

# **Solid Waste Management-A Case Study For Hosur-Krishnagiri District, Tamil Nadu**

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**ABSTRACT:** Solidwastes are the wastes arising from human and animal activities, that are normally solid and that are discarded as useless or unwanted. One of the most important environmental problem faced by towns and cities are solidwaste management. Increasing population, unplanned urbanization and limited alternative solutions make the problem more threatening. The amount of solid waste generated is higher than the handling capacity of the local municipal authorities and as a result, wastes are disposed off unscientifically leading to serious catastrophic environmental consequences. The present study deals with physical and chemical analysis of solidwaste samples collected from residential and commercial areas of town. The generation rate was found to be 0.316 kg/capita/day. The physical characterization study has revealed that the municipal solidwaste contains composting material in larger quantities (48%) when compared with the other segregants. The quantity of recyclable materials viz plastics, paper, metals and glass obtained was about 12% of the total weight. The average density of solid waste was 383.12kg/m. The average moisture content of solid waste in residential area and commercial area were 37.70% and 38.02%, it is slightly higher than the standard values.

**KEYWORDS:** Solidwaste, Composting, Environment, Urbanization, Population

## **I. INTRODUCTION**

Solid wastes are the wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted (CPHEEO, 2000). Both technical processes and consumptive processes results in the formation of solidwastes. Towns and cities have become the centres of population growth which accelerates the amount of municipal solidwaste generation. Urbanization and industrialization envisage the production of large quantity of solidwaste (Talashikar, 1985). In urban areas volume and composition of residential waste may vary considerably from different communities and in general per capita waste production increases with per capita income. On the other hand ecological impacts such as water, air and land pollution are attributed due to improper solidwaste management(Hilary,1977). Municipal solidwaste management(MSWM) involves management of various activities related in collection, storage, transportation, processing and disposal of solidwaste in an environmentally compatible manner. As such, it comprises an extremely complex set of operations, which has to take place on an enormous scale (Kinman, 1987). Hence, the solid waste management is one of the essential municipal services, to protect the environment, safeguard public health and improve productivity. To plan effective solid waste management system, information and data on the expected composition of the solid waste are most essential. Information on the composition of solid waste is important in evaluating alternative equipment needs, operation of equipment and facilities, in assessing recovery and in the analysis and design of disposal facilities.

## **II. STUDY AREA**

Hosur is an industrial town in Krishnagiri district of Tamil Nadu located on the Krishnagiri-Bangalore National Highway about 45 km from Bangalore. It lies between 12°44'N latitude and 77°50' E longitude extending over an area of 76.2 sq.km. It is having a good connectivity by road and rail. It receives annual rainfall of 644 mm. The current population of the town is about 2.44 lakhs (As per 2011 census). It is also an important educational,

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administrative and trade centre, market, commercial activities and floriculture activities are there in the study due to favourable climatic conditions. The entire town is divided into six sanitary zones covering 45 wards. Figure 1.0 shows the study area map.



Figure 1.0 Study Area Map

### III. MATERIALS AND METHODOLOGY

To study the characteristics of solid waste, a net quantity of 10 kg of sample was collected from 6 sampling points considering three samples from residential areas of Hosur and three samples from commercial areas. The samples were collected during pre-monsoon and monsoon season for a period of three years during (2009-2011). The collected samples were segregated into various physical constituents like papers, plastics, wood, leather/rubber, rags, organic wastes, glass, metals, debris, bones, etc. The segregated components were then weighed using a rough

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balance. Cone and quadrant method was adopted for obtaining a homogeneous waste mixture for determination of moisture content. 10 kg of sample was first manually shredded well, thoroughly mixed and formed into a conical heap. The apex was flattened and divided into four quarters. One set of opposite quarters was discarded and the other set was mixed thoroughly. This was again divided into four quarters and the procedure was repeated, till sample of approximately 500 grams was obtained.

## Determination of Bulk Density

Solid waste was taken in the small box of 0.028 m<sup>3</sup> volume to get a composite sample, from different parts of the heap of waste, and then weighed with the help of a rough balance.. This procedure was repeated for three times and the average weight was taken. Thus the weight per cubic meter is obtained.

