

# A Review on Municipal Solid Waste: Generation and Treatments

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**Abstract**— Municipal solid waste management is becoming one of the major environmental problems in Indian cities. Mismanagement of MSW can cause harmful environmental impacts and public health problems. Many studies reveal that about 90% of MSW is disposed of unscientifically in open dumps and landfills, which create environmental and public health problems. The uncontrolled dumping of waste on the borders of towns/cities have create many environmental problems. This paper presents an overview of production of MSW and available technologies in Indian Cities.

**Key words:** Municipal Solid Waste Management, MSW Treatments, Composting, Vermicomposting, Incineration, RDF Plants, Gasification, Anaerobic Digestion

## I. INTRODUCTION

### A. Municipal Solid Waste Generation:

India is the world’s second largest populated country after China with population of 1.21 billion (census 2011). The annual rate of growth of urban population in India is 3.35% (census 2011). [1] In India, approx. 1.33 lacs metric tons of MSW generates daily. Out of that about 50-90% of total waste is dumped into uncontrolled landfill sites after collected it. The generated MSW was collected without sorting and remainder left to decompose in streets and drains. Due to rapid increase in the population living in urban areas, the volume of MSW is increased. The present annual quantity of solid waste generated in Indian Cities has increased from 6 million tons in 1947 to 48 million tons in 1997 and to 90 million tons in 2009 and it is expected to increase to 300 million tons by 2047. [4]

The quantity of MSW generated depends on a number of factors such as food habits, standard of living, degree of commercial activities and seasons. The quantity and characteristics of solid waste change from place to place. Factors that influence the quantity and composition are the average income level, the sources, the population, social behavior, climate, industrial production and the market for waste materials.

A study showed that 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). The studies carried out by the National Environmental Engineering Research Institute (NEERI) in Indian Cities have revealed that the quantum of MSW generation varies between 0.21-0.35 Kg/capita/day in large cities. Based on this the waste production in municipalities of Kerala can be taken as an average of 0.28 Kg/capita/day. The studies conducted by the Urban Development Section of World Bank, considering the relation between Gross National Product and per capita waste production is estimated to grow at an exponential rate of 1.41% per annum. Therefore, the average production of MSW can be considered as 0.343 Kg/capita/day, with total MSW production of 7056 tonnes/day.

Sr. No	Name of the state	No. of cities	Municipal Population	Municipal Solid Waste (t/day)	Per capita generated (t/day)
1	Andhra Pradesh	32	10,845,907	3943	0.364
2	Assam	4	878,310	196	0.223
3	Bihar	17	5,278,361	1479	0.280
4	Gujrat	21	8,443,962	3805	0.451
5	Haryana	12	2,254,353	623	0.276
6	Himachal pradesh	1	82,054	35	0.427
7	Karnatka	21	8,283,498	3118	0.376
8	Kerala	146	3,107,358	1220	0.393
9	Madhya Pradesh	23	7,225,833	2286	0.316
10	Maharashtra	27	22,727,186	8589	0.378
11	Manipur	1	198,535	40	0.201
12	Meghalaya	1	223,366	35	0.157
13	Mizoram	1	155,240	46	0.296
14	Orissa	7	1,766,021	646	0.366
15	Punjab	10	3,209,903	1001	0.312
16	Rajasthan	14	4,979,301	1768	0.355
17	Tamil Nadu	25	10,745,773	5021	0.467
18	Tripura	1	157,358	33	0.210
19	Uttar Pradesh	41	14,480,479	5515	0.381
20	West Bengal	23	13,943,445	4475	0.321
21	Chandigarh	1	504,094	200	0.397
22	Delhi	1	8,419,084	4000	0.475
23	Pondichery	1	203,065	60	0.295
		299	128,113,865	48,134	0.376

Table 1: Municipal solid waste generation rates in different states in India (Mufeed Sharholly et al.2007)

### B. Composition of Municipal Solid Waste:

Municipal solid waste is generally a mixture of domestic and commercial waste which is generated from the living community. Mainly MSW consist food waste, rubbish, commercial waste, institutional waste, street sweeping waste, industrial waste, construction and demolition waste, and sanitation waste. The composition of MSW mainly a large organic fraction (40%–60%), ash and fine earth (30%–40%), paper (3%–6%) and plastic, and glass and metals (each less than 1%). [4]

