Kolkata, Chennai, Hyderabad, and Ahmedabad have gone in for large contracts and have attracted national and international firms.

In some cases cities have strategically gone in for small waste collection and transportation contracts promoting local firms with modest financial resources. Cities must ensure that such service responsibility is distributed amongst multiple firms or between private firms and ULB staff so that in case one firm fails others can take over without disrupting the service.

Role of Resident Welfare Associations (RWAs), Non-governmental Organizations (NGOs), and Community Based Organizations (CBO)

There is enormous potential to involve RWAs, NGOs and CBOs in SWM services in a cost-effective manner without getting into contracts with private operators. With some support from the ULB in the form of grant or subsidy, the community is keen to manage its own waste. There are NGOs / CBOs which also promote the welfare of rag pickers. They are willing to come forward to involve the rag pickers in door-to-door collection and source segregation of waste. In this model, followed in Ahmedabad and Ludhiana, there is no contractual relationship between the ULBs and RWAs/NGOs as they only get grants to support their activity carried out through their own labour and grants can be discontinued if purpose is not served.

Initiatives taken by State Governments to Handle Solid Waste

A few state governments have taken important initiatives towards long-term solutions to SWM catalysed by the MSW Rules 2000. These are - Karnataka, Gujarat, West Bengal, Rajastan and Maharashtra

Maharashtra

All India Institute of Local Self-Government (AIILSG), Mumbai**,** which is a premier training institution in the country in the field of Municipal administration, organized a state level consultation on SWM in February 2001 for Maharashtra. The consultation succeeded in extracting a commitment from the political and administrative leadership of Maharashtra towards improved solid waste management practices within the framework of the MSW Rules 2000. The path breaking state level consultation was followed by a series of meetings to evolve a consensus for a 'nucleus cell' in the AIILSG to enhance institutional capacity of the ULBs towards understanding the provisions of the MSW rules and selection of technologies for waste management. Accordingly, the SWM Cell was established in the AIILSG and became operational in May 2002.

The cell has organized many training workshops as well as study tours for city managers to visit the United States to learn the latest waste processing technologies. The SWM Cell has been providing useful inputs both to the state government of Maharashtra and the Government of India on the policy issues.
Based on the feedback of the field agencies, particularly the ULBs, the cell has referred several issues to the state government for policy decisions and recommended amendments in the statutes governing the ULBs. The cell released status reports of all the cities along with a consolidated action plan in February 2005. It has done a study on the marketability of MSW-derived manure. The study covered all regions and all major crops of the state to estimate the market potential in terms of the quantity and the price of the municipal solid waste derived manure. The cell is also active in preparing and distributing material on the compliance criteria of the MSW Rules and sustainable waste management.

Grant of Government Land for Treatment and Disposal

The state government has taken decision to grant government land free of occupancy price to the ULBs for developing sanitary landfills as per the MSW Rules. As a result of this policy decision, with the exception of about 7–8 cities all the councils have acquired land for landfill construction. Two hundred and two sites are good enough for about 25 years.
The government has also set up district level committees under District Collectors to coordinate the implementation of the MSW Rules. The implementation of the Rules in the state is particularly lacking in doorstep collection of waste and waste processing (Table 8.8).
The government is also considering a capital grant to the cities for developing the infrastructure required for processing and disposal facility. The SWM cell has estimated that an amount of Rs 776 crore may be required to fund the entire capital expenditure for implementing all the components of the MSW Rules.
It can be inferred from recent developments in states that some states have become proactive in extending technical and financial support to ULBs to implement the rules. However, in spite of support from state governments, many local bodies are at a loss to identify appropriate technologies for treatment and

disposal of waste. They are not aware of merits and demerits of each technology advocated by the vendors. Without past experience and technical expertise, several local bodies end up with facilities, which neither fully meet the statutory requirements nor are they suitable under local conditions.

PPP in Cities : *Bangalore, Chennai, Hyderabad, Ahmedabad, Surat, North Dumdum and New Barrackpore Municipalities have taken lead in establishing Private Public Participation.*

Issues related to PPP in SWM

Labour Issues—Contract Labour (Regulation and Abolition) Act, 1970 (CLA)

This Act was passed in 1970 when the government was concerned about exploitation of workers under the contract labour system. The Act abolished contract labour in various jobs and processes and regulated its employment where it could not be abolished. It essentially lays down the relationship between the principal employer and contract labour.

In accordance with provisions laid out under Section 10 (1) of the CLA, the state governments may prohibit employment of contract labour in any process, operation or work in any establishment (defined to include any office or department of a local authority). Any state that chooses to exercise this provision must carefully review implications of such a decision on the delivery of SWM service, staff strength and related expenditure of the local body. Further such a ban would preclude private sector participation. Tamil Nadu has banned the use of contract labour in sweeping and scavenging services. The Chennai Municipal Corporation had to request the state for special exemption from the ban to privatize SWM services.

