# Solid Waste Management of Bidar City

**Kamaladevi[1] Saraswati Reddy[2]**
[1]P.G Scholar (Environmental Engineering) [2]Professor
[1,2]Department of Civil Engineering
[1,2]Poojya Doddappa Appa College of Engineering Kalaburgi-585102, Karnataka, India

*Abstract*— Due to rapid industrialization, education, business activities, software development population of Bidar city of Karnataka state of India is increasing day by day, present population of Bidar city as per 2011 census is 257644 hence increasing solid waste generation. Around 0.35kg/person/day solid waste is generated and around 90 ton wastes are dumped in dumping site daily. Collection and transportation is one of the important functional components of solid waste management. Thus to keep city clean and environmentally healthy, the management of solid waste has now becoming an important issue, therefore undertaken to generate information on physical and chemical parameters and route optimization of Bidar municipal solid waste. The average results showed that municipal solid waste in the city i,e moisture content is 30.02% by weight of fresh waste. And the average density of waste is being 304.2kg/m3. The other parameters in the physical analysis like paper, plastic, metal, glass, rubber & leather, stone & brick, ash & earth and total compostable matter are 6.13%, 6.27%, 4.34%, 3.77%, 4.54%, 10.99%, 18.71%, 31.98% having their average percentage values respectively. In the chemical analysis the pH of the waste is slightly acidic having an average value is 6.8, the high calorific average value is13.64k.j/kg carbon, nitrogen, phosphate are 25.50%, 13.11%, 0.44% having their average values respectively. And volatile matter 73.75% and non-volatile matter 26% having their average percentage values.

***Key words:*** SWM, Municipal solid waste management, Waste generation

## I. INTRODUCTION

### *A. General:*

Municipal solid waste management is one of the major problems facing city planners all over the world. The problem is especially severe in most developing-country cities where increased urbanization, poor planning, and lack of adequate resources contribute to the poor state of municipal solid waste management Technological development, globalization and population growth have accelerated the dynamics of the urbanization process in developing countries.

Municipal solid waste management planning had concluded that many uncertain factors exist in the planning for municipal solid waste (MSW) management. In this paper for the first time an evolutionary algorithm is combined with simulation to determine solutions for the MSW management problem.

Solid Waste Management in Katmandu, concluded its analyses, municipal solid waste production trends, and other related topics like conservancy wings, organizational and financial aspect to address the actual existing practice. Prediction of solid waste generation was done for an efficient waste management program and infrastructures that would be needed for the purpose.

Network Analysis Based Designing for a Municipal Solid Waste Collection and Transportation System The current maintenance, collection and transportation system of Ardebil city has lot of defects and problems that need to be fixed through engineered system design. Hence, in research ahead, using engineering principles, formulas and techniques in designing collection and transportation system for municipal solid waste, the transportation system was designed for ardebil city regarding the available facilities. By implementing the proposed municipal waste collection and transportation system, while increasing the efficiency and saving money, lot of current problems related to required facilities and manpower will be fixed in ardebil.

In India alone, the urban population has increased from 11% in 1901 to 26% in 2001. The rapid growth rates of many cities, combined with their huge population base, has left many Indian cities deficient in infrastructure services like water supply, sewerage and solid waste management. Due to a lack of serious efforts by town/city authorities, the management of garbage has become a tenacious problem, notwithstanding the fact that the largest part of any municipal expenditure is allotted to it. A substantial amount of the total expenditure (85%) is spent on collection and as such improvement in the design of the collection systems could result in substantial savings, thereby saving a large proportion of the funds. However just collecting the waste from different parts of city does not solve the problem, it requires disposing the waste in environmentally safe and economically sustainable manner. An effective solid waste management system is needed to ensure better human health and safety.

### *B. Objectives:*

The main objective of the present study is to assess the status of solid waste management in Bidar city. The detailed objectives of the study are:

(1) To advise a system of storage of waste and segregation of recyclable waste at the source of generation of waste
(2) To advise system to eliminate the age old practice of dumping of garbage on the streets and outside the dustbins causing nuisance to the people and posing a threat to the health of the community at large.
(3) To improve efficiency of day to day cleaning of streets and public place
(4) To find the adequacy of solid waste management system for area development.
(5) To ensure safe disposal of solid waste
(6) Physical and chemical analysis of municipal solid waste

 

## II. MATERIALS & METHODS

*A. Functional Elements of Municipal Solid Waste Management:*

The activities associated with the management of municipal solid wastes from the point of generation to final disposal can be grouped into the six functional elements:

