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Solid Waste Management in Davangere

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Abstract - *Davangere being the sixth largest city in the state is home for a population of 4.35 lakh as per 2011 census and is estimates to grow further to 6.87 lakh of population by 2031 in a business usual scenario. At present Davangere generates around 168 tons per day of municipal solid waste which is collected by the City Corporation at door step level using auto tippers and pushcarts engaging Self Help Groups. The waste from bulk generators and chicken centers are collected separately by the tractor tippers. The street sweeping waste is also collected and transported to Avargolla site. The silt from drains is collected and transported to designated spots which are used for reclamation of low lying area. Of the estimated generation of 168.32 TPD of waste, the city currently collects 120 TPD. Therefore, the present collection efficiency is estimated 71%.Per capita household waste generation was found to be 210 gms. The result of Physical characterization of the solid waste of the Davangere city consisted of Organic waste-51%, plastic polythene bags-2.2%, PVC-1.4%, HDPE-1.15%, Laminated/Multilayered plastic- 2%, Polyprolene 3.5%, Polystyrene-1.3%, Paper-5.5%, Cardboard-1.5%, Glass-0.8%, Metal-0.24%, Wood-0.41%, Textile-6.84%, Leather/ Rubber- 7.56%, Inert-9.9%, Battery/ bulb – 0.%, Electronic wastes- 0.4%, sanitary napkins/ diapers/Medicines – 1.1%.Based on the quality and quantity of garbage generated in Davangere windrow compositing was found as the most suitable option.*

1. INTRODUCTION

It is estimated that, at present, 1.5 lakhs tonnes per day of solid waste is generated in India. Where in major Indian cities, per capita generation of the solid waste ranges from 0.2 kg to 0.6 kg for major cities, the efficiency of collection ranges from 70% to 90% whereas in smaller cities it is below 50%. In recent years, collection, disposal of MSW has been a serious issue in city areas. It is important to scientifically treat and dispose the solid waste, which in turn not only essential for preservation and enhancing the health of the public, but also it has an unlimited potential for the recovery of resources.

2. MATERIALS AND METHODOLOGY

Waste Quantification

The current practice for quantifying the waste generation rate in the city is by measuring the waste load in the collection by the collection vehicles at the private or municipal weighbridge in the city. The alternative to this method is that the capacity or the volumes of the different vehicles involved in the waste collection and transportation is considered and as a thumb rule of 400 to 500 kg/m3 is taken to quantify the waste that is being transported per trip per vehicle. Finally, sum of the total quantities of the waste that is transported by the each vehicle is multiplied by the total number of the trips that is transported to the landfill is made to determine the final total quantity of the waste transported in the ULB. This practice of the eye estimate of quantities is not reliable many a times as many a times the trucks carry half of its full capacity or carry light materials.

Procedure for the Quartering and Coning of the samples.

- 10 KG of municipal solid waste is taken by thoroughly mixing from the waste pile after it is mixed inside and outside of the representative sample which is taken for the quartering and coning method.
- The municipal waste samples collected must be heterogeneous samples from different points of sampling and this must be thoroughly mixed.
- A heap of the waste sample is made which is further divided into the four portions by the perpendicular straight lines.
- The municipal solid waste from the opposite corners in the perpendicularly divided quarter is taken to leave the remaining original half of the waste sample. Then the remaining portion is repeatedly mixed by further carrying out the quartering and coning process until a sample of desired size is obtained.
- The final remaining fraction of the portion must be efficiently mixed to carry out various physical and the chemical properties of the waste.
- The chemical analysis of the municipal waste sample is carried out in a laboratory which is accredited by MoEFCC (Ministry of Environment, Forest and Climate change).

Density

Density plays a significant role in the waste management as it is an essential element in the storage, transportation and disposal of the MSW. For instance, in higher income nations, it is observed that the solid waste that is produced is of lower densities and hence the principle of compaction may be applied by utilising the compaction vehicles. By this process of compaction, the solid waste that is produced with an initial density of about 100 kg/m3 will be easily increased to around 400 kg/m3.

