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Characterization of Municipal Solid Waste for Muzaffarnagar City in Western UP, India

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ABSTRACT: This report consists of the Characterization of municipal solid waste and management of MSW for Muzaffarnagar City, UP, India. Characterization of Municipal Solid Waste in a city of western UP has been performed in order to determine the suitability for waste processing technologies in the city. Characterization is an important parameter in order to decide an appropriate design, cost effective and environmentally friendly municipal waste management system. Physical characterization suggests about the organic and inorganic fraction in the waste. Geotechnical characteristics of waste helps in deciding the technology in design and maintenance of the landfill, whereas chemical characterization of the waste helps in deciding the technology in order to process the waste such as composting, vermicomposting, and Refused Derived Fuel. The results of characterization indicate that the approximated generation of the waste of the city is 135 -145 MTD. The average per capita waste generation is 0.415 kg/person/day. A big fraction of the waste is organic in nature and has a significant calorific value too. Moreover, analysis for better Municipal Solid Waste management also has been done. Around 80 - 85% of the city is covered by door-to-door collection method. The whole city is divided into 41 wards. Each ward has a collection point. Most of the ward's bin are overflowing throughout the year. Moreover, some of the wards don't have bins, so open dumping of the waste is taking place. There are not separate bins for organic and inorganic waste. There are 8 dumpers, 5 JCB, 4 tractors and 1 Ace are deployed in the city. There are inadequate labour and transportation system for the conveyance of waste. Composting and RDF are the methods to process the waste. Since last few years load on the treatment plant has increased significantly. There are not enough equipment and machines on the site that can process the waste, which has resulted into the mountains of waste in the site and around the site as well. Heaps of waste around the site cause bed odour and made unhygienic environment in the vicinity. The site has become house for many animals and insects. Still there is no provision of engineered landfill site, so ground water is going to be contaminated. It is observed as environmental problem in future. Due to no landfill provision it is a leachate problem which is the big problem.The thesis summarizes that the current solid waste management system is not sustainable and not proper. The proposed system can be improved on following the list of recommendations mentioned in the thesis. The thesis concludes that people in Muzaffarnagar city area are willing to participate and contribute towards the development of a sustainable system. Finally, a set of recommendations have been provided for laying the foundation towards good solid waste management system in Muzaffarnagar City. Muzaffarnagar city does not have any sanitary landfill for final disposal of the waste. In the Muzaffarnagar Municipal limit, the collected MSW is disposed off Near Kali Nadi and Saharanpur Bus stand (earlier).

Keywords: Municipal solid waste, Municipal Solid Waste (management and handling) rules, 2000, Muzaffarnagar Corporation, Characterization, MSW, Landfill, RDF, Composting, Leachateetc.

I. INTRODUCTION

1.1 General

This chapter will involve basic introduction about Solid waste management andIndian Scenario. This chapter will also include the brief introduction of solid wastemanagement practice in the Muzaffarnagarcity.The thesis concludes that people in Muzaffarnagar city area are willing to participate and contribute towards thedevelopment of a sustainable system. Finally, a set of recommendations have beenprovided for laying the foundation towards good solid waste management system in Muzaffarnagar City. Muzaffarnagarcitydoesnothaveanysanitarylandfillfo rfinaldisposalofthewaste.Inthe Muzaffarnagar

Municipal limit, the collected MSW is disposed off Near Kali Nadi and Saharanpur Bus stand (earlier).

1.2 Solid Waste and its Management

"Waste is defined as any material that is not useful and does not represent any economic value to its owner, the owner being the waste generator". Municipal Solid Waste involves collection, segregation of waste generated by different part of our society i.e. residential, commercial, institutional, farms, gardens, slums etc., handling, transportation, processing and final disposal on engineered and fill siteina cost effective and environmental friendly manner. Amount of solid waste generated varies with place, season and income group. [Urban solid waste management in Indian cities, PEARL, 2015] There is no doubt to say that now management of municipal solid waste is an essential part of our modern society and one among the essential and obligatory services provided by local administration in the country to establishaneat,cleanandhygienicenvironment.Today intheeraofrapidlygrowingeconomies and population mainly in developing countries generation of Solid Waste and its managenth as emerged as huge problem all over the world. The development and collection of reliable data regarding generation and characterization of the waste is one of the main issues in front of the Urban Local Bodies (ULB) all over the India in order to maintain a successful MSW management. As if now, scarcity of reliable information and data regarding generation rate, amount,andtypeofsolidwastecreatesanobstacleindev elopinganefficientandenvironment friendly waste management plan. (Indris et al. 2004) has reported that problem of municipal solid waste generation has increased continuously in relation to the population and demands more land disposal. "However, waste generation increases continuously in proportion with population and challenging more land disposal." (Indris et al.2004)