It may be noted that in case a local body chooses to employ contract labour for SWM, it would be the principal employer and the onus of fulfilling the terms under the CLA would rest with it. In case a contract is awarded to a private operator, the local body as the principal employer must ensure that the private firm meets duties under the CLA. Alternately, the local body must specify/identify the private firm as the principal employer in the project agreement. If a private firm takes up the job of collecting household waste and transporting the same either to the municipal dust bin or up to the designated dumping sites as per an agreement reached with individual households or residential associations, the said activities cannot be taken as done at the instance of the local body and it cannot be taken as the principal employer.

The Supreme Court of India has interpreted this law and set the matter to rest in Special C.A. No. 6009–6010 of 2001 in Steel Authority of India Limited and others versus National Union, Water Front Workers and others which must be carefully studied by municipal authorities.

Environmental issues

a. Siting: Siting of a landfill facility is very difficult task and meets with stiff resistance from the community living nearby as well as by vested interests operating in that area. The MSW rules for siting must be adhered to in order to minimize adverse impact on environment and quality of life of citizens.

A number of PILs have been filed in recent years regarding the siting of waste treatment and disposal facilities. Such PILs delay project implementation and have financial implications for the private firm.

b. Adherence to Environmental Standards: Since treatment and disposal of municipal solid waste poses problems of the environmental pollution and health

hazards, the private operators as well as municipal authorities are expected to be very careful. The Pollution Control Boards are duty bound to ensure that MSW is managed properly as per terms of MSW Rules 2000. The treatment and disposal facilities can face closure if the standards are not met.

Patents issues

In the case of patented technology/process, the issue of patent transfer needs to be reviewed. This may become critical for local bodies to be able to successfully operate and maintain such facilities upon transfer.

Role of Informal Sector: NGOs and CBOs

Whereas the private sector can play an important role in construction, operation, and maintenance of treatment and disposal facility, NGOs can play an important role in:

- organizing rag-pickers/waste collectors for door-to-door collection and segregation of waste
- creating public awareness for storage of organic and recyclable waste separately at source and handing over the waste to the waste collector.
- promoting recycling of waste and decentralized treatment of waste involving community, CBOs, etc.

Rag-pickers could be involved in door-to-door collection of municipal solid waste as well as recyclable waste so that they could get a user fee for collecting waste from the doorstep and derive additional income from sale of recyclables. There is a potential of recovering at least 15 per cent of the waste generated in the country which could be more than 15,000 MT per day providing employment opportunities to about 5,00,000 rag-pickers in the country. Despite immense potential in big cities in this area, NGO/CBO participation is still on a very small scale.

The Self-Employed Women's Association (SEWA) has taken up the task of door-to-door waste collection in Vejalpur and Gandhinagar cities near Ahmedabad and providing employment to over 500 rag-pickers. Similarly, the Centre for Development Communication in Jaipur has taken up the work of primary collection and transportation of waste involving half a dozen cities covering population of over a million. Exnora which initially introduced the concept of door-to-door collection on cost recovery basis in India has been playing an important role in Chennai and Bangalore in door-to- door collection of waste with community participation.

Sustainability of this service can be ensured through user charges levied on beneficiary households, shops, and establishments.

Funds Required for SWM

To improve SWM services in urban areas the Supreme Court Appointed committee had estimated a cost of Rs 1.5 crore per 100,000 population in 1999. This includes collection, transportation, processing and disposal of waste in a scientific manner. This amounts to a total expenditure of Rs 4275 crore consisting of Rs 1710 crore spent on vehicles, tools, equipment, and Rs 2565 crore for the treatment and disposal.

The Ministry of Urban Development appointed an expert committee which wrote the manual on solid waste management, has given standard cost estimates for modernization of solid waste management practices in various categories of cities and towns in India.

Given the financial position of the municipal authorities central and state government assistance is imperative for SWM service improvement.
The urban development ministry formulated a waste management scheme for class I cities/towns indicating a need of nearly Rs 2500 crore and posed it to the 12th Finance Commission for devolution of funds to ULBs. Public–private partnerships have been suggested by the ministry as integral part of the scheme in order to leverage funds and add efficiencies. It is essential that the operating and maintenance costs be carefully assessed. SWM collection equipment has a shortlife and operating and maintenance costs are substantial.

Investment by the Private Sector

Role of the private sector in financing resource recovery (composting, waste-to-energy) facilities is growing in India. Many composting facilities and two power plants have been set up in the country with private sector participation.

Pool Financing Mechanism

Under this arrangement local bodies can come together to develop/construct common facilities on a cost sharing basis and access the capital market to raise funds for such projects through a common lead agency that must be established by the state government.