Bulk density

To produce a composite sample, waste must be taken from the different parts of the heap and measured in a box of less than 0.028 meter cube volume, and with the help of the spring balance, the weight is noted. After carrying out this weighing process, it must be emptied to a bigger capacity container of 1 meter cube capacity and the weight of this container after filling it with the municipal waste is noted. This waste must not be compacted by an external pressure. This process must be carried out three times and its average must be taken. Hence by this process the weight per cubic meter is obtained

Bulk density (kg/m3) = (A- B) / (V)

B = weight of the empty container.
A = Weight the container and its contents
V = Weight a container of known volume

Moisture content

The weight of moisture content that is present in the unit weight of wet materials is called as moisture content of the solid waste.

Moisture content (%) = ((*A*−*B*)*A*) X 100

Where, A= initial weight of the sample as delivered
B= weight of sample after drying

3. RESULTS AND DISCUSSIONS.

Waste Generation.

As per the detailed quantification and characterisation survey conducted, the total waste generated for the Davangere city is 168.32 TPD. This excludes the construction and demolition waste and biomedical waste generated in the city. The major source of waste generated in the city is from the domestic households.

	Source of generation	Emission rate	unit	numbers	TPD
1	Residential	0.21	Kg/capita/day	1,07,876	111.27
2	Commercial shops	1.50	Kg/shop/day	11,649	17.47
3	Choultries/ marriage halls	0.58	TPD	57	2.69
4	K.R. Market	2000	Kg/market	1	2
5	Hotel waste	13.08	Kg/hotel/ day	456	5.97
6	Meat/chicken shops	8.37	Kg/stall/day	203	1.70
7	Floating population (railway station /bus stand)	1667	Kgs/station	3	5
8	Street sweeping and drain silt			3	19.02
9	Hostels	20	Kgs/hostel	18	0.36
10	Vegetable shops	5	5	90	0.45
11	Waste from hospitals	10	Kgs/unit	56	0.56
	Total				168.32

Collection and Transportation.

a) Waste collection

Of the estimated generation of 168.32 TPD of waste, the city currently collects 120 TPD. Therefore, the present collection efficiency is estimated to be 71%. The collection of wastes is divided into two stages, primary and secondary collection. The primary collection involves collection of wastes from various sources to the secondary storage units while secondary collection involves transfer of wastes from secondary storage to the landfill site.

b) Collection and transportation system.

The primary collection system currently comprises of door to door collection of mixed wastes from the households and from the street sweeping. All other generators are not currently not covered directly as there is a predominance of bins in the city. There is no segregation practiced at the source, primary or secondary levels of collection.

Waste quantification and characterisation in Davangere Landfill site.

Table:- Physical Characterisation of the Old Dump Site Solid Waste, 12.5 Kg of Sample Collection.

Waste composition	Units	Results
Organic waste	%	39.19
Plastic polythene carry bags	%	3
PVC	%	1.5
HDPE	%	1.1
Laminated/Multi-layered	%	2.2

plastic		
Polypropylene	%	4
Polystyrene	%	2.1
Paper	%	2.35
Cardboard	%	3
Glass	%	1.4
Metal	%	0.24
Wood	%	3.26
Textile	%	5
Leather/Rubber	%	5.26
Inert	%	25.3
Battery/Bulb	%	1
Electronic wastes	%	
Domestic hazardous-Diapers/Sanitary Napkins/Discarded Medicines	%	1
	100	100

Table: Physical Characterization of Fresh Solid Waste of 12.5 Kg of Sample.

Waste composition	Units	Results
Organic waste	%	54
Plastic polythene carry bags	%	2.2
PVC	%	1.4
HDPE	%	1.15
Laminated/Multilayered plastic	%	2
Polypropylene	%	3.5
Polystyrene	%	1.3
Paper	%	5.5
Cardboard	%	1.5
Glass	%	0.8
Metal	%	0.24
Wood	%	0.41
Textile	%	6.84
Leather/Rubber	%	7.56
Inert	%	9.9
Battery/Bulb	%	0.2
Electronic wastes	%	0.4
Domestic hazardous-Diapers/Sanitary Napkins/Discarded Medicines	%	1.1
Total	100	100