"Around the world, waste generation rates are rising. In 2016, the worlds' cities generated 2.01 billion ton of solid waste, amounting to a footprint of 0.74 kilograms per person per day. With rapid population growth and urbanization, annual waste generation is expected to increase by 70% from 2016 levels to 3.40 billion tonnes in 2050."

Definition according to the Basel Convention by UNEP; "as substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law". Activities involved in our day to day life results into wide variety of wastes generated from different sources. It is the fact that source reduction and prevention ofwasteatsourceismuchcheaperthanpreventingthew astecontaminationintheenvironment.

Globally,almostallofthecountriesarefacingagreatcha llengeinordertoproperlymanagetheir waste and minimize the final load on the landfills within provided and fund and eco- friendly manner.

"Inefficientmanagementofwasteisoneofthedominant reasonsbehindtheenvironmental pollution. The World Health Organization (WHO) reported that approximately one fourth of the diseases faced by mankind today happen due to exposure of human with environmental pollution for a long duration." Among all of the diseases most of them are not easily detected and result of which not appe are din childhood and manifested laterinyoungage. It is generally noticed that waste is usually dumped near to the slums so it generally affects the poorer communities of the society. Heath implications for people who are involved in the waste management is most common because of the unsound waste management. A significant number of waste picker are directly in contact with hazardous waste as they have to do it for the survival of their family. Heavy Metals like Lead, mercury, iron, nickel, cobalt and copper are "infectious agents from healthcare facilities—as well as dioxins and other harmful emissionsreleasedduringtherecoveryofvaluablemate rialsfrome-waste—notonlyaffectthe health of waste pickers, but also contribute to air, land and watercontamination."

Waste management based on the Industry is one of the most effective Waste Management practice with an annual turnover above $433 billion and unites approximately 40 million workers(includinginformalrecyclers).Thisindustryc oversasignificantvarietyofoperations fordifferentwastestreamsanddifferentphasesofthewa stelife-cycle.Itisconsideredthatthe industry will further grow, especially in developing countries, and recycling business will be the cornerstone of it. If we talk about the employment from waste industry, Waste Recycling is one of the most important sectors in terms of development of employment. Currently 12 million people are involve in it in just three countries—Brazil, China and the United States, methane generated from l and fills biggest ource of GHG emissions,generated bytheanaerobic decomposition of organic fraction of the waste stream. "The average per capita waste generation in India is 370 grams/day as compared to 2,200 grams in Denmark, 2,000 grams in USand700gramsinChina."(FactorsInfluencingMuni cipalSolidWasteGenerationinChina: A Multiple Statistical Analysis Study2011).

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1.3 Study Area and its MSWmanagement