Supplementing ULB Resources

The 12th Finance Commission Grants

The 12th Finance Commission has taken a very considered view for improving urban infrastructure and allotted Rs 5000 crore for supplementing the resources of the ULBs in the country.
Out of above amount, 50 per cent amount has been earmarked for improving SWM services. This is the first time a sizeable allocation has been made towards SWM by the government. This amount is to be spent between 2005–10. The urban renewal fund of the government also has an SWM component. If the state governments and ULBs come forward with matching funds, effective management of MSW should be possible.

Support from State Governments

Uttar Pradesh, Madhya Pradesh, Tamil Nadu, Andhra Pradesh, Maharashtra, Haryana, Karnataka, Gujarat, and Rajasthan have announced policy measures pertaining to allotment of land at nominal lease rent, free supply of garbage and facilities for evacuation, sale and purchase of power to encourage the setting up of WTE projects. The tariff for power purchase is agreed upon as per the general guidelines issued by the Ministry of Non-Conventional Energy Sources (MNES). However, there are often delays in finalization of actual contract terms with the entrepreneur, especially with regard to power tariff, in the wake of the deregulation of the power sector and the absence of clear policy direction.
Operations and maintenance costs is generally obtained from two sources: current general revenues and SWM operating revenue, essentially user charges.

Operational Expenditure

SWM constitutes up to 10 to 50 per cent of municipal budget expenditure depending on the income sources of the municipal authorities. The main expenditure heads under SWM are in salaries and allowances, consumables, vehicles repair and maintenance, contingencies and others. A recent survey by the National Institute of Urban Affairs shows ‘salaries of sanitation workers’ for

SWM in class I cities, constitute as much as 75 per cent of total SWM expenditure. This is still higher at 85 per cent in class II cities.

Capital Investments

Capital costs for SWM in India are met from the current revenue and borrowings. City level planning with related budget estimates, is usually absent in most local bodies. Cities borrow funds from financial institutions such as HUDCO and banks for financing equipment and vehicles to the extent their financial health permits.

Sources of Funds

Conservancy Tax

Traditionally, funding for solid waste systems comes from the general fund. Most ULBs use a percentage of the property tax to support the solid waste management system. This tax, known as conservancy tax, is easy to administer since no separate billing or collection system is needed. However, the disadvantage is that in most Indian cities' assessment and collection of property tax is poor and this poor base provides for very little income.

User Charges

Increased public awareness of solid waste issues and public involvement in the decision-making process may provide the opportunity to adjust user charges to reflect real costs of providing solid waste services. User charges if properly administered:

• are an equitable means of funding SWM services;
• can provide incentive to reduce waste generation; and encourage recycling.

Revenue from Recovery and Treatment of Waste

Waste recycling, composting, waste-to-energy, may generate operating revenues or at least reduce the cost of treatment of the MSW.

Subsidy for Compost Plants and WTE Projects

The Ministry of Agriculture (MoA) and the Ministry of Environment and Forest (MoEF) have been actively promoting waste composting, while the MNES has designed schemes to promote WTE projects.

Further the Ministry of Environment and Forests had also sanctioned a project to the Central Road Research Institute for conducting research on effective utilization of MSW in road construction.

The MoA and the MoEF have two separate schemes to promote MSW composting.

Both schemes provide only subsidies without follow-up on implementation and performance monitoring.

As a result the impact of these schemes is not known readily at the GOI level.

The National Programme on energy recovery from urban and industrial waste was launched by the MNES during the year 1995 with the approval of the Commission for Additional Sources of Energy (CASE). MNES has notified an accelerated programme providing financial assistance for projects on energy recovery from urban waste during the year 2005–6. The incentives offered vary from scheme to scheme.

GOI Subsidy on SWM Plants

Project for power generation from MSW Rs 1.5 crore per MW involving refuse derived fuel (RDF)

Power project based on high rate Rs 2 crore per MW bio-methanation technology

Demonstration project for power Rs 3 crore per MW generation from MSW based on gasification / Pyrolysis and plasma arc technology
Biomethanation technology for power 50 per cent of project generation from cattle dung, vegetable cost up to a maximum market and slaughterhouse waste of Rs 3 crore per MW above 250 KW capacity
Bio-gas generation for thermal Up to Rs 1 crore per application MW equivalent
Project development assistance Up to Rs 10 lakh per project
Training course, seminar, workshop, etc. Rs 3 lakh per event
Note: The financial assistance for any single project will be limited to Rs 8 crore.
Source: Government of India, Ministry of Non-Conventional Energy Source Scheme, 25 July 2005.
The Supreme Court of India has, however, ordered the government of India not to sanction any subsidies for projects based on municipal solid waste until further orders of the Supreme Court. Therefore, Government of India subsidies for waste to energy projects are on hold at the moment. This is mainly because issues have been raised before the Court about the misuse of the provisions made and the matter is under judicial scrutiny.

