physico-chemical parameters of municipal solid waste analysis and disposal techniques at Ujjain city

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Abstract - **Various segregation techniques are present now a days for the municipal solid wastes, still hand segregation in this New India takes place, giving various types of health hazards to poor people segregating it for their Living and earnings. In this paper we try to find out the amount of solid waste generated in the city with physical and chemical properties of MSW (Municipal Solid Waste). We try to find out the composition analysis, chemical analysis of the physical MSW. In this research we try to do the justice with four R's of the solid waste with the calorific values, Material analysis and proper disposal techniques before landfilling or composting of the solid waste. These characteristics of Municipal solid waste may be used to carry out detailed sustainability analysis of refuse, and/or disposal or reuse of composting.**

keywords - **Segregation, poor, health hazards, justice, physical and chemical properties, chemical analysis, MSW, solid waste, composting, disposal**

Introduction –

The Physico-chemical characteristics of municipal solid waste depends on various factors as Season, Topography of area, Food habits of Locals, Population, Economy, Purchasing power, socio-economic characteristics of area etc. etc.[1]. The basic data comprising of quality and quantity of solid waste helps us in management of solid waste throughout the city.[2] The Ujjain city is 151.8 sq Kms and is the Fifth largest city in Madhya Pradesh state population wise.[4] Ujjain is at 494 MSL (Meters from Sea Level) in elevation and the average precipitation every year is about 900 mm.[3]

As per 2011 censes (as 2021 censes not done because of COVID-19 pandemic) the population in Ujjain is about 5.15 Lakhs and the Ujjain Municipal Corporation has divided it in 54 Different Wards and these wards come under 6 Zones of UMC.[17]

Figure – 01 – 4R's of Solid Waste Management [20]

Present Practice –

In old city area as the area is congested and densely populated there are many unidentified local dump sites but due to the action taken by government of Swach Bharat various local dump sites are been removed and various vehicles come door to door in every locality to collect solid waste generated. [6] As we already know that the whole 152 sq Kms, of Ujjain city is been divided into 6 zones, numbering Zone 01 to Zone 06. The total waste generation in city is estimated about 320 Metric Tons per day. Various segregation points are been made by Ujjain Municipal Corporation. The biggest dumping point of Ujjain Municipal Corporation is in Undasa near Undasa lake were site is more than 100 hectare and is been in operation since 1992 Singhastha. Undasa village is present in Ujjain tehsil and is approximately 8 Kms NE of Ujjain city. [5]

Photo – 1 Cow doing segregation of Municipal solid waste Credit: Wikipedia [21]

The storage points in city or trade waste in the city is done in rude unscientific manner also the waste is collected and transported in large metal containers.[7] These containers are different from dry and wet wastes initial segregation of the waste is done by bare hands of local driver or conductor of the waste collecting vehicle.[8] Locally the waste is disposed at the place of ease of the local resident.[9] There are 350 small blue and 350 small green containers for the waste disposal throughout the city. Also we have 51 big blue and 20 big yellow containers in the city for waste disposal.[10]

Photo – 2 the new bins introduced in Government norms 2016[22]

The Ujjain Municipal Corporation owns a fleet of 113 vehicles which are directly involved in Solid waste collection, out of these 2 vehicles are specified per ward so that they do the door to door collection.[11] Rests are taking garbage from collection point to big collection area or to the landfill area. All these vehicles operate within their zonal limits.[12]

The characteristics of Solid Waste –

To see and analyze the Solid Waste Management characteristics various representative samples are been collected from different zones and are analyzed for Physico-chemical analysis of Municipal solid waste.[13] The Municipal solid waste generation of Ujjain city according to Ujjain Municipal Corporation is about 320 Metric Tons per day.

The samples taken are been divided in A, B, C & D of which –

- **A.** Comprises of the residential areas of the city of 3 different colonies i.e. Singhpuri, Vivekanand colony and Mahashweta Nagar Colony.
- **B.** Comprises of commercial areas of Nai-sadak, Freegunj and Mahananda nagar Market areas.
- **C.** Comprises of commercial areas of Chatri chauk, Dhaba road and Patni bazaar areas.
- **D.** Comprises of residential cum commercial areas of city one of which is Favwara Chauk area and other one is Vikramaditya Cloth Market areas.