UttarPradeshisthebiggeststateinthecountryinterms ofpopulation.Thereare5cities in the state which population more than 1 lack, Muzaffarnagar is one of them. The Study area is Muzaffarnagar City, UP, India, Fig.1.6 shows the location of Muzaffarnagar onthe mapofIndia.Muzaffarnagar,locatedinthenorthernpartofUttarPradesh,popularlyknown as Sugar bowl of India. It is roughly rectangular in shape. The economy of the district is mainly based on agriculture & sugarcane, paper and steel industry. Muzaffarnagar urban coversanareaof150Km^2."RecentlyMuzaffarnagarhasbeenincludedinNationalCapital Region by government of India. The city is located in the middle of highly fertile upper Ganga-Yamuna Doab region and is quite near to the National capital, making it one ofthemostdevelopedandprosperouscitiesofUttarPradesh"(Wikipedia).Temperaturein Muzaffarnagar varies between 47°Cto -0.9°C. The average annual temperature of the city is24.02°C.TheAveragerainfallofthecityis955mm.Thedriestmonthis April,with3mm of rain. Highest precipitation falls in July, with an average of 294 mm. The Urban agglomerationliesbetween$29^0 28' 56'' N 77^0 42' 00^0 E$(Wikipedia).Asper2011census, Muzaffarnagar Municipality has a population of 392,451 and the urban agglomeration has a population of 494,792. The population of the city is increasing at a rate of 1.5% per annum.Sugarandjiggeryareimportantindustriesinthecity.Sinesoilandenvironmentis veryfavorableforthefarmingMuzaffarnagarhasbecomehubofjiggerytradingbusiness. Muzaffarnagar has 8 Sugar mills and many steel industries. More than 40% population is involved in farming. According to Economic Research firm Indicus Analytics, "MuzaffarnagarhasthehighestagriculturalGDPinUttarPradesh.Muzaffarnagarhasmajor paper, sugar and steel industries." Daily generation rate varies between 120-130 MTPD. The Average generation rate of MSW is 0.315 kg/person/day. Whereas per capita waste generation for LIG, MI Gand HI Gare0.1388,0.1666,0.6441kg/dayrespectively.Thecityhas ample number of institutes, hospitals, shops, hotels and restaurants and approximately 64000 households. The organic matter in solid waste in developing countries is much higher than that in the waste in developed countries (Bhide and Sundaresan 1983).By2010, waste used to dump near the Kali Nadi and Near Saharanpur Bus stand in outskirts of Muzaffarnagar, as still there is not any engineered landfill in city. Though there is an integrated SWM in the city, but due lack of interest of local bodies and funds the management is not taking place efficiently. In present study review of MSW management in the city has been done moreover physical Characterization, characterization based on income level i.e. High-income group, Low Income Group, Medium Income Group, Chemical properties, geotechnical properties and physiochemical properties of the MWS has beendone.

Map of Muzaffarnagar City

In the city, there are approximately 28 no. of hospitals and 35 no. of clinics are there, biomedical waste generated from those hospitals and clinics does not under go to separate processing of waste. Waste from hospitals and clinics are collected and directly send to the same MSW dumping site. Moreover, there are total 79 no. of mills in the Muzaffarnagar, sugarmills(6) papermills (25) and Steel Rolling mills (36) presentin the city,hazardous and toxic waste produced by the malsodon' tunder goto any special treatment.Allofthem discharge there waste into local stream (Kali Nadi) or directly dump in theopen.

In 2010 MSW management has been implemented as per Municipal Solid Waste (Management and handling) rules (MoEF 2000), still open dumping is the predominating for a big fraction of MSW.

This thes is presents the characterization of MSW of Muzaffarnagarcitywhichincludes Physical,chemicalandgeotechnicalcharacteristicsoftheMSWtodecidethesuitabilityof various waste management technologies.

Moreover,this paper alsore views andanalys ist he current MSW practices in thecity.

II. LITERATURE REVIEW

1. Rapidly increasing rate of solid waste generation has not been only local issue but also a global issue. Developing countries like India; in order to become one of the fastest economies in the world setting up new

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industries, which are one of the main solid waste generators.

2. With rapidly increasing population, urbanization, industrialization and changing life style; problem such like generation of MSW has taken place.
3. Due to lack of resources people living in rural are migrating to the urban area which is resulting into significant increase in the urban population hence in the increase in the solid waste generation and load on the landfills.
4. Today collection, transportation, disposal, processing and final disposal of Municipal waste in a scientific and efficient manner is a big problem in front of the Urban Local Bodies in different cities of India.
5. Waste stream can be divided into different components i.e. Food, paper, plastic, metals, rubber, construction debris, street sweeping, agricultural Waste etc.
6. Mainly constituents of MSW can be divided in two categories: Organic and Inorganic.
7. Organic can further be divided into food waste, agriculture waste, tree leaf, grass etc.
8. Different properties (physical, chemical) can help in design criteria's.
9. If Organic content is high; Composting is best way to process the waste.
10. Thorough understanding of different characteristics of waste helps in deciding which process (composting, incineration etc.) has to be adopted for any particular city.
11. Uncontrolled dumping of waste on the roadsides, outskirts of the cities in a non-engineered manner has cause huge problem for the people living in the vicinity and for the environment as well.
12. In most of the places in India, there is a trend of open dumping; after the rainy season; contamination of ground water and surface water has always been a very serious issue throughout the country