(1) Waste generation
(2) Waste handling and sorting, storage, and processing at the source
(3) Collection
(4) Sorting, processing and transformation
(5) Transfer and transport
(6) Disposal

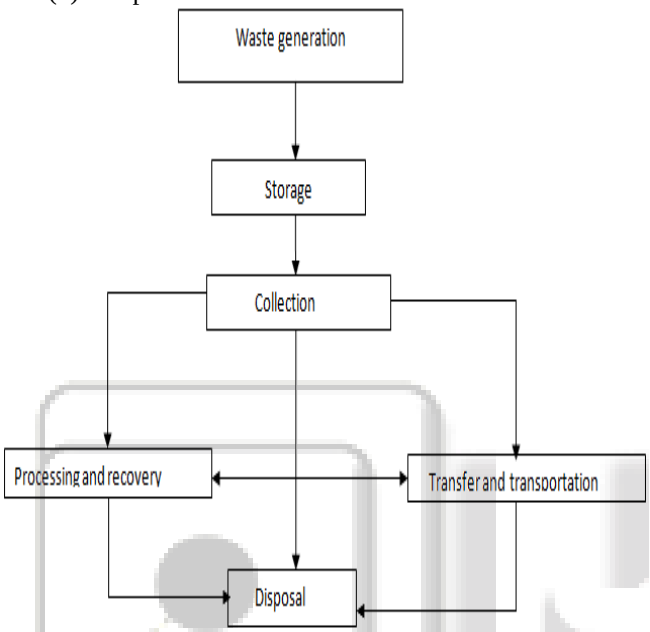


Fig. 2.1: Interrelationship of functional elements comprising a SWM System

*B. Collection of Sample and Measurement of Density:*

The samples were collected early in the morning once in Fifteen days from the dumping site. The early morning time was selected keeping in view that rag pickers may remove paper, plastics, metals etc. Sampling was not done on moderate or heavy rain days as it affects density and moisture of the solid waste. The density of the waste is measured by a cubic meter box method. For this a box of size 0.5 M x 0.5 M x 0.5 M is made. This box is taken to the collection point at Sultanpure Site and collected the sample from the site.

During sample collection, ten points were chosen in the dumping yard and from that ten grab samples were taken at different depths. This procedure is repeated until the cubic meter box gets filled up. This sample is then transferred to a plastic bag and it is brought to the laboratory. In the laboratory, the sample is weighed on the platform type balance to get the mass in kg. Then the density is calculated by using formula mass / volume (kg / cum.) and some part of the waste is taken for moisture contain test. After finding density, the sample is then taken for physical analysis.

*1) Physical Analysis of Municipal Solid Waste:*

The sample that has been collected is sorted on the table in the laboratory, then the different ingredients such as paper, plastic, rags, metal, glass, rubber and leather, wooden, matter, crockery, bones, stones and bricks, as and earth and total compostable matter are separated. After separation the weights are taken separately and expressed as the percentage of its original weight. The results are shown in the next chapter.

*2) Chemical Analysis of Municipal Solid Waste:*

A 1000 gm sample is taken for moisture determination and it is heated overnight at $70^0$C to obtain weight loss. This loss is expressed as percentage of total weight. Normally moisture content is determined as soon as the sample is collected. After moisture content determination, the sample is again mixed thoroughly. After mixing 500 gm representative sample is taken out for chemical analysis. The 500 gm sample is first dried and then it is grinded. After grinding, the powder is sieved through 0.45mm IS sieve. The analysis was carried out for various parameters like pH, moisture content, nitrogen, phosphorus, organic matter, carbon content, and calorific value.

*3) Determination of volatile substance and non-volatile substance:*

Procedure: Place abut 5g finely ground sample in constant mass silica or porcelain dish and heat in an electric furnace (muffle furnace) up to a temperature of $600^0$C for 2 hours. Allow the dish to cool in a desiccator and weigh it again.

Non-volatile substance percent by mass = 100 – VS

*4) pH Measurement:*

5gm of sample is mixed with 50ml of distilled water and the mixture is stirred for 30mins with a glass rod. The mixture is allowed to settle for 5 min. Then electrode is immersed in the suspension and pH value is recorded when reading is stabilized using a pH meter.

*5) Determination of Moisture Content:*

Moisture content is measured immediately after the collection of sample, wet weight of the sample is measured, and it is dried in the oven at a temperature of $105^0$C till the weight is constant. The dried sample is then cooled at room temperature and weighed again. The moisture content is the determined using the formula.