Landfill Site Leachate Analysis

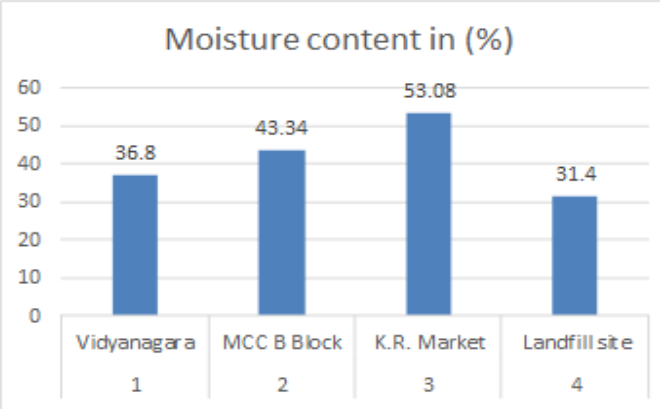
Test parameters	Units	Results
pH	mg/L	7.29
Suspended solids	mg/L	289
Dissolved solids	mg/L	6951
BOD	mg/L	4200
COD	mg/L	14700
Ammonical Nitrogen	mg/L	80
Total Kjeldahl Nitrogen	mg/L	240
Chloride as Cl	mg/L	577.6
Fluoride as F	mg/L	1.8
Arsenic	mg/L	1.2
Mercury as Hg	mg/L	0.09
Lead as Pb	mg/L	0.38
Cadmium as Cd	mg/L	0.05
Total Chromium	mg/L	0.12
Copper as Cu	mg/L	2.6
Zinc as Zn	mg/L	1.15
Nickel as Ni	mg/L	0.2
Cyanide as CN	mg/L	0.09
Phenolic compounds	mg/L	Not detected

Moisture content.

With an increase in the moisture content of the waste, weight of the solid waste increases. It was found out that the moisture content is usually high in the lower income areas due to the fact that in that the waste of the lower income communities consists of higher quantities of the food waste.

The table below represents the moisture content of the waste from the four stations that is the mixed waste from the (1) Vidyanagara block, (2) MCC B Block, (3) K.R Market and (4) the landfill site respectively.

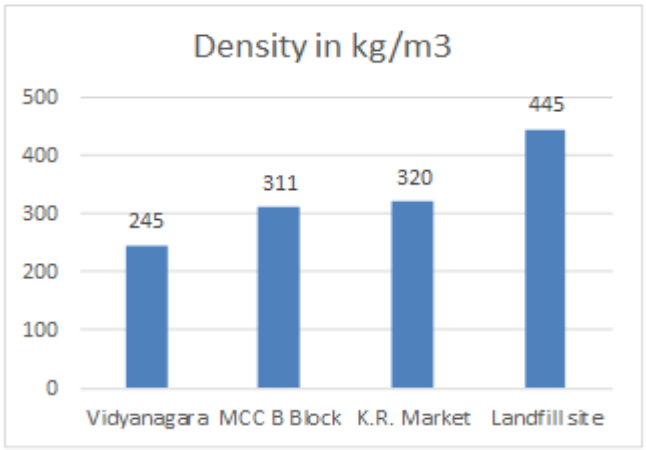
Sl no	Location of sample	Moisture content in (%)
1	Vidyanagara	36.8
2	MCC B Block	43.34
3	K.R. Market	53.08
4	Landfill site	31.4



Density.

The table below represents the densities of various samples. The highest value of the density was found to be that of the landfill site, which might be due to the compaction of the waste in the compactors or due to the transportation of the waste. The least values of the density was that of the mixed waste from the vidyanagara block.

Sl no	Location of Sample	Density
1	Vidyanagara block	245
2	MCC B block	311
3	K.R. Market	320
4	Landfill site	445



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Major issues.

a) Environmental impacts.

As there is no proper waste collection and segregation system exist in the entire Davangere town, haphazard dumping of wastes was observed in most parts of the town. This situation is even worst in the slum and low income group wards. These wastes are mixed in nature mainly from residences and commercial entities. This is due to lack of awareness in local public and deficiency of logistics and man power in the local body. A collected waste from the town is taken to Avaragolla landfill site located 8 km away from town towards North West side.