2.4 Objectives

1. To review the present MSW generation, composition, handling, transport and final disposal methods applicable in the area for management of MSW under Integrated MSW management plan in the city.
2. Characteristics of municipal solid waste will be reviewed and different physical and engineering properties of municipal solid waste will be determined

III. METHODOLOGY

3.1 Materials and Methods

The methodology adopted in conducting the Laboratory tests to find out the physical, Chemical and geotechnical properties of MSW and Refuse. The following geotechnical tests were conducted on refuse samples to determine their geotechnical engineering characteristics. Laboratory tests were performed according to the Indian Standards (IS-2720) methods of testing soil for engineering purposes. The geotechnical laboratory tests were conducted at Al Falah University Department of Civil Engineering, Dhauj Faridabad, Haryana. After a set of recommendations have been provided for laying the foundation towards good solid waste management system in Muzaffarnagar City. Muzaffarnagar city does not have any sanitary landfill for final disposal of the waste. In the Muzaffarnagar Municipal limit, the collected MSW is disposed off Near Kali Nadi and Saharanpur Bus stand (earlier).

Figure 3.1 shows the flow diagram of research methodology adopted in this report in order to accomplish the project

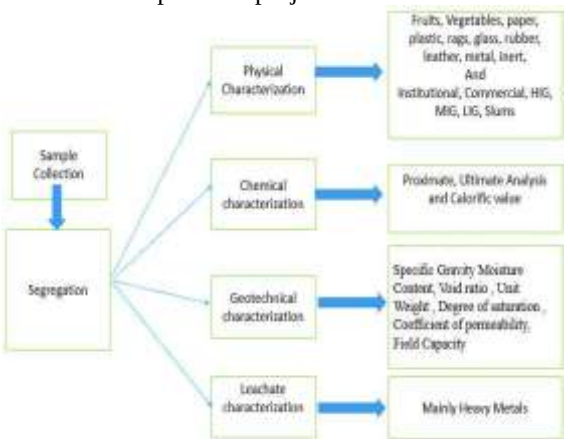

Fig.3.1 Methodology for the Solid waste Characterization

3.2 Data and Information Related present Solid Waste Management exercise in the City

The data and information regarding present solid waste management exercise in the city were collected initially by carrying out a primary survey of different waste management practices, starting from the household collection, segregation, transportation, handling, processing and final disposal. Further, the information from the preliminary survey was supplemented with that obtained from Municipal Corporation Muzaffarnagar and A2Z Infrastructure Limited.

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IV. RESULT AND DISCUSSION

4.1 Assessment of SWM in the City

A2Z Pvt. Ltd has taken the responsibility of collection. Approximately 80% of the city's waste is collected by Door-to-Door method. There are 41 collection points are there in the city, person from A2Z comes for street sweeping and to collect the waste to each door and dump it those collection point (transfer station), and houses those don't come under door-to-door collection dump their waste on these collection points. Most of the collection points either doesn't carry metallic containers or with insufficient capacity, moreover there are open spaces to dump the waste, no boundaries are defined resulting to spreading the waste on the roads also.

At some places it is also found that waste is dumped in middle of road, City's vegetable market is one of the cases where waste dumped in the middle of road, though collection crew comes daily to collect the waste except Sundays and national holidays but in case if collection crew doesn't come on time due to any reason like national holiday or heavy rain it becomes the epidemic. Loading is done manually, there is only one garage in the city from where the vehicle vehicles are operated and maintenance is also done with the help of private contractors.

After the collection waste is sent to the processing site, at the site there are to processing methods are adopted to process the waste one is composting and other is RDF but due to the very poor condition of plant including machines, equipment, scarcity of technical manpower the processing of waste coming each day can't be processed. Though from the data provided by the plant manager it is observed that compost and RDF made after the processing of the waste is very efficient has very well C, N, P and calorific values respectively. Since waste generation rate is very high and machines capacity to processes the waste is very low, waste stream coming to the plant is turning in to mountains of waste with in and around the site.