Funds from Sale of Carbon Credits

Major international initiatives are underway to mitigate greenhouse gas emission (GHG). Rio-Earth summit 1992 focused attention on this issue and it was further strengthened at Kyoto in 1997 wherein industrialized nations agreed to reduce their aggregate emission to 5.2 per cent of 1990 levels by 2008–12. As reduction of emission invites huge costs for developed nations, they have evolved an ingenious system where in they can reduce emissions in any part of the world and earn carbon credits to count towards their effort to reduce greenhouse gas emissions globally. There are three mechanisms to supplement the national effort to achieve measurable and cost effective GHG reduction as under.
1. Clean development mechanism (CDM)
2. International emission trading (IET)
3. Joint implementation (JI)
Cities can take up waste treatment and disposal projects under this mechanism and avail of the benefits through sale of certified emission reduction credits at the prevailing market price (ranging from US$6 to US$9 per tonne carbon equivalent) to the developed countries through well established mechanism involving consultants dealing with this matter.
The MoEF has a nodal officer handling these matters. Landfills generate biogas consisting of 50 per cent methane. A tonne of methane is equivalent to 21 tonnes of carbon dioxide and a serious threat to the cause of GHG reduction. Appropriately management of landfills, compost plants or WTE plants can earn municipal authorities in large cities substantial carbon credits which can be sold not only to recover cost of system installation and upgradation of operations but also generate surplus funds invaluable for the cash starved ULBs. Smaller cities can pool resources together and make a combined case for availing of carbon credits.

Way Forward

While SWM was completely neglected in past and is now receiving some attention at the highest levels in several cities and states, many are lagging behind and several have not bothered to make any improvement at all.

The national and state solid waste management missions need to be created to ensure that municipal authorities perform their obligatory duties regularly in compliance with MSW Rules 2000 within a predetermined time frame.

The financial allocation of the government of India as per the 12th Finance Commission recommendations, the urban renewal fund, and state level allocations for SWM need to be pooled judiciously and used in a planned manner through the national and state missions. ULBs need to be strengthened with handholding wherever necessary to meet the challenge.

More specific steps could include the following:

1. The national mission, in consultation with state missions, could prepare strategies to implement Municipal Solid Waste (Management & Handling) Rules 2000 in time bound manner.
2. The national mission should include a nation-wide awareness campaign through media using expert communication agencies seeking community participation in solid waste management. State missions should give wide publicity to conducive solid waste management practices to attract community, NGO and private sector participation.
3. The national and state missions could identify, empanel and circulate lists of national and international experts, individuals, and organizations, to provide technical know how as well as commercial SWM services to the ULBs. These firms could, construct and operationalize treatment and disposal facilities, take up O & M contracts, etc.
4. The national mission, in consultation with state missions, could prepare tender documents, designs and specifications, and concession agreements to facilitate expeditious procurement of tools, vehicles, and services.
5. It could dovetail programmes of various ministries responsible for different aspects of solid waste management with the activities of national and state missions. Ministries involved would include Ministry of Environment and Forests, Ministry of Urban Development, Ministry of Health and Family Welfare, Ministry of Agriculture, and Ministry of Non Conventional Energy Sources.
6. To market compost produced through SWM activities, the mission should include a programme to promote its use as compost amongst farmers raising awareness about its advantages over chemical fertilizers in preserving the fertility of the soil while leading to productivity increases. Linking the subsidy on chemical fertilizers with the use of compost could introduce an incentive into the system.
7. State level task forces under respective district magistrates/ collectors could be given a timeline of 6 months to identify suitable sites for treatment and disposal of waste within the parameters of the MSW Rules 2000 for cities and towns falling in their jurisdiction.
8. All states should appoint an Empowered Committee for the allotment of government land for treatment and disposal of waste free of cost. Local bodies as well as regional planning authorities like the District Planning Committee and Metropolitan Planning Committees, Improvement Trusts, and Urban Development Authorities should make adequate provisions of appropriate land for setting up temporary waste store depots in each city and for setting up treatment plants and sanitary landfill sites in land-use plans keeping in mind requirements projected for the next 25 years.
9. Common cost sharing facilities could be created on large parcels of land for groups of cities, which could be professionally managed for shared benefits.

10. A state policy could be formulated to ensure that government and semi-government parks, gardens and farmlands give preference to the use of compost produced by ULBs within the state.

Though levels of SWM services in the country have started improving on account of active monitoring by the Supreme Court of India, the central and state pollution control boards and finance and technical support from proactive state governments there still is a long way to go. Save the formalization of the MSW Rules 2000, state action in this regard at many levels has been fairly uninspiring thus far. While MSW Rules 2000 is a watershed document in India's history of effective SWM, implementation issues still overwhelm the system. A firm commitment from central and the state governments towards a time bound mission to turn the provisions into action is urgent. Isolated cases of short-term steps to manage solid waste can hardly be cited as instances of governmental awareness and sensitivity to a problem that is only getting more daunting with each passing hour. It is no longer enough to take ad hoc measures to merely postpone the inevitable consequences of decades of neglect and nationwide mismanagement of SWM. A comprehensive nationwide programme needs to be actively implemented keeping in mind possible future scenarios. Key individuals within the governing system and the bureaucracy need to be educated to the magnitude of the crisis and motivated to use their power to influence the system and appropriately channelize resources to actively promote effective and progressive SWM projects and practices.