The waste density is been measured by a cube box of dimensions 0.3m x 0.3m x0.3m at the collection point of samples. The 10 samples collection days are been selected of every points. The weight of empty box and filled boxes are taken. After segregation of the waste we came to various findings of the paper.

Result and Discussion –

The samples were taken in the dry month of July 2022 and analyzed as per norms [23]. See table 1 with average density and weight of sample.

Table – 1 Average Density of Waste

Sample	Wt. of box and sample	Wt. of Sample	Density
	gms	gms	Kg/m3
A	13210	11250	416.67
B	12100	10150	375.93
C	13680	11720	434.07
D	12650	10690	395.93

So the average density will be about 405.65kg/m3.

The second turn is for segregation of the waste we took out of bin so in table 2 we have given the physical composition of Municipal solid waste.

Table 2 – Physical composition of wastes

Sample	Wt.	Mud& Sand	Organic Matter	Paper	Plastic	Pieces	Metals	Rubber	Leather	Stone/ dust	Wood	Glass/ Crockery	Misc.
	Kg.	gms	gms	gms	gms	gms	gms	gms	gms	gms	gms	gms	gms
A	1.96	586	1065	126	12	72	5	7	5	5	32	23	22
B	1.96	617	902	170	18	169	6	5	2	7	30	22	12
C	1.96	556	870	180	20	170	9	2	8	6	12	92	35
D	1.96	560	950	146	25	180	10	9	12	10	30	10	18
if we see this in percentage than													
A	100%	29.90	54.34	6.43	0.61	3.67	0.26	0.36	0.26	0.26	1.63	1.17	1.12
B	100%	31.48	46.02	8.67	0.92	8.62	0.31	0.26	0.10	0.36	1.53	1.12	0.61
C	100%	28.37	44.39	9.18	1.02	8.67	0.46	0.10	0.41	0.31	0.61	4.69	1.79
D	100%	28.57	48.47	7.45	1.28	9.18	0.51	0.46	0.61	0.51	1.53	0.51	0.92

In this Municipal solid waste various hands have done segregation with help of masks and gloves which became friendly to humans after COVID-19 pandemic.

The table 2 depicts of two residential areas A & D and two commercial areas B & C. since the container is same the net weight of the garbage is uniform i.e. 1.96 Kgs. Since the segregation is done by human hands the waste is been divided in various physical characteristics such as - Mud& Sand, Organic Matter, Paper, Plastic, Pieces, Metals, Rubber, Leather, Stone/ dust, Wood, Glass/ Crockery and finally Miscellaneous one. Since B and C are from domestic residential areas the weight of organics and pieces are maximum in them. The latter half of table 2 comprises of the percentage of these items present in Municipal solid waste of which maximum goes to organic biodegradable waste.

After finding of Physical composition of wastes we try to find out the moisture content in the waste.[19] This we get from the bag having the waste, this bag is than dried up in an oscillating oven at 60-80°c after drying the weight loss is been calculated.[14]

Table – 3 Moisture content of given Municipal solid waste

Sample	Empty wt of bag	wt of filled bag	dry Wt of bag after drying sample	wet wt of sample	dry Wt of sample	Wt loss	Moisture content
	gms	gms	gms	gms	gms	gms	%
A	980	2940	2310	1960	1330	630	32.14
B	986	2946	2200	1960	1214	746	38.06
C	990	2950	2180	1960	1190	770	39.29
D	1020	2980	2360	1960	1340	620	31.63

This weight loss v/s initial weight ratio gives us the approx moisture content in the Municipal solid waste of different areas of the city. This moisture content leads the Municipal solid waste weight reduction from 31.63% to 39.29%, highest in area C and lowest in area D.