There is no provision of engineered landfill, approximately 140-150 MTPD waste is collected and disposed off at the site without segregation and applying soil covers. There is no provision for leachate collection on the site so it can easily percolate into the ground. The physiochemical properties of the landfill leachate samples has shown in the Table.3. These values clearly shows that there is presence of higher concentration of organic and inorganic chemicals including heavy metals. The concentration of these chemicals in the surrounding water resources is further a scope of the study. By the time effect of leachate on the water resources has been a matter of ignorance only.

Analysis of City's MSW management system can be performed with the flow diagram shown in the Fig. 4.1 and Fig. 4.2. Both the figures describe the complete process of Management of solid waste in the city with formal and informal sector.

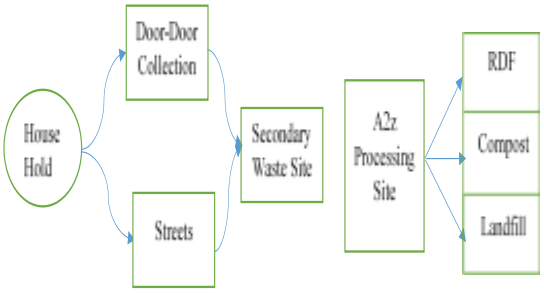

Fig.4.1 Muzaffarnagar MSWM system design with A2Z Infrastructure Limited Collection.

As shown in the above figure, whether the waste is collected from the houses by door- to-door collection method or the households through it on the road side, from both the places waste is collected by the people of A2Z Infrastructure Limited. Once waste is collected, it is send to the secondary waste site or kind of small transfer site. From the secondary waste site itself waste is send to the A2z processing centre with the help of transportation system provided by A2z Infrastructure Limited, though Municipality of Muzaffarnagar also provides transportation system if needed. At the site waste is segregated by mechanical means.

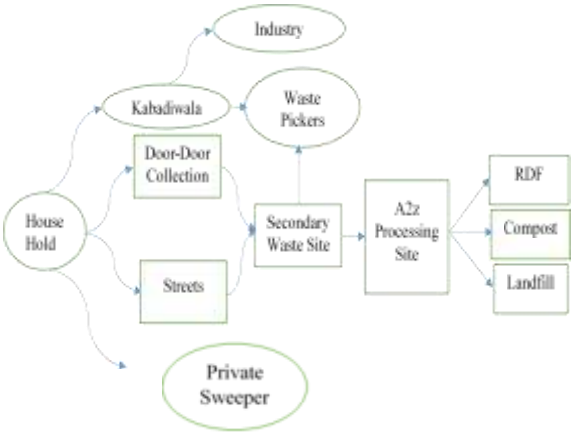

Fig.4.2 Muzaffarnagar MSWM system design with informal sector.

Once the segregation is done, organic fraction segregated from the waste stream is converted into compost, which is further used for the agriculture purposes and the fraction of the waste which can be bur or incinerate easily is used to make RDF, reject from both the process is send to the landfill.

The flow chart shown in Fig 4.2, the analysis of MSW management system with informal sector. As shown in the diagram above, at the household level itself, kabadiwala collects the recyclable waste as paper, plastic, metals, glass etc. and sell it to the small scale industries or large scale industries. Waste from the households is collected by door-to-door method or households through it on the roadsides, in both the cases waste is collected by A2Z infrastructure Limited and further send to the transfer site. From the transfer site, waste picker collects recyclables as paper, plastic, glass, metals etc. and sells it to the industries. Thereafter, waste is send to the processing site and treated. Reject from the processing send to the landfill site for the final disposal.