*6) Determination of Total Organic Carbon:*

There exists definite ratio between carbon and nitrogen. By estimating organic carbon, the amount of nitrogen released can be known. Grind 10-15 grams of sample in agate pestle and mortar and pass the sample through 0.2mm I.S. sieve. Weigh one gram of sample in 100ml conical flask. Add 10ml of potassium dichromate ($K_2Cr_2O_7$) solution and 20ml of sulfuric acid. After half an hour, add 10ml of distilled water. Transfer the contents to 50ml test tubes and keep the contents overnight to settle the particles. Reading can be taken same day if centrifuged. Measure the absorbance at 660nm using spectrophotometer.

*7) Determination of Phosphorus Content:*

Phosphorous occurs in waste almost solely in the form of various types of phosphates. These forms are commonly classified into orthophosphate and total phosphate. These may occur in the soluble form, in particles of dedtritus or in the body of aquatic organism. The various forms of phosphate find their way into wastewater, effluents and polluted water from variety of sources. Larger quality of same compound may be added in the water is used for laundering or other cleaning, since these materials are major constituents of many commercial cleaning preparations.

Orthophosphate applied to agricultural or residential cultivated land as fertilizers are carried into surface water with storm runoff and to a lesser extent to melting snow contributed to sewage by body waste and food residues.

Presence of phosphates in waste analysis has great significance. Phosphate in small concentrations are used in water supplies to reduce scale formation, to increase carrying capacity of main, to avoid corrosion in water mains to remove iron and manganese micro quantities in coagulation especially in acid condition.

(1) Into a series of 100ml Nessler tubes pipette appropriate amounts of phosphate working solution to cover the range of 5-30 mg/l or 0.3-2mg/l sncl2 is used as a reducing agent.
(2) Add 2ml ammonium molybdate and mix well
(3) Add 2ml stannous chloride and dilute to 100ml
(4) Prepare blank using distilled water in the same way
(5) Measure the intensity of intensity of blue colored complex at 690nm or 880nm light path between 10and 12 minutes after the development of the color.
(6) Plot absorbance vs phosphate concentration to give a straight line passing through the origin.

*8) Determination of Nitrate:*

(1) Take suitable aliquot or the sample in a beaker and evaporate to dryness on water bath
(2) Dissolve the residue using glass rod with 2ml PDA (phenol di-sulphonic acid) reagent. Dilute and transfer to nesslers tubes.
(3) Add 8-10ml 12N KOH. If turbidity is developed add the EDTA reagent drop wise
(4) Prepare blank in the same way using distilled water instead of sample.
(5) Read the colour developed at 410µ with a light path of 1cm. record $NO_3$ as N in mg/l
(6) Prepare calibration curve using suitable aliquots of standard $NO_3$ in the range of 5 to 500µgmN/l following the above procedure.

*9) Determination of Calorific Value:*

High calorific value of the material in K.j/kg is determined as per by using bomb calorimeter. A known amount of the sample is burnt in a sealed chamber ( here after we shall refer to the chamber as bomb as shown in the below figure 3.8 a ). The air is replaced by pure oxygen .The sample is ignited electrically. As the sample burns, heat is produced. The rise in temperature is determined. Since, barring loss of heat, the amount of heat produced by burning the sample must be equal to the amount of heat absorbed by the calorimeter assembly, knowledge of the water equivalent of the calorimeter assembly and of the rise in temperature enables one to calculate heat combustion of the sample.