Municipal solid waste is mixture of compostable organic matter (fruit and vegetable peels, food waste), recyclables (paper, plastic, glass, metals, etc.), toxic substances (paints, pesticides, used batteries, medicines), and soiled waste (blood stained cotton, sanitary napkins, disposable syringes). MSW consists papers, plastics, yard debris, food waste, wood, textiles, disposable diapers, bones, leather, glass, metal and aluminium. [6]

MSW components like paper, plastic and glass are having the increasing trend from 4.1%, 0.7% and 0.4% respectively in 1971 to 8.18%, 9.22% and 1.01% respectively in 2005, metals are also having the increasing trend during the 190 same period while inert materials and compostable matter are having the decreasing trend from 49.2% and 41.3% respectively in 1971 to 25.61% and 40% in 2005. Increasing trend suggests that the setting up the formal recovery and recycle facilities will be economically a feasible option. [5]

#### C. Storage and Collection of MSW:

In India, the waste is collected very careless. Most of the urban areas are lacking in MSW storage at the source. In Indian cities, for waste collection bins are used which are neither properly designed nor properly located and maintained. This has resulted in the poor collection efficiency. The bins are common for both decomposable and non-decomposable waste. In India, no segregation of waste is performed. After collection, the waste is disposed at a communal disposal center. There are two types of storage bins are used (i) movable bins and (ii) fixed bins. The movable bins are easily transport but it is not durable. But the fixed bins are more durable but their positions cannot be changed once they have been constructed. The collection of MSW is responsibility of corporations/ municipalities. For collection of waste, bins are placed at various points along the roads. [5]

#### D. Transfer and Transport of MSW

Collection and transportation activities consume approximately 80–95% of the total budget of MSWM. Municipal agencies use their own vehicles for MSW transportation, in some cities they are hired from private contractors. [6]

## II. TREATMENTS FOR MUNICIPAL SOLID WASTE

The target of treatment and processing of municipal solid waste (MSW) are minimizing the volume of landfilled waste and recovering possible resources. India is facing the lacking of the technical expertise necessary to deal with the disposal of MSW. In India, very small amount of the MSW is converted into compost (Annepu and Annepu, 2012). Remaining MSW is disposed on landfill sites. In India, an incineration and anaerobic digestion was also introduced as waste-to-energy system of solid waste disposal.

#### A. Composting:

Composting process define as the decomposition of the organic matter present in MSW in the presence of oxygen and moist conditions. After composting process, finally compost (humus) are produced, which has very high N, P, K value. It can be used as fertilizer, and is non-odorous and free of pathogens. Composting can be carried out in two

ways i.e., aerobically and anaerobically. As a result of the composting process, the waste volume can be reduced to 50–85%. Composting of MSW is, the simplest and cost effective technology for treating the organic fraction of MSW.

#### B. Vermicomposting:

Vermicomposting is a process for turning organic waste into valuable compost by using earthworms and microorganisms. Vermicomposting define as decomposition of organic waste by using the joint action of earthworms and aerobic microorganisms. In Vermicomposting, initially decomposition of organic waste occurs through microorganism's activity. Then Earthworms feed on partially decomposed waste. In a day, Earthworms consuming organic matter five times more than their body weight. The consumed food is further decomposed in the gut of the worms, so that particle size decreased. The worm cast is known as vermicompost, which is a fine, odorless and granular product. Vermicompost can use as a bio fertilizer in agriculture. Nutrients in vermicompost are often much higher than traditional garden compost. Vermicomposting has been used in Hyderabad, Bangalore, Mumbai and Faridabad.

#### C. Biomethanation (Anaerobic Digestion):

Biomethanation is the process of conversion of organic waste to methane and manure by using anaerobic microorganisms in absence of oxygen. The solid wastes from agro-based industrial is treated by biomethanation process and produced useful products such as biogas and manure because that solid waste have high organic content. Generally, Biomethanation Process consists two steps, (i) Acidification and (ii) Methanation. Biogas which obtain from biomethanation, consists 55–60% of CH<sub>4</sub> and CO<sub>2</sub>, which can be used directly as a fuel or for power generation. It is estimated that by Biomethanation, 1 ton of MSW produces 2–4 times as much CH<sub>4</sub> in 3 weeks in comparison to what 1 ton of MSW in landfill will produce in 6–7 years.