4.2 Compliance with Municipal Solid Waste (Management and Handling) Rules (MoEF 2000)

This report analyse the current MSW management in the city, which implies that management of waste is in very preliminary stage, manual handling of the waste is exercised from collection to the final disposal of the waste. Non-engineered, unscientific and inefficient practice of MSW in the city has resulted to unhygienic situation, littering of waste, transportation in open vehicle, no proper segregation. Many times, when collection crew don't reach at time to collect the waste for a long duration (1-2 days), people living in the surrounding burn the waste. Right now machinery, tools, equipment, manpower involve in management of MSW are not enough. The present practices of MSW management in Muzaffarnagar city does not comply with Municipal Solid Waste (Management and Handling) Rules (MoEF 2000) in any aspect from collection to final disposal of waste. Participation of public in MSW management is necessary in the city.

4.3 Community Participation

Spreading awareness among the residents regarding the waste management is the biggest challenge in front of the developing countries.

A. Awareness programs should be conducted by the Urban Local Bodies of the city in order to make people aware of waste minimization at source, reuse, recycling and segregation of the waste; Mixing of different type of waste should be prohibited.
B. Time to time awareness among the people, campaigns based on information, education and communication strategy may be important step to motivate and inspire the people regarding the waste management issues. The awareness programs involves advertisements, local ward meetings, rallies and distribution of pamphlets.
C. There must be hoardings in the public places and it should be advertise in public transports. Moreover, there should be training or sessions on waste management problem for corporation worker, revenue officers, zonal officers, technical staffs, school children and college students.
D. The Urban Local Bodies must take the responsibility to conduct programmes in order to ensure public participation in waste segregation, for this purpose, regular meetings at certain intervals must be arranged by the Urban Local Bodies with and nongovernmental organizations. The NGOs and women associations can play a vital role in communicating and guiding the public on waste management issues.

4.4 Municipal Solid Waste generation and its characteristics

For seven days consecutively segregation and weighing of the segregated wastes has been done. Percentage of each type of waste for all seven day has shown in the table 2.

From Fig. 1 it can be clearly seen that that Biodegradable fraction is approximately 45% which mainly include food, vegetable, fruit, leaves tissue paper, flowers from temples etc. Inert fraction is reported approximately 37%, which mainly include sand, silt, ash, human hair, stone, concrete, batteries etc. The reason behind the big fraction of inert is construction work going on in the city and pathetic condition of city's unpaved roads. It should also be noticed that more the inert fraction will be lesser will be the calorific value. The combustible material, which involve paper, pouches, cardboards, polyester fibres, rubber, leather, egg tray, jute bags etc., was found to be approximately 19%. Recyclables, which involve glass, metal, plastic, carton packs, synthetic fibres (nylon ropes), toys etc. , was found to be approximately 1%, which is very less, reason being rack pickers, who travel almost every street of the residential areas moreover all markets, institutes, industrial areas and pick up the plastic, glass and metals and then sell it to the kabaddis. The kabadi directly sell the inert materl to the industries or the

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material which is not picked up by rack pickers will be segregated on the processing site and sell to the industry.

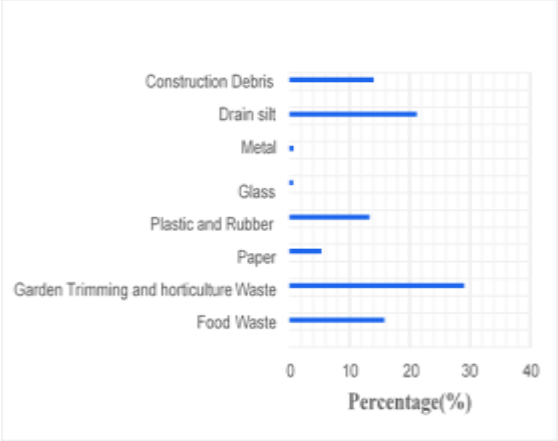

Fig.4.8 Physical Composition of the MSW

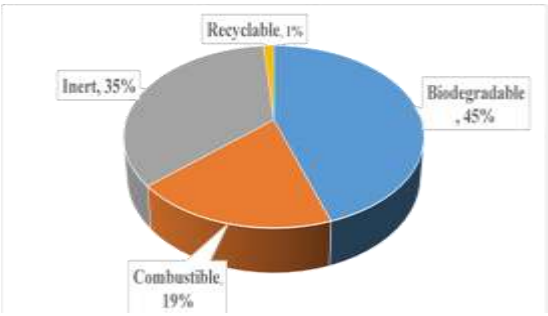

Fig.4.9 Physical characterization based on Biodegradables, recyclables, inserts and combustibles