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From India Infrastructure Report 2006Pp from 160 - 189

ANNEXURE D.

"Solid Waste Management in Mumbai"

[46]The Bombay Community Trust

Mumbai has a coastal stretch of 603 sq km. Geographically, the city of Mumbai can be divided into three sections, namely, the island city (or main city), the western suburbs and the eastern suburbs. These are also known for administrative purposes as Division I, Division II and Division III, respectively. The total population of the city amounts to nearly 13million that is increasing on a daily basis. Such a huge habitat obviously generates a huge amount of waste of many kinds the management of which is a massive task for the local administration.

Waste Generation

Mumbai generates waste to the tune of approximately 7,025 tons per day. The waste consists of:

- 5,025 tones of mixed waste (bio-degradable and recyclable)
- 2,000 tons of debris and silt.

The biodegradable waste (wet waste) is made up of vegetable and fruit remainders, leaves, spoiled food, eggshells, cotton, etc. Recyclable (dry waste) consists of newspapers, thermocol, plastic, battery cells, wires, iron sheets, glass, etc. Debris includes construction waste, renovation waste, demolition waste, etc. Silt comprises earth and clay from drains and road corners. It is estimated that by 2008 such waste will aggregate 9,000 tons per day due to increase in the city's population.

Average Generation of Waste by a Citizen of Mumbai

The generation of waste by an individual depends on the socio-economic conditions to which the person belongs. For example, a rich family will generate nearly four to five kg of mixed waste per day; a middle class family will generate between one to three kg of mixed waste per day and a poor family, in slums, will generate close to 500grams per day.

Management of Waste

The Municipal Corporation of Greater Mumbai (MCGM) is formally responsible for the management of waste in the city. The prevailing approach has been one of collection and disposal that is, garbage is collected from communities by the municipal authorities and disposed off at the three main dumping sites that are currently servicing the city.

Garbage collectors employed by various housing societies manually collect the waste generated at the household level and dump it in the garbage bin at specified street corners. There are around 5,800 community bins in the city. In case of South Mumbai, trucks collect garbage from the garbage bins and transport it to a transfer station which is located in Mahalakshmi. A separate transport is arranged for transferring the garbage from Mahalakshmi to the northern part of Mumbai where the dumping grounds are situated. From all

[46] The Bombay Community Public Trust Report

other parts of the city, garbage is sent directly to the dumping grounds. Nearly 95% of the waste generated in the city is disposed off in this manner. This largely manual operation involves 35,000 personnel employed by the MCGM and is collected by a fleet of 800 vehicles, including vehicles hired from private contractors, that work in shifts each day. MCGM spends about Rs15-20lakh per day on collecting and transporting garbage and debris with municipal and private vehicles making about 2,000 trips every day.

The Crisis

Dumping Ground

A dumping ground is, generally, a low-lying, and marshy area, which is located on the outskirts of a city, where there is, usually, no human population. We have, in our city, three dumping grounds which are located in the northern part of Mumbai at Gorai (Borivali), Mulund and Deonar. A fourth one at Chincholi has recently closed down. Amongst the three, Deonar is the largest dumping ground. All the dumping grounds are nearly 30-40km from South Mumbai which explains the huge costs on transportation. The increase in the population of the city has forced people to settle near the dumping grounds. This has led to the twin problems of people living in unhealthy conditions and protesting for the closure of the dumping grounds, as dumping causes health hazards for the people in the vicinity. The average life of a dumping ground is 30 years. The remaining life of our largest dumping ground, i.e., Deonar, is only five to six years and, so far, no alternative site has been found for waste disposal. The waste, which offers an incentive after selling like paper, metal, etc., is sold to informal dealers by rag pickers. But the other organic waste, old batteries, polystyrene (thermocol), polythene bags, debris, to name a few, do not have such incentives and these are in huge quantities. Also, since it takes a long time to decompose, when dumped, such waste occupies and fills the low-lying areas. In fact, the search for a new dumping ground starts only when the filling area of the dumping ground is exhausted. Basically, the lower the waste, the longer the life of the dumping ground and vice versa. The waste at the dumping ground is covered with debris and spread evenly in layers. The organic waste undergoes natural decomposition and generates a fluid, which is known a leachate, and is very harmful to the ecosystem, if not treated properly. The leachate penetrates the soil and, if not prevented, pollutes the ground water. Also, flies, mosquitoes and many other pests breed on the waste and unless properly maintained, the dumps are a public health hazard.