#### D. Incineration:

In Incineration Process, the solid waste is complete combusted in control condition. Incineration Process is used for toxic wastes such as hospitals waste. In Incineration Process, the waste was burned at 980°C to 2000°C temperature. After Incineration Process, the volume of solid waste is reduced by 80%-90%. Unfortunately, in Indian cities, incineration is not very much used for treat MSW. Because in Indian cities, the waste consists high organic material (40–60%), high moisture content (40–60%), high inert content (30–50%) and low calorific value content (800–1100 kcal/kg). The first large scale MSW incineration plant was constructed at Timarpur, New Delhi in 1987 with a capacity of 300 t/day and a cost of Rs. 250 million (US\$5.7 million) by Miljotechnik volunteer, Denmark. In many cities, small incinerators are used for burning hospital waste. [5]

#### E. Landfilling:

Landfilling is disposal of waste with different liners and finally with earth cover. In Indian cities, open, uncontrolled and poorly managed dumping is commonly practiced, due to that many serious environmental problems are rise. In India, more than 90%-95% of total MSW are directly disposed on

land in an unsatisfactory manner. Landfills produce landfill gases and leachate which can harm human and natural systems. Landfills produce landfill gases (LFGs), produced when methanogens decompose complex molecules, are primarily methane and carbon dioxide (up to 90%), but also include CO, N<sub>2</sub>, alcohols, hydrocarbons, organosulfur compounds, and heavy metals. Leachate can cause surface water and ground water pollution. In many Indian cities, the land availability for waste disposal is limited. In many landfill sites, compaction and levelling of waste not done and leachate collection and landfill gas monitoring was also not practiced. As MSW was not segregated at source, all of the wastes including infectious waste from hospitals generally find its way to the disposal site. [2]

#### F. Pyrolysis:

Pyrolysis is a thermochemical conversion process where a solid fuel is heated in the absence of an oxidizing agent (in an inert atmosphere). Pyrolysis, as a conversion process, yields 3 products:

- a gas mixture;
- a liquid (bio-oil/tar); and
- a solid residue (char).

Two technologies exist and differ on the method of heat transfer: fast pyrolysis for production of bio-oil and slow pyrolysis for production of charcoal. The primary disadvantages of pyrolysis processing are:

- 1) The product stream is more complex than for many of the alternative treatments;
- 2) The product gases cannot be vented directly in the cabin without further treatment because of the high CO concentrations.

#### G. Gasification:

Burning of solid waste under insufficient oxygen conditions is called gasification. By the Gasification Process, fuel gas was produced which could be stored and used when required. In India, there are few gasifiers in operation, but they are mostly for burning of biomass such as agro residues, sawmill dust, and forest wastes. Gasification can also be used for MSW treatment after drying, removing the inerts and shredding for size reduction. [4] There are two gasifiers exist in India. The first one (NERIFIER gasification unit) is installed at Nohar, Hanungarh, Rajasthan by Narvreet Energy Research and Information (NERI). The second unit is the TERI gasification unit installed at Gaul Pahari campus, New Delhi by Tata Energy Research Institute (TERI) (CPCB, 2004). [4]

#### H. RDF Plants:

RDF define as Refuse Derived Fuel. RDF plants used for treating MSW and reduce pollution and producing power. Due to RDF plant pressure on landfills was reduced. RDF may be fired as the conventional fuels like coal without any adverse effects for producing power. Operation cost of the thermal treatments are high, and it require a relatively higher degree of expertise. The main purpose of the RPF treatment is produce fuel from MSW. [4] In India, many RDF plants are in operation at Hyderabad, Guntur and Vijaywada in Andhra Pradesh State. In Hyderabad RDF plant the RDF production is about 210 t/day as fluff and pellets, and it is going to be used for producing power (about 6.6 MW). In Bangalore RDF plants compacting 50 t/day of garbage,

converting into 5 t of fuel pellets, which can be designed both for industrial and domestic uses.

### III. SUMMARY

In India, large amount of MSW is dumped on land in uncontrolled manner. These dumping activities creates human and animal health problems and result in economic, environmental and biological losses. In MSW management, the lack of resources such as financing, infrastructure, suitable planning and data, and leadership, are the main barriers.

Composting and vermicomposting are successful and quite popular now in India instead of incineration. But, it is slow process and requires a large space. An open dump or an uncontrolled waste disposal area should be reformed. It is necessary to move from open dumping to sanitary landfilling for Sustainable Development. Landfilling should be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing.

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