Table 4.4 Physical Characterization of MSW of Muzaffarnagar in percentage

Waste Type	S1 (%)	S2 (%)	S3 (%)	S4 (%)	S5 (%)	S6 (%)	S7 (%)	Average (%)
Food Waste	15	14.8	13.9	17.15	18.33	15.78	15.45	**(±1.50)15.772**
Garden Trimming	30	31.8	32.3	25.3	23	28.56	31.5	**(±3.30)29.051**
Paper	4	4.9	5.13	7.7	4.6	5.1	5.87	**(±1.18)5.328**
Plastic and Rubber	15	13.9	12.3	9.4	12.5	16.8	13.31	**(±2.32)13.314**
Glass	0.5	0.2	0.6	2	0.4	0.54	0.1	**(±0.63)0.62**
Metals	0.25	0.56	0.52	1.8	0.88	0.76	00.2	**(±0.54)0.71**
Drain Silt	19.25	20.12	21.37	25.2	23.4	19.57	19.34	**(±2.30)21.178**
Construction Debris	16	13.72	13.88	11.55	15.89	12.89	14.24	**(±1.57)14.024**

Particle size distribution of the particles is shown in the table no. 4. Which clearly interprets that paper and cardboard has the maximum where as food varies between 20-100 mm. The importance of the particle size distribution in context of MSW is that the rate at which MWS will be decomposed will be directly related to its particle size. Lesser will be the particle size more will be the surface provided for the bacteria hence faster the degradation. Moreover, if size of the particle of MSW will be small, lesser will be the pore size between two adjacent particle and limiting the movement of oxygen, which is beneficial for anaerobic decomposition but not for aerobic decomposition. For any composting system, the optimum range of particle size usually varies between 12-50 mm diameters.

Table 4.5 Particle size distribution of MSW

Component	Size Range (mm)
Food	20-100
Paper and Cardboard	above 200
Plastic	50-150
Glass	50-200
Rubber	below 20
Ash and Dust	below 20
Rags	100-20

Table 4.6 Characterization of MSW based on Income

Waste Type	HIG	MIG	LIG
Food Waste	24.72	17.26	14.82

4.5 Physicochemical Characterization of Leachate from Muzaffarnagar dump site.

In the physicochemical analysis of leachate collected from dumpsite, it is observed that the concentrations of Copper (Cu), Iron (Fe), Chromium (Cr), Lead (Pb) and Cd, as shown in Table 3, were not within the range of the as per Municipal Solid Waste (Management and

Handling) Rules (MoEF 2000). Moreover, pH, TDS and BOD5 were not also within the range of the as per Municipal Solid Waste (Management and Handling) Rules (MoEF 2000). Since concentration of all the heavy metals is above the permissible limits, there should be proper landfilling of waste with appropriate liner system so that not even a single drop of leachate can percolates into ground and meet to the ground water. Otherwise in Muzaffarnagar, almost every household has such system in which they directly extract water from the ground. If ground water is contaminated, it may affect the people of city adversely

Table 4.6 Physicochemical Characterization of Leachate from Muzaffarnagar dump site

Parameter	S1	S2	S3	S4	Average	Permissible limits
pH	10.7	10.9	9.8	9.8	10.3	5-9
TS (mg/l)	24,148	23,980	23,117	24,986	24057.75	-
TDS (mg/l)	20,056	19,347	18,967	16,786	18789	2100
Electrical Conductivity(m Moh/com)	20.01	19.83	19.44	21.1	20.12	-
BOD5 (17°C)	14180.50	14375	13989.5	14876	14355.25	100
COD (mg/l)	22547.64	23000	22242.51	22956	22686.53	-
Cu (mg/l)	0.040	0.089	0.076	0.067	0.272	0.05
Ni (mg/l)	0.020	0.045	0.034	0.022	0.030	3.0
Fe (mg/l)	0.320	0.567	0.043	0.045	0.243	0.3
Pb (mg/l)	0.400	0.487	0.003	0.002	0.223	0.05
Cr (mg/l)	0.060	0.089	0.075	0.068	0.073	0.05
Cd (mg/l)	0	0.001	0.890	0.003	0.2235	0.01