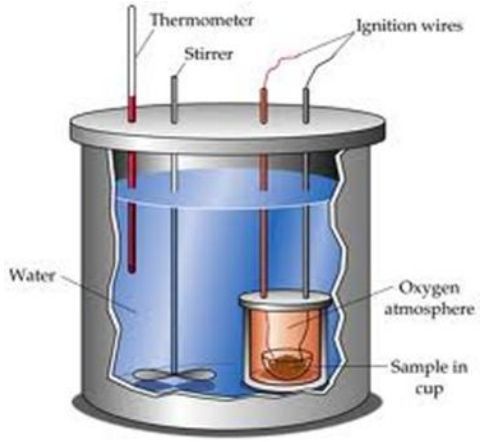


Fig. 2.2: Bomb calorimeter

*10) Procedure:*

(1) About one gram of the fuel is weighed in the crucible; a weighed piece firing wire is stretched between the electrodes in a manner that it is in close contact with the fuel so that it may be ignited.
(2) Often the powered coal is made into a small pellet with the fuse wire inserted in it, weighed and placed in the crucible
(3) The cap is screwed down on the bomb and oxygen is filled in the cup to a pressure of about 30 atm. The bomb is then placed in a weighed amount of water, taken in the calorimeter.
(4) Electrical connections are made, stirring is started and temperature reading is taken with a thermometer reading to 0.01degree Celsius.
(5) When the thermometer shows a steady temperature the electrical contact is made to fire the fuel and temperature readings are continued for 5 minutes after the maximum temperature is attained.
(6) The water is stirred during the experiment.
(7) The bomb is then removed and allowed to stand so that acid mist may settle down. The pressure is then slowly released and the content of the bomb are carefully washed.
(8) In actual practice correction needs to be made for the heat of fuse wire.

## III. RESULTS AND DISCUSSIONS

The total solid waste generated in the city of Bidar is found to be 90tons /day. The population being in the city is 257644 (2011 census). The per capita waste produced from the city is 0.35 kg/day. Density of municipal solid waste generated in the city for eight samples has been shown in the table and variation of density as shown as figure the average density of municipal solid waste is 304.82 kg/$m^3$.

| | **Sample no 1** | **Sample no 2** | **Sample no 3** | **Sample no 4** | **Sample no 5** | **Sample no 6** | **Sample no 7** | **Sample no 8** | **average** |
|---|---|---|---|---|---|---|---|---|---|
| wt of sample in kg | 40 | 36.80 | 35.12 | 38.5 | 38.0 | 38.2 | 39 | 39.2 | 38.10 |
| Density in Kg/$m^3$ | 320 | 294.4 | 280.96 | 308 | 304 | 305.6 | 312 | 313.6 | 304.82 |

Table 3.1: Average density of Bidar municipal solid waste

 

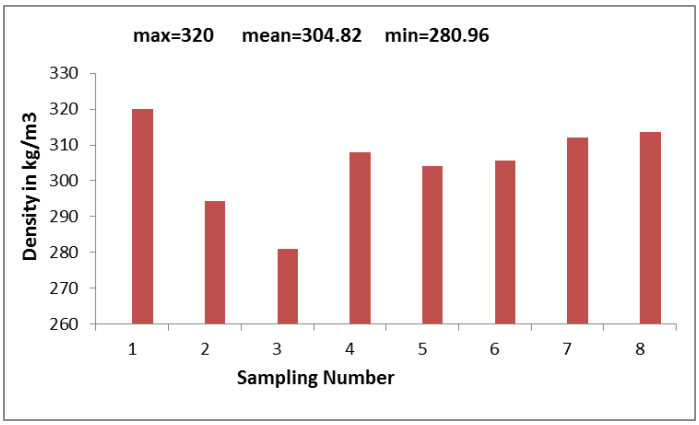


Figure 3.1: Average density of municipal solid waste

| Sino | parameters | Sample no 1 | Sample no 2 | Sample no 3 | Sample no 4 | Sample no 5 | Sample no 6 | Sample no 7 | Sample no 8 | Average values | Max | Min | Standard deviation(σ) | Coefficient of variation(cv) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Paper | 7.25 | 7.1 | 6.12 | 5.35 | 6.01 | 5.07 | 6.66 | 5.54 | 6.13 | 7.25 | 5.54 | 0.80802 | 0.123 |
| 2 | Plastic | 8.0 | 7.75 | 5.20 | 5.66 | 6.65 | 7.37 | 4.61 | 4.92 | 6.27 | 8.0 | 4.61 | 1.3433 | 0.200 |
| 3 | Rags | 3.74 | 3.9 | 4.14 | 2.1 | 3.54 | 3.16 | 2.18 | 2.91 | 3.2 | 3.74 | 2.1 | 0.7668 | 0.224 |
| 4 | Metal | 3.54 | 3.55 | 3.92 | 4.85 | 5.94 | 7.0 | 2.82 | 3.16 | 4.34 | 7.0 | 2.82 | 1.4657 | 0.315 |
| 5 | Glass | 3.74 | 5.03 | 4.14 | 3.81 | 5.0 | 3.21 | 2.05 | 3.18 | 3.77 | 5.03 | 2.05 | 0.9899 | 0.245 |
| 6 | Rubber&leather | 4.2 | 3.35 | 4.06 | 5.59 | 4.97 | 5.4 | 3.07 | 5.75 | 4.54 | 5.75 | 3.35 | 1.02911 | 0.212 |
| 7 | Wooden matter | 4.35 | 3.1 | 4.75 | 5.3 | 3.79 | 4.34 | 6.41 | 4.92 | 4.62 | 6.41 | 3.1 | 0.9945 | 0.202 |
| 8 | Crockery | 2.5 | 4.9 | 2.76 | 2.85 | 2.09 | 2.63 | 4.23 | 3.92 | 3.23 | 4.23 | 2.09 | 0.9872 | 0.285 |
| 9 | Bones | 3.3 | 1.72 | 3.64 | 2.45 | Nill | 1.71 | 2.05 | Nill | 1.85 | 3.64 | 1.71 | 0.8214 | 0.302 |
| 10 | Stone&brick | 10.12 | 7.54 | 11.1 | 11.6 | 10.13 | 11.13 | 13.76 | 12.53 | 10.99 | 13.76 | 7.54 | 1.8457 | 0.157 |
| 11 | Ash&earth | 18.14 | 23.15 | 16.21 | 18.49 | 19.14 | 18.15 | 17.55 | 18.91 | 18.71 | 23.15 | 16.21 | 2.0078 | 0.100 |
| 12 | Total compostable matter | 31.12 | 28.91 | 31.2 | 31.95 | 32.74 | 31.05 | 34.61 | 34.26 | 31.98 | 34.61 | 28.91 | 1.8643 | 0.054 |