## Determination of Moisture Content

Moisture content of solid waste sample was measured immediately after the collection of sample. The net weight of mass of the solid waste was recorded as 'w<sub>1</sub>' grams. The content was dried in an oven at 70°C to 75°C until to get constant weight. The dried crude sample was then cooled to the room temperature and net dried mass of the solid waste sample was recorded as 'w<sub>2</sub>' grams. The moisture content of the crude sample in percentage is given by

$$M = \frac{W_1 - W_2}{W_1} * 100$$

Where, W<sub>1</sub> = Wet weight of sample

W<sub>2</sub> = Dry weight of sample

## Generation Rate

Municipal solid waste generation rate was determined by load count analysis and was calculated using the following expression.

$$\text{Generation rate (kg/capita/day)} = \frac{\text{No of trips/day} \times \text{volume (m}^3\text{)} \times \text{density (kg/m}^3\text{)}}{\text{Population}}$$

## Physical Characteristic of Municipal Solid Waste

The samples collected from various sampling points are analysed for various physical parameters during pre-monsoon and monsoon as per the standard procedure.

## Chemical Characteristic of Municipal Solid Waste

The samples collected from various sampling station during the pre-monsoon and monsoon season are analysed for pH, Potassium, Phosphorus, Carbon, Nitrogen, Oxygen, Hydrogen, Calorific value, fusing point and C: N ratio.

## IV. RESULTS AND DISCUSSION

From the above analysis it was observed that the municipal solid waste generation rate in the town was 0.316 kg/capita/day and the quantity of solid waste generated was 77.2 t/day.

## Variations of Density and Moisture Content

The density and moisture content of solid waste were determined as per the standard procedure. The variation of density and moisture content of solid waste from various sampling station are shown in Table 1.0. From the result, it was observed that the density varies from a minimum value of 351.60 kg/m<sup>3</sup> to a maximum of 406.25 kg/m<sup>3</sup>, the average density of solid waste was 383.12 kg/m<sup>3</sup>. Their value is within the standard range for Indian town's as per IS 9622-1980. It was observed that the average moisture content in residential area and commercial area were 37.70% and 38.02% respectively. This value is slightly higher than the standard values of 25.81% as per manual of municipal solid waste management, the expert committee (2000)

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**TABLE 1.0 DENSITY AND MOISTURE CONTENT OF SOLID WASTE**

Samples	Density (kg/m <sup>3</sup> )	Moisture content (%)
Residential – I	392.46	37.15
Commercial – I	357.28	37.84
Residential – II	385.35	39.40
Commercial – II	351.60	37.70
Residential – III	395.81	36.60
Commercial – III	406.25	38.54
Average of residential areas	394.54	37.70
Average of commercial areas	371.71	38.02
Average	383.12	37.86

### Physical Characteristics of Municipal Solid Waste

The average percentage of physical composition of solid waste during pre-monsoon and monsoon season during 2009 - 2011 are shown in Table 2.0, 3.0. From the results it is noted that the physical segregation of the sample shows that, major constituent obtained was the organic matter, which was about 48% of the total weight and hence this material can be converted into composting material like manure. The remaining portion comprised of paper, plastic, clothes, metal, glasses, inert metals etc. The quantity of recyclable materials like plastic, paper, glass and metals available were about 12% of the total weight.

**Table 2.0: Average percentage of physical composition during pre-monsoon**

Particulars	Average percentage of physical composition during monsoon (%)
Paper	4.06
Plastic	6.29
Clothes	3.77
Hazardous waste	0.34
Metal	0.16
Glass	0.58
Combustible matter	4.8
Bones	0.06
Stones & inert material	29.47
Rubber	0.07
Organic matter	50.09

**Table 3.0: Average percentage of physical composition during monsoon**

Particulars	Average percentage of physical composition during pre-Monsoon %
Paper	4.58
Plastic	6.76
Clothes	3.67
Hazardous waste	0.46
Metal	0.143
Glass	0.57
Combustible matter	4.02
Bones	0.16
Stones & inert material	33.59
Rubber	0.19
Organic matter	45.83

### Chemical Characteristics of Municipal Solid Waste during Pre-Monsoon

The results shown in Table 4a,b,c represents the percentage summary of chemical composition of solid waste during pre-monsoon for a period of 3 years from 2009 – 2011. The pH value ranged between 6.4 to 6.7 during pre-monsoon and was within the standard values. Potassium, Phosphorus, Carbon, Nitrogen varied between 2.7 to

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3.1%, 1.5 to 2.3%, 0.9 to 1.3%, and 1.57 to 1.85% during pre-monsoon. The C:N ratio varied between 20.33 to 36.1 with an average of 27.88 during pre-monsoon which indicates it is suitable for composting.