Unscientific dumping of wastes in town as well as in the landfill site may have serious impact on the environment. Decomposition of mixed waste into the constituents of chemicals is a most common source of the environmental pollution. Methane in turn is a by-product of anaerobic respiration of bacteria and these bacteria thrive in high amounts of moisture. Due to this, there are many incidences of fie accidents witnessed in the landfill site. Apart from the methane gas emission, there are other forms of gas emissions such as VOC, CO2,H2S, toxic gases etc., due to disposal of biomedical and hazardous wastes from the households. These gases are major contributors of the enhanced greenhouse gas effect and climate change.

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Leachate from these wastes dumps infiltrate into the groundwater level causing ground water contamination. Further during rainy season, surface runoff from these waste dumps pollute nearby surface bodies, causing serious health impacts on its users especially aquatic ecosystem.

Surface Land fire in Avaragolla Landfill Site.

B) Health impacts

Improper disposal of wastes in residential and commercial areas are directly associated with health hazards. Deterioration of the health, flood incidences, accidents and environmental pressures are some of the harmful effects. Waste dumping near households or on the outskirts of the settlements, boosts the incubation and propagation of flies, mosquitoes and the rodents. These are in turn will be the disease transmitters that affect health of local population, which has its organic defences in a formative and creative state. Common health issues related to these vectors are respiratory, dermatological, genetic, gastrointestinal, and several other kind of infectious diseases. Sanitary labourers, who re directly working in waste collection process and labourers working in landfill sites are more prone for the health related issues

c) Social impacts

Social concerns in solid waste management are indirectly associated with health and environmental issues. Dumping of wastes near the road ends/ corners or at road side unmanned locations creates nuisance to the public. It especially aggravates when the dumped wastes start sinking. This becomes a social concern for public and they start to protest, registering complaints with concerned officials and reporting in the media/newspapers. NGOs and associations will play a key role in expressing their grievances. Transportation of wastes without covering vehicles is also one of the major concerns for the public. Davangere city lacks scientific disposal system at present.

4. EVALUATION OF WASTE TREATMENT OPTION

The detailed evaluation of various waste treatment options are reviewed and assessed. These options are not considered due to the following reasons:

1. Incineration:

Incineration is not suitable for the Davangere because of the waste characteristics indicated low calorific (960Kcal/Kg) value and 31.4% moisture content with inert materials. Incineration is a processing technology for the management of heterogeneous mixed waste and also affects maximum reduction in mass in volume of the waste to ensure lower quantities of the rejects going for the sanitary landfill. However incineration has major environmental issues such as toxics emission of harmful dioxins, furnaces, especially if plastic waste is also incinerated along with other types of waste. In addition, disposal of fly ash and bottom ash are also additional environmental considerations in this process. The regulatory policies in many countries do not allow the incineration technology. Some of the international development and funding agencies also do not approve of the incineration process for WTE (waste to energy) technology.

2. Refuse derived fuel:

Thermo chemical conversion: RDF may be done for segregated waste portions only and not for the complete waste. The RDF (Refuse derived fuel) technology typically include process of pre-separation of recyclables, drying, shredding and densifying to make a product that can be easily handled. RDF in the soft fibres form fabrics can be used for onsite power generation or the densified RDF pellets can be used in other industries as a fuel.

3. Bio-methanation/Bio-chemical/Anaerobic digestion successful:

Successful solutions to this option will only develop if they are basically self-sustaining and economically viable. Bio-methanation technology requires completely segregated wastes as the input material and the process is not suitable for mixed waste at all. Secondly, Bio-methanation also requires an energy evacuation source in the vicinity of site for establishing its feasibility.

4. Pyrolysis/gasification –Thermo-chemical conversion:

This is an emergent technology for the energy/ recovery of resources from the organic waste and high costs.
Based on the quality and quantity of garbage generated in Davangere the above options are not suitable except windrow compositing. Moreover, these technologies are very expensive, complex ones and are suitable only where waste generation is in very large quantity. In view of these constraints, high capital costs, complex design and high cost of O and M as mentioned above, these treatment methods are not recommended. As per the MSW rules (in management and handling) 2016 specifies that the organic fraction of the municipal solid waste shall be treated with appropriate technology before it is landfilled. Therefore, composting is preferred for treating the organic waste.