Table – 4 Organic Matter present in Municipal solid waste

Sample	Organic matter wt of sample	dry Wt of sample	Wt loss	Organic Matter
	gms	gms	gms	%
A	1065	580	485	45.54
B	902	650	252	27.94
C	870	610	260	29.89
D	950	530	420	44.21

In table 4 we try to find out the organic matter present in the Municipal solid waste. The weight of A sample is 1065 grams and its weight loss is 485g this depicts us to big leap of 45.54% organic biodegradable matter present in sample A. similarly least organic matter is present in area B which is 28% about and the maximum is as above which is 45.54% in A.

Table – 5 Average Density of Municipal solid wastes

Sample	Wt. of box and sample	Wt. of Sample	Density
	gms	gms	Kg/m^3
A	13210	11250	416.67
B	12100	10150	375.93
C	13680	11720	434.07
D	12650	10690	395.93

In table 5 we find out the average density of the sample which is calculated as the weight of the box with sample is been subtracted by weight of box which leads us to the weight of sample now the dimensions of box is 0.3m x 0.3m x 0.3m so the volume will be 0.027m^3 and the weight of samples are given in table 5. Dividing weight by volume gives us the density of the sample which is least in B area which is 375.93 **Kg/m^3** and Maximum in Area C which is 416.67 **Kg/m^3**.

Table – 6 Chemical composition of Municipal solid waste

Sample	Moisture content	Organic Matter	pH	Carbon	Nitrogen	Phosphorous	Potassium	Sulphur	Heavy Metals	Carbon/Nitrogen Ratio	Phosphorous/Sulphur Ratio
	%	%		%	%	%	%	%	gms		
A	32.14	45.54	6.2	21	2	1	0.96	0.26	5	10.5	3.85
B	38.06	27.94	8.5	15	2.6	1.6	0.82	0.27	6	5.8	5.93
C	39.29	29.89	8.1	22	2.8	1.2	0.68	0.22	9	7.9	5.45
D	31.63	44.21	6.7	18	2	2.5	1.2	0.3	10	9.0	8.33

The above are all the physical qualities of the waste from different areas of Ujjain city. Now we came to the material analysis of the waste compositions as Moisture content, Organic Matter, pH, Carbon %, Nitrogen%, Phosphorous%, Potassium%, Sulphur%, Heavy Metals in weight which are magnetic in nature and also one which are not.[16] Then also we find out the Carbon/Nitrogen Ratio of the waste content which is 5.8 to the minimum and 10.5 to the maximum. Also here we calculate the Phosphorous/Sulphur Ratio so as to find out the hazardicity of the waste. [18]

Table – 7 Material Analyses

Sample	Material for composting	Material for landfilling

	%	%
A	56	44
B	68	32
C	70	30
D	56	44

In table 7 we get the material analysis which gives us the percentage we get through compost and also the percentage we get to the landfill out of the material sample we can use as compost about 70%of the sample of area C. Last but not the least in table 8 we try to find out the calorific values of the Municipal solid waste of different localities of Ujjain city area. This is done by Bomb-Calorimeter technique finding by weight and heat here we get the values ranging from 403Kcal/Kg to 912Kcal/Kg.

Table – 8 Calorific analysis of Municipal solid waste

Sample	Calorific Value	Higher Calorific Value	Lower Calorific Value
	Kcal/Kg	Kcal/Kg	Kcal/Kg
A	2258	1449	809
B	1568	1165	403
C	1625	1185	440
D	2562	1650	912

Conclusion –

Finally going throughout all the data's we got in tale 1 to table 8 we finally came to conclusion that management of Municipal solid waste is not that hard as its predicted to be by anthropogenic activities. By the means of the calorific value the material analysis can be done easily and we can decide the future of that Municipal solid waste part that it's been used for composting of Landfilling. The areas of the Ujjain city is been divided very carefully and intelligently so that all aspects as Residential, Industrial and commercial all areas are been covered of the city in sample collection and analysis. The data of sample help us in following the four **R**'s of the solid waste so that landfills are been reduced and the reuse of the product increases which thus reduces the amount of Municipal solid waste a bit.

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