Table 4.7 Chemical Characterization

Garden Trimming	31.45	29.12	28.56
Paper	7.98	5.12	5.23
Plastic and Rubber	17.23	13.76	12.86
Glass	0.7	0.45	0.32
Metals	0.45	0.35	0.28
Drain Silt	11.24	25.34	28.56
Construction Debris	6.23	8.66	9.37

Parameter	Unit	Value
Moisture Content	% by Weight	20.2
Volatile Matter	% by Weight	21.3
Ash Content	% by Weight	47.2
Fixed Carbon	% by Weight	11.3
Calorific Value	KJ/ Kg	4,387
Carbon	% by Weight	25.2
Hydrogen	% by Weight	3.87
Nitrogen	% by Weight	1.34
Oxygen	% by Weight	20.9
Mineral Content	% by Weight	48.69

The analysis of chemical characteristics of Municipal Solid Waste plays a very important factor in deciding and fixing up the best waste processing and disposal facility in the city and in finding out the efficiency of a waste treatment process. The Results of Chemical Characterization has shown in table no. 4.7. Moisture content of the waste was determined about 20%. The results shows that there is a good amount of minerals are present in the waste. The Calorific value was determined to be low (about 4387 KJ/kg) due to the lesser amount of paper and plastic and significant amount of inert material which makes the waste lesser incompatible for incineration. The ash content was also determined and found significantly high due to the large amount of inert matter present in the waste sample.

4.6 Geotechnical Properties of the MSW

In order to analyses Geotechnical properties of the MSW moisture content, degree of saturation,

specific gravity, unit weight and coefficient of permeability has been determined, result of the geotechnical properties has been shown in the table 4.7

Parameter	Mean± SD (%)
Moisture Content (v/v)	0.19±0.03
Degree of Saturation (%)	76.1±9.6
Specific gravity	2.15±0.11
Wet Unit Weight (kN/ m^3)	11.34±1.82
Coefficient of Permeability(cm/s)	3×10^{-3}

Table 4.7 Geotechnical Properties of the MSW

The wet unit weight for the MSW of the city was reported approximately 11.34 KN/m3. The Degree of Saturation was also found 76%. Wet unit weight, Moisture content, degree of saturation and coefficient of permeability play a very important role in strength and stability of the MSW when it is finally dumped in the landfill.

V. CONCLUSION

This Study helps in deciding important strategies for waste handling and disposal, which will ultimately improve the MSW management practice in the city.Due to the explosive rise in the population, growing demands of modern society and poor management of solid waste by the municipality, waste generation rate is increasing every year. Segregation of the waste at source is not taking place and people are still throwing the waste on the road sides leads to the pathetic condition of environment. Notunlike maximum cities of India,wasteis dumped on the ground without engineered landfilling leads to the various pollutions as ground water contamination and air pollution. Approximately 140-150 MTPD of waste were analyzed and physical characterization of the waste showed the high organic and combustible fraction. Unpaved roads, streets weeping and ampleno. of construction activitie shasled to the highinert fraction in the city, so it discourages waste to energy method like incarnation. Moreover, mixing of inerts with MS W needs to be avoided because it is very difficult of separate because of the irvery small particle size. As if now composing RDF, biomethanation and disposal of rejects and inertsseems to be suitable waste processing technology for the city. Organic fraction has been significant so composting should be appropriate method to process the waste.

Explosive increment in the waste generation and scarcity of land to manage the waste in the city will require best strategies for the waste management in the coming time. Although public participation is also very important, and will remain a great challenge in front of the local administration. There is a need of efficient planning by the collaboration of local administration and private sector which will improve the aesthetic and hygienelevelinthecity and also spread awareness among the people not to spread trash on the roadsides and to cooperate in this mission in mission in their best interest.There is a greats cope of improvement in the MSW management in the city, therefore significant amount of efforts are required by the Municipal Corporation Muzaffarnagar and public. Waste reduction, waste segregation at source, reuse, recycling, composting at household could provide long-term solutions toreduce the amount of waste and load on the landfillsites.

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