**Table 4(a) Percentage summary of Chemical composition of solid waste pre-monsoon Season during 2009**

Parameters	Percentage by Weight						Average % age residential sample	Average % age commercial sample	Average % age
	RI	RII	RIII	CI	CII	CIII			
pH	6.4	6.4	6.5	6.6	6.7	6.6	6.43	6.63	6.53
Potassium (%)	2.8	2.7	2.7	3.2	3	3	2.73	3.07	2.90
Phosphorous %)	1.8	1.7	1.6	2.3	2.3	2.2	1.70	2.27	1.98
Carbon (%)	1.18	1.18	1.3	0.9	1.03	1.05	1.22	0.99	1.11
Nitrogen (%)	1.85	1.85	1.85	1.37	1.57	1.85	1.85	1.60	1.72
Oxygen (%)	3.6	3.85	3.7	3	2.85	2.7	3.72	2.85	3.28
Hydrogen (%)	14.75	15	15.6	14.55	14.5	14.5	15.12	14.52	14.82
Calorificvalue MJ/Kg	2.3	2.3	2.4	2.8	2.8	2.6	2.33	2.73	2.53
Fusing Point (°c)	1350	1380	1350	1600	1650	1650	1360.00	1633.33	1496.67
C:N ratio	28.98	24.65	20.33	26.51	36.32	27.53	24.65	30.12	27.39

**Table 4(b) Percentage summary of Chemical composition of solid waste pre-monsoon Season during 2010**

Parameters	Percentage by weight						Average % age Residential sample	Average % age Commercial sample	Average % age
	RI	RII	RIII	CI	CII	CIII			
pH	6.5	6.2	6.4	6.7	6.6	6.5	6.37	6.60	6.48
Potassium (%)	2.6	2.8	2.9	2.9	3.1	3.1	2.77	3.03	2.90
Phosphorous (%)	1.7	1.5	1.4	2.1	2.2	2.1	1.53	2.13	1.83
Carbon (%)	1.2	1.2	1.4	0.85	1	1.1	1.27	0.98	1.13
Nitrogen (%)	1.9	1.95	1.95	1.26	1.62	0.9	1.93	1.26	1.60
Oxygen (%)	3.4	3.62	3.5	2.9	2.9	2.6	3.51	2.80	3.15
Hydrogen (%)	14.65	15.2	15.8	14.83	14.8	14.8	15.22	14.81	15.01
Calorific value m J/Kg	2.4	2.2	2.6	2.7	2.9	2.7	2.40	2.77	2.58
FusingPoint (°c)	1365	1360	1375	1590	1670	1665	1366.67	1641.67	1504.17
C:N ratio	29.63	25.26	20.43	27.62	35.9	28.43	25.11	30.65	27.88

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**Table 4(c) Percentage summary of Chemical composition of solid waste pre-monsoon Season during 2011**

Parameters	Percentage by weight						Average % age Residential sample	Average % age Commercial sample	Average % age
	RI	RII	RIII	CI	CII	CIII			
pH	6.1	6.5	6.4	5.99	6.9	6.2	6.33	6.36	6.35
Potassium (%)	3.1	3	3.01	3.1	3.5	3.2	3.04	3.27	3.15
Phosphorous (%)	1.9	1.2	1.51	2.3	2.1	1.92	1.54	2.11	1.82
Carbon (%)	0.9	1.5	1.51	1.2	1.2	1.51	1.30	1.30	1.30
Nitrogen (%)	2.1	2.01	2.01	1.41	1.5	1.01	2.04	1.31	1.67
Oxygen (%)	3.1	3.21	3.6	2.1	3.1	2.5	3.30	2.57	2.94
Hydrogen (%)	15.1	16.01	16.5	15.9	15.01	15.1	15.87	15.34	15.60
Calorific value MJ/Kg	2.1	2.5	2.01	2.1	3.1	2.1	2.20	2.43	2.32
Fusing Point (°c)	1321	1410	1410	1610	1651	1651	1380.33	1637.33	1508.83
C:N ratio	30.42	26.21	19.92	28.72	36.01	29.6	25.52	31.44	28.48

### Chemical Characteristics of Municipal Solid Waste during Monsoon

The results shown in Table 5a,b,c represents the percentage summary of chemical composition of solid waste during monsoon for a period of 3 years from 2009 – 2011. The pH value ranged between 5.9 to 6.5 during monsoon and was within the standard values. Potassium, Phosphorus, Carbon, Nitrogen varied between 2.3 to 3.2%, 1.5 to 2.6%, 1.0 to 1.14% and 1.1 to 2.3% during the monsoon season. The C:N ratio varied between 20.22 to 36.11 with an average value of 27.23 during monsoon season which indicates it is suitable for composting.