Debris Disposal

In Mumbai, every day 2,000 tons of debris is generated officially, of which some part goes to the dumping ground for spreading over the organic garbage, as earth is expensive. The remaining debris is spread next to the roads, in the creeks, next to railway tracks and on open grounds. Every day, somewhere or the other, in some building, some renovation takes place, generating debris. This could be of houses or shops; it could be for repair of buildings or demolition of old buildings for reconstruction. To give an example, if the external surface of a building of 20 floors is repaired, the waste generated would be nearly 200 truckloads which can be used either in filling low-lying areas or for reclamation. Presently, there is no way of monitoring renovations and repairs because it does not need any permissions from authorities. The concerned housing societies give

the permissions for the renovations / repairs; hence, no data is available on this. The only regulation, which has been imposed by the Corporation, is that the area where the repairs, renovations and new constructions have happened, needs to be cleaned up from all wastes, after the completion of work.

There are truckers who earn a livelihood by collecting this debris and transporting it for disposal. However, disposing it off properly remains a concern, as there is very little space in Mumbai. It has to be carted over long distances which increases transportation costs so significantly as to make the entire "business" unprofitable. So it is dumped clandestinely in the creeks, thus, destroying our valuable mangroves. As Mumbai has a coastal stretch of 603 sq. km, it has numerous creeks. These are channels of water which occupy marshy land during high tide. The salty water occupies the land during high tide and drains off during low tide. This nurtures plants called mangroves. These plants, in turn, have leaves which provide oxygen to the water for fishes to breed in the creeks. In many areas, like Versova, Gorai, Charkop and Mankhurd, the entire eco-system of the creek has been destroyed as waste is dumped surreptitiously. Increasing prices of land and more construction activities are forcing the demolition of old structures and building new structures and creating more debris wastes. Debris, being very bulky in nature, requires more space, reducing the life span of the dumping ground. Therefore, municipalities, generally, refuse the entry of debris into dumping grounds other than what they need to cover the garbage. Finding few viable alternatives, people just dump the debris by roadsides. Over time, people start dumping organic waste on top of debris not only compounding the waste disposal problem but also creating a health hazard.

Garbage Collection - Low Serviced Areas

The garbage collection activity itself has several differences amongst the localities; there are highly-serviced areas, medium-serviced areas and very low-serviced areas. I would like to highlight the low-serviced areas which are the slums; slums are not seen as the rightful recipients of the formal systems of solid waste management (SWM). The local government extends its services only to regularised slums which are declared official or recognised under the census of slums. This step motherly treatment is, in effect, the city's own undoing, since slums form 60% of Mumbai. Moreover, these artificial boundaries can hardly prevent the spread of dirt and disease. A study done by Youth for Unity and Voluntary Action (YUVA) in 1998, covering 100 communities in the slum pocket of Jogeshwari (East), found that while residents were aware of the problems related to inadequate practices of household disposal of waste and systems of collection and transportation of garbage in the community, there was very little community involvement in solving the problem.

Chapter 14 - Table 5 : Time for Waste to Decompose

When the waste is dumped, it does not decompose very quickly and make way for the other waste. The nature of waste being dumped and the time it takes to decompose, pose a serious threat to the environment as well as human health. Given below are some examples to understand how much time it takes for various materials to decompose. Vegetables, Fruit Skins, Waste Food	3-4 Weeks
Paper Bags	1 Month
Cloth Bags	5 Months
Wood Pieces	10-15 Years
Leather Shoes and Sandals	40-50 Years
Iron Sheets	50-100 Years
Aluminium Sheets	200-250 Years
Plastic Bags	1 Million Years

ANNEXURE E.

"Role of NGOs, Rag Pickers and Pollution Control Boards in Solid Waste Management"

[47] Inderscience Enterprises Ltd.

ROLE OF NGOs

During the recent years, NGOs (non-governmental organizations) have taken up initiatives to work with local residents to improve sanitation. They have been playing an active role in organizing surveys and studies in specified disciplines of social and technological sciences. In the field of garbage management, such studies are useful in identifying areas of commercial potentials to attract private entrepreneurs. They can play an important role in segregation of waste, its collection and handling over to local authorities.

A large number of NGOs are working in the field of solid waste management such as Clean Ahmedabad Abhiyan, Ahmedabad, Waste-Wise, Bangalore, Exnora, Chennai, Mumbai Environmental Action Group, Mumbai, and Vatavaran and Srishti in Delhi. They are all successfully creating awareness among the citizens about their rights and responsibilities towards solid waste and the cleanliness of their city. These organizations promote environmental education and awareness in schools and involve communities in the management of solid waste.

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ROLE OF RAG PICKERS

Rag pickers are the people who are actually going through the garbage bins, dumping sites to pick out the 'rags'. These rag pickers: women, children, and men from the lowest rung in the society, are a common sight in most cities and towns around the country. Rag picking is considered the most menial of all activities and it is people who have no other alternative that are generally driven to it. Rag pickers contribute a great deal towards waste management as they scavenge the recyclable matter thereby saving the municipality of the cost and time of collecting and transporting this to the dumps.