Table 3.2: characteristics of physical analysis

| Sino | Parameters | pH | Carbon % | Nitrate % | Phosphate % | Calorific value k.j/kg | Volatile substance % | Non- volatile substance % | Moisture content % |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Sample no 1 | 6.7 | 26.25 | 10.54 | 0.37 | 12.216 | 76 | 24 | 27 |
| 2 | Sample no 2 | 6.9 | 26.40 | 11.39 | 0.41 | 14.699 | 72 | 28 | 25.5 |
| 3 | Sample no 3 | 7.2 | 25.86 | 11.69 | 0.36 | 12.745 | 78 | 22 | 31 |
| 4 | Sample no 4 | 6.8 | 24.20 | 13.84 | 0.52 | 11.489 | 76 | 24 | 30.50 |
| 5 | Sample no 5 | 6.7 | 24.82 | 13.24 | 0.12 | 16.057 | 74 | 26 | 32 |
| 6 | Sample no 6 | 6.7 | 25.61 | 14.25 | 0.19 | 13.941 | 72 | 28 | 28 |
| 7 | Sample no 7 | 7.1 | 25.64 | 14.70 | 0.57 | 14.692 | 68 | 32 | 33.20 |
| 8 | Sample no 8 | 6.9 | 25.11 | 15.21 | 1.03 | 13.240 | 74 | 26 | 33 |
| 9 | Mean | 6.8 | 25.49 | 13.11 | 0.44 | 13.64 | 73.75 | 26 | 30.025 |
| 10 | Max | 7.2 | 26.40 | 15.21 | 1.03 | 16.057 | 78 | 32 | 33.20 |
| 11 | Min | 6.7 | 24.20 | 10.54 | 0.12 | 11.489 | 68 | 22 | 25.5 |
| 12 | Standard deviation(σ) | 0.19 | 0.7403 | 1.7057 | 0.2789 | 1.5012 | 2.90 | 2.90 | 2.8719 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 13 | Coefficient of variation(cv) | 0.27 | 0.029 | 0.1301 | 0.6271 | 0.11016 | 0.04 | 0.11 | 0.0956 |

Table 3.3: Characteristic of Chemical Analysis

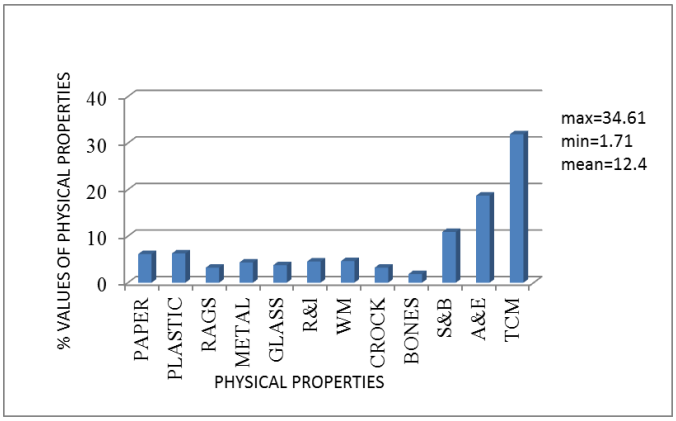


Fig. 3.2: Average physical properties of municipal solid waste

From the above results, it has been observed that the low density of solid waste is generated in some sampling .the reason may be due to the presence of light materials such as paper, plastic, rags etc. From table No 5.2 and figure No 5.2 it is observed that the paper content varies from as low as 5.54% to as high as 7.25% and the average value is 6.13 % .The plastic content varies from 4.61% to 8 %, and the average value is 6.27 % .The rags varies from 2.1 % to 3.74 % , and the average value of is 3.2 % .