**Table 5(a) Percentage summary of Chemical composition of solid waste Monsoon Season during 2009**

Parameters	Percentage by weight						Average % age residential sample	Average % age commercial sample	Average % age
	RI	RII	RIII	CI	CII	CIII			
pH	6.2	6.4	6.2	6.5	6.7	6.1	6.27	6.43	6.35
Potassium (%)	3.1	2.5	2.3	3.1	3.2	3.2	2.63	3.17	2.90
Phosphorous (%)	1.6	1.5	1.8	2.5	2.6	2.5	1.63	2.53	2.08
Carbon (%)	1.21	1.91	1.5	1	1.08	1.14	1.54	1.07	1.31
Nitrogen (%)	2.1	1.75	1.95	1.5	1.81	1.67	1.93	1.66	1.80
Oxygen (%)	2.9	3.95	3.4	2.9	2.95	2.5	3.42	2.78	3.10
Hydrogen (%)	15.1	14.9	15.3	15.1	14.3	14.7	15.10	14.70	14.90
Calorific value MJ/Kg	2.5	2.4	2.8	2.7	3	2.9	2.57	2.87	2.72
Fusing Point (°c)	1350	1380	1350	1600	1650	1650	1360.00	1633.33	1496.67
C:N ratio	29.1	24.85	20.22	25.9	36.52	27.61	24.72	30.01	27.37



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**Table 5(b) Percentage summary of Chemical composition of solid waste Monsoon Season during 2010**

Parameters	Percentage by weight						Average % age residential sample	Average % age commercial sample	Average % age
	RI	RII	RIII	CI	CII	CIII			
pH	5.9	6.12	5.9	6.1	6.2	6.4	5.97	6.23	6.10
Potassium (%)	2.9	3.1	3.1	3.1	2.9	2.9	3.03	2.97	3.00
Phosphorous (%)	2.1	2	1.5	2.3	2.1	1.9	1.87	2.10	1.98
Carbon (%)	1.1	1.1	1.5	1.01	0.9	1.01	1.23	0.97	1.10
Nitrogen (%)	1.91	2.1	2.1	1.5	1.5	1.1	2.04	1.37	1.70
Oxygen (%)	3.1	3.4	3.5	3.01	3.1	2.5	3.33	2.87	3.10
Hydrogen (%)	15.1	14.9	16.1	15.01	15.1	15.1	15.37	15.07	15.22
Calorific value MJ/Kg	2.1	2.4	2.5	2.1	3.1	2.1	2.33	2.43	2.38
Fusing Point (°c)	1310	1385	1430	1580	1640	1635	1375.00	1618.33	1496.67
C:N ratio	30.1	24.6	20.1	28.01	36.01	29.1	24.93	31.04	27.99

**Table 5(c) Percentage summary of Chemical composition of solid waste Monsoon Season during 2011**

Parameters	Percentage by weight						Average % age residential sample	Average % age commercial sample	Average % age
	RI	RII	RIII	CI	CII	CIII			
PH	6.5	6.1	6.1	6.1	6.5	6.5	6.23	6.37	6.30
Potassium (%)	3.01	2.5	2.5	3.2	2.9	2.9	2.67	3.00	2.84
Phosphorous (%)	2.1	1.6	1.5	2.1	2.41	2.3	1.73	2.27	2.00
Carbon (%)	1.01	1.1	1.2	1.1	1.9	0.9	1.10	1.30	1.20
Nitrogen (%)	2.1	2.1	2.3	1.5	1.5	1.1	2.17	1.37	1.77
Oxygen (%)	3.01	3.1	3.5	2.9	3.1	2.6	3.20	2.87	3.04
Hydrogen (%)	15.1	14.9	15.1	15.9	15.1	15.2	15.03	15.40	15.22
Calorific value MJ/Kg	2.1	2.2	2.5	3.1	3.1	2.5	2.27	2.90	2.58
Fusing Point (°c)	1413	1290	1415	1594	1645	1608	1372.67	1615.67	1494.17
C:N ratio	30.1	25.1	21.1	25.1	36.1	26.5	25.43	29.23	27.33

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## V. CONCLUSIONS

From the present study the following conclusions were drawn

- Average Municipal solid waste generation rate in the town was found to be 0.316 Kg/capita/day.
- The total quantity of waste generated was 77.42 t / day.
- The average density of solid waste was 383.12 kg/m<sup>3</sup> and their value is within the standard range.
- The average moisture content in residential area and commercial area were 37.70% and 38.02% and is slightly higher than the standard values.
- The quantity of recyclable materials obtained was about 12% of the total weight.
- Major constituent obtained was organic matter which was about 48% of the total weight and hence the material can be converted into composting material like manure.
- The pH values were within the permissible limit.
- The C/N ratio, Potassium, Phosphorus, Carbon, and Nitrogen content of refuse were 3%, 2%, 1.3%, 1.6% and 27.5 shows higher values and the refuse is most suitable for composting than energy recovery.
- Well planned allocation of available resources, the application of proper technology and better sanitation standards, need to be enforced in order to provide environmental protection to the citizens of the growing town.

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