They are one of the focal points for the recycling of waste. They are the persons who, in spite of all the dangers that they faces, goes on relentlessly picking through the garbage bin, looking for waste that could be useful to them. They sell all the material they picked to the whole sellers and retailers who in turn sell it to the industry that uses this waste matter as raw material. The main items of collection are plastics, paper, bottles, and cans.
While picking through waste, the rag pickers puts themself at a great risk and is always prone to disease as the waste that they rummages through can be infected. We can indirectly help the rag pickers by carefully segregating the waste that is generated at our homes, thereby facilitating their search for materials that are useful to them. They will not have to scavenge in the bins/yards for long hours.

ROLE OF POLLUTION CONTROL BOARDS

Since the disposal of municipal solid wastes poses problems of the pollution and health hazards, the Pollution Control Boards are expected to take action for persuading the civic authorities in proper management of municipal solid wastes. Though, direct responsibility of management of solid wastes is on the local municipal authorities, the Pollution Control Boards need to have close linkage with local authorities in rendering assistance in terms of carrying out necessary surveys and providing technological back-up. The Central Pollution Control Board and the State Pollution Control Boards at the national and state levels are to disseminate information and create awareness among the concerned authorities and public at large.

Action Taken

The Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs) within the given powers to them under relevant Acts and Rules have been attempting to persuade local bodies to take appropriate measures for the treatment and disposal of domestic sewage and municipal solid waste.

Directions

In order to initiate a systematic approach on proper management of municipal waste (sewage and solid), CPCB issued directions to all SPCBS under section 18 of the Water (Prevention and Control of Pollution) Act,1974.

Follow-ups on Directions - In compliance to the directions of the CPCB and through initiatives of SPCBs some actions have been taken. Also SPCBs have issued notices to local bodies in the states/ UTs and impressed upon them to take proper measures.

Annexure F.

"Integrated Solid Waste Management"

[48]National Solid Waste Association of India

Population, infrastructure and regulation are the three main factors that play a significant role in achieving an **Integrated Waste Management** in any locality as they are interrelated. In India, though the waste management policies and regulations are in place, their effective implementation fails due to the growth in population at alarming rate and ineffective implementation plans.

Countries all over the world have developed their own strategies to combat their waste management issues and have been successful. Municipal Solid Waste Management is limited to collection, transportation and disposal of un-segregated waste. The treatment and process technologies more often imported from other countries does not suit our waste characteristics and prove to be unsuccessful. Hence, most of our garbage finds its way to the Municipal Solid Waste Dumping Grounds. The dumps are filling up faster than we can even find newer sites for them. There is a need to have an Integrated Waste Management System that would provide sustainable solutions in our country. The 4 R's principles i.e. **Reduce, Reuse, Recycle & Recover** are the basic components of any waste hierarchy that has to be understood and implemented by each and every citizen of our country to achieve **Sustainable Integrated Waste Management.**

Why do we need to Reduce, Reuse, Recycle & Recover the waste?

- Reduces the amount of solid waste going to landfill.
- Turns waste into a resource &
- Saves natural resources

REDUCE:

Source reduction is by far the most effective way to battle the flow of garbage into the landfill. If we avoid making garbage in the first place i.e. at the point of generation, we don't need to worry about disposal of waste later. Source reduction also refers to segregation of waste at source which plays an important role in reducing the amount of waste going to the landfill. A comprehensive waste-reduction strategy can provide significant financial benefits not just by reducing purchases of unneeded materials, but also reducing real estate and energy costs from having to store and transport them. Hence source reduction is the most preferred method of waste management and is the first step in the waste management hierarchy Waste reduction can be practiced by following simple tips at Home, at Office and in Industry. Most of the components of waste can be reused and recycled if they are segregated, stored and collected in a proper way.

[48] ENVIS NSWAI • ELEVENTH ISSUE - JUNE, 2008
National Solid Waste Association of India (NSWAI) is an NGO working in the field of MSW in India.

Segregation: Waste should be segregated efficiently in an appropriate manner whether at home, office or in industry. Segregation of waste is a key to success for all the successive waste hierarchy components i.e. Reuse, Recycle and Recover.