5. CONCLUSIONS AND RECOMMENDATIONS

- The estimated generation of Municipal Solid waste in the Davangere city was found to be 168.32 TPD out of which the city currently collects 120 TPD. Therefore, the present collection efficiency is estimated 71%.
- Per capita household waste generation was found to be 210 gms.
- The result of Physical characterisation of the solid waste of the Davangere city consisted of Organic waste-51%, plastic polythene bags-2.2%, PVC-1.4%, HDPE-1.15%, Laminated/Multi-layered plastic- 2%, Polyprolene 3.5%, Polystyrene-1.3%, Paper-5.5%, Cardboard-1.5%, Glass-0.8%, Metal-0.24%, Wood-0.41%, Textile-6.84%, Leather/ Rubber- 7.56%, Inert-9.9%, Battery/ bulb – 0.%, Electronic wastes- 0.4%, sanitary napkins/ diapers/Medicines – 1.1%.

- The result of Chemical characterisation of the solid waste was found to be Moisture-31.42%, Volatile-43.15% ,Combustible matter-4.0%, Fixed carbon-6.77%, Ash content-18.66%, Potassium as K-0.88%, C:N ratio-80.01:1, Arsenic-0.22 ppm, Selenium-0.04 ppm, Zinc as Zn-4.52 ppm, Iron as Fe-0.5ppm, Nickel as Ni-3.2ppm.

- The result of the Moisture content of the waste from the four stations that is the mixed waste from the are (1) Vidyanagara block- 36.8%, (2)MCC B Block-43.34%, (3) K.R Market-53.08% and (4) the landfill-31.4% site respectively.

- The result of the Density of the waste from the four stations that is the mixed waste from the are (1)Vidyanagara block- 245 kg/m3, (2)MCC B Block-311 kg/m3, (3) K.R Market-320 kg/m3 and (4) the landfill-445 kg/m3 site respectively.

- Based on the quality and quantity of garbage generated in Davangere the above options are not suitable except windrow compositing.

- The results of the leachate analysis at the landfill site clearly indicates the immediate need for the construction of a leachate treatment system in the Avaragolla landfill site.

- The present system of treatment and disposal of solid waste by Davangere City Corporation does not comply with MSW Rules 2016 and the major key issues in the existing SWM system are detailed below;

  a) Waste collection and transportation needs to have proper planning and redeployment.
  b) Decentralized waste management system should be introduced.
  c) Unplanned dumping of waste is leading to loss of valuable land which will otherwise costs Davangere City Corporation very heavy if looked for any new land procurement.
  d) Unscientific dumping of waste is degrading the environment and health of surrounding residents and property.
  e) Non recovery of resources which due to absence of segregation is leading un-necessarily being dumped in landfill site, thereby reducing the life of landfill and also losing good resources like compost, recyclables etc.
  f) Aesthetic depreciation of land and its surrounding areas.
  g) Un-hygienic condition will invite spread of epidemic and endemic diseases for villagers/workers around the site

The current practices are thus unsafe and do not confirm Municipal Solid Waste (Management and Handling) Rules, 2016. Hence, there is an immediate need to upgrade the existing system of treatment and disposal, to well-planned scientific disposal of solid wastes, where, not only the wastes are treated in scientific way, but, the energy can be recovered through proper windrow composting, along with material recovery

RECOMMENDATIONS

- **For the Unscientific practices of Waste collection**
  The existing unscientific practise of garbage collection system and disposal of garbage in the drains and open spaces, burning of garbage etc needs to be stopped.

- **For the Segregation of waste at source**
  Presently there is no segregation of garbage at the household level. Therefore, distribution of two bins and one bag for promoting segregation of waste at the source is recommended.

- **For the Primary collection and secondary transportation**.
  Tractors should be replaced with 4 wheeled Auto-Tippers with hydraulic mechanism for the wet waste. Primary collection vehicle carrying the wet waste should be transported to refuse compactor vehicle at the respective transfer point. Handling over of dry waste collection centers (DWCC)

- **For the Waste processing by composting.**
  The existing 4 mm sieve is often reported due to clogging problem. This needs to be strengthened with additional sieving equipment for the compost plant and upgrading it with 100 mm, 35 mm and 16 mm sieves with necessary infrastructure.

- **For the Waste disposal by landfill.**
  The rejects from the compost plant and the non-bio degradable waste must be disposed off in the Sanitary landfill at Avaragolla.

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