The average percentage ingredients such as a metal, glass, rubber and leather, wooden matter and crockery where found 4.34%, 3.77%, 4.54% , 4.62% and 3.23% . The bones were much less compared to other ingredients is found to be 1.86%. The average values of stones and bricks, ash, earth, and compostable matter (vegetable matter) is observed to be 10.99%, 18.71 % and 31.98 % respectively.

It is also observed that the there is a large amount of compostable matter. And inert material such as a ash and earth in the refuse. Composting may be practiced with such type of waste. This compost may be used as organic manure with a good soil conditioner rich in carbon (C) ,Nitrogen (N), Phosphorus (P). the use of compost as soil conditioner along with organic fertilizer is recognized all over the world.

The materials like papers, plastics metal, rubber and leather, wooden matter crockery were found to be low as a result of rags picking by which recycling is done selling the above materials in the market or to the industries .The earth stones and bricks content are found to be high essentially due to the mixing of street sweepings which contain these materials with the municipal refuse

The ash & earth content is also observed to be more as a result of our practice of burning the combustible materials in the dustbins itself. Also it is noticed that some small scale industries and road side shops which have boiler or utilize organs fuel like blacksmiths dispose large amounts of ash.

*A. The Results of Average Chemical Characteristics of Bidar Municipal Solid Waste:*

Considering all the samples it has been observed that the moisture content of refuse varies from as low as 25.5 % to as high as 33.2 %. The total average moisture content under the study was observed to be 30.02 %

The variation exists because of the fact that commercial area disposes paper, plastics, rags glass and wooden materials which have very low moisture content whereas residential area disposing lot of vegetable matter as kitchen waste, sewage and floor washing left on to the streets as a result of low standard of living. The pH of refuse varies from 6.7 to 7.2. The total average pH value was observed to be 6.8. It has been observed that the total average $P^H$ was found to be 6.8, which indicates that the refuse is in fresh condition and not yet decomposed. The volatile matter and non-volatile matter varies from as low as 12%and 78 % to as high as 22 % and 88%. The total average volatile matter and non-volatile matter of the city is 16%and 84% respectively.

The average calorific value (14.50K.j /Kg) of refuse of Gulbarga city is found to be very low. This is because the rag pickers remove the wood, papers, plastic etc., from the municipal containers leaving only ashes and broken earthy wares at disposal site.

The Carbon result is found to be as low as 24.20% and as high as 26.40% and the average value of Carbon is 25.49%. The Nitrogen found to be as low as 0.33% and as high as 0.76% and the average value of Nitrogen is 0.47%.The Phosphate result is found to be as low as 0.37% and as high as 0.56% and the average value of Phosphate is 0.45%.

The high calorific value was noticed to vary from a low of 12.216k.j/kg to a high of 16.057k.j/kg and the average value of high calorific value is of 13.64k.j/kg. The disparity arise from the activity of rag pickers being high, a low standard of living inhabiting people of the low income group at area who take away lot of combustible matter like paper, plastic, rags and wooden matter etc.

## IV. CONCLUSIONS

In the present study, an attempt has been made for the Bidar municipal solid waste management and the conclusions may be drawn based on the result obtained on the present study:

(1) Generation rate of municipal solid waste is 0.35kg/capita/day
(2) The average density of waste 304.82kg/m3
(3) The major constituents of Bidar city municipal solid waste contains relatively high organic matter i,e 73.75%
(4) Paper(6.13%), plastic(6.27%), metal(4.34%), glass(3.77%), rubber & leather(4.54%), stone & brick(10.9%), ash & earth(18.7%), and compostable matter(31.9%), are generally present, although not always so, the relative proportion depending on local factors.
(5) The pH of refuse from the city under study was found 6.8 and it is slightly acidic.
(6) The refuse of the area under consideration contains average high calorific value (13.64%), carbon (25.5%), nitrogen (13.11%), phosphate (0.44%), and matter in analysis.
(7) The refuse of the area under consideration contains high percentage of compostable matter. Therefore "composting" method can be practiced yielding

high amounts of manure for the vast agriculture lands around the city.

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