REUSE:

Reuse is the second step in the waste hierarchy. It is often possible to extend the life of something by reusing it in its original state. Reusing items by repairing them, donating them to charity and community groups, or selling them also reduces waste. Reusing an object will use far less energy than recycling it. One person's rubbish is another person's treasure. Reusing products, when possible, is even better than recycling because the item does not need to be reprocessed before it can be used again. Scrap paper for making notes, scratch pads, (cut, lift & use elsewhere)

RECYCLE:

Recycling of aluminum saves 95% of the CO2 emissions—an environmentally harmful greenhouse gas—compared to refining new metal. Recycling one kilogram of aluminium saves up to 8 kilograms of bauxite, four kilograms of chemical products and 14 kilowatt hours of electricity. It takes 20 times more energy to make aluminum from bauxite ore than using recycled aluminum.
For every ton of recycled glass used, approx 315 kilos of Carbon dioxide and 1.2 tons of raw materials are spared. A 20% reduction in emissions from glass furnaces and up to 32% reduction in energy usage. A ton of paper from recycled material conserves about 7,000 gallons of water, 17-31 trees, 60 lb of air pollutants and 4,000 KWh of electricity. Milling paper from recycled paper uses 20% less energy. Recycling is the physical reprocessing of old materials into new products, with the aim to preventing the waste of potentially useful materials. In addition, it generates a host of environmental, financial, and social benefits, for example Recycling aims to collecting, separating, processing, manufacturing and ultimately using this material which otherwise would have been thrown away as waste. Proper segregation of waste materials at the generation point helps in efficient recycling program. Recycling is a key concept of modern waste management and is the third component of the waste hierarchy. Like any other enterprise, recycling is a business.

The four main stages involved in waste recycling process are:
1. Collection & separation of recyclables.
2. Delivery to a place in waste recycling sector.
3. Processing of recyclables.
4. Manufacturing of new product.

Common household items that contain recycled materials include newspapers and paper towels, aluminum, plastic, and glass soft drink containers, steel cans, and plastic laundry detergent bottles. Recycled materials also are used in innovative applications such as recovered plastic in roadway asphalt, in carpeting, park benches, and pedestrian bridges and also as 'plastofuel'. Construction/demolition wastes are also recycled to manufacture bricks. E-waste recycling is a huge business today due to the technological boom in the IT sector. Collecting recyclable materials is just the first step in a series of actions that generate a host of financial, environmental, and societal returns.

RECOVER:

The biodegradable fraction of waste can be used directly, as feed stock for the production of biological and chemical conversion products, such as, for the production of manure and energy. Bio-methanation is a process of energy recovery from waste in which microorganisms break down biodegradable material in absence of oxygen. The process produces methane and carbon dioxide rich biogas for energy production, the nutrient rich solids left after digestion can be used as fertilizer. There are a large variety of methods and technologies available varying in complexity from simple home compost heaps, to industrial-scale enclosed-vessel digestion of mixed domestic waste.

The energy content of biodegradable waste can be harnessed directly by using them as a direct combustion fuel, or indirectly by processing them into another type of fuel. Recovery of energy through thermal treatment ranges from using waste as a fuel source for cooking or heating, to fuel for boilers to generate steam and electricity in a turbine.

Pyrolysis and gasification are two related forms of thermal treatment where waste materials are heated to high temperatures with limited oxygen availability. The process typically occurs in a sealed vessel under high pressure. Pyrolysis of solid waste converts the material into solid, liquid and gas products. The liquid and gas can be burnt to produce energy or refined into other products. The solid residue (char) can be further refined into products such as activated carbon.

Gasification and advanced Plasma arc gasification are used to convert organic materials directly into elements.

THE INDIAN SCENARIO OF 4R's

The Indian scenario is totally different in terms of reducing waste at source. Due to diverse culture and tradition, source reduction of waste lies far apart as the last option in the waste hierarchy. Besides, there is no segregation of waste in India, since there is no efficient collection system, non enforcement of law and huge cluster of population with paucity of living space particularly in the urban areas. This is a major issue in slums and low-income communities. Ultimately the waste goes to the open dumping yards. However, reusable materials such as plastic and glass bottles, toys, electronic items, etc are reused in the form of refilling and reselling the item. The recycling business in India has a huge network but is highly informal and performed in an un-organized manner such as the e-waste recycling process which are extremely harmful to workers and environment.

CONCLUSION

Waste Management system discussed indicates that the first component of waste hierarchy plays a vital role for Sustainable Integrated Solid Waste Management. The 4R's are interrelated and depend on component in the direction towards the upstream of waste hierarchy. Considering the present scenario of Indian Municipal Solid Waste Management, the first component of waste

Secondly the reuse, recycling and recovery is accomplished in a haphazard way which needs to be organized in a practicable and proficient manner.
However, there are some successful case studies that are being initiated at community and Municipal level in our country which are based on 4 R's principle and aim towards achieving Sustainable Integrated Solid Waste Management.

THIS REPORT IS PREPARED ON BEHALF OF M.P.C.B. (MAHARASHTRA POLLUTION CONTROL BOARD) BY ECO FRIEND AND CO. THIS IS A COMPREHENSIVE REPORT OF VARIOUS METHODS OF DISPOSAL OF PLASTIC WASTE GENERATED IN MUMBAI. THE CONTENTS OF THE REPORT ARE TO THE BEST OF OUR KNOWLEDGE AND WE WOULD LIKE TO APOLOGIZE FOR ANY MISREPRESENTATION.

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