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ENERGY RECOVERY POTENTIAL AND POWER GENERATION POTENTIAL FROM MUNICIPAL SOLID WASTAGES – A CASE STUDY OF NANDYAL MUNICIPALITY, KURNOOL DISTRICT, ANDHRA PRADESH, INDIA

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The continuous generation of Municipal Solid Waste (MSW) of the world urban centers due to urbanization, industrialization and globalization. The MSW has a great energy potential. The potential of utilizing various municipal solid waste streams for green energy production. The total generation of MSW per day in Nandyal town is about 65 metric tons. The present study is to identify the combustible portion in the MSW generated and to calculate the moisture content, calorific value of dry combustible solid wastages and in total, estimating the energy recovery potential and power generation potential. The energy recovery potential is 2,22,266.7 KWh and power generation potential is 9.25 MW.

KEYWORDS : Municipal Solid Waste (MSW), Waste to energy (WTE), Calorific value (CV), Net Calorific Value (NCV),Urban Local Bodies (ULBS),Municipal Solid Waste Yard (MSWY), Urban Local Bodies (ULBs), Bomb Calorimeter.

INTRODUCTION

Waste to Energy (WTE) is one of the best option for MSW treatment. It is motivated by both the necessity to minimize the environmental stresses and to produce the energy. A solid waste can be defined as any solid or semi solid resulting from activities of human beings, discarded as useless or unwanted. MSW is a waste type that includes domestic waste, commercial waste, construction and demolishing debris, sanitation residue and waste collected by the municipalities in agiven area.

S. Rathi [1] reported that improper management of MSW affect public health and degradation of the environment. A. Pappu *et al*., [2] studied the significant increase of MSW generation in India. Ramachar *et al*., [3] examined and reported solid waste management of Kurnool municipality. Ramachar *et al*., [4] calculated energy recovery potential and power generation potential from municipal solid wastes of Kurnool city. Aydi [5] estimated the energy recovery from municipal solid waste of Tunisian case study. Lie Yang *et al*., [6]

explored a bibliometric approach of solid waste research from 1997 to 2011.A.Omari *et al*., [7] described energy recovery routesfrom MSW of Arusha-Tanzania.

The WTE from MSW has environmental benefits like disposal of waste, reduce the dependence on fossil fuels, which is a major contributor of Green House Gasses (GHG).The present study is confined to MSW generated from Nandyal town, Kurnool district, Andhra Pradesh.

Historical Importance of Nandyal town:

Nandyal is derived from the word Nandi Alayam. It is approximately centre point of nine nandi temples and has been an important pilgrimage site since the days of Vijayanagara kingdom owing to its nine nandi temples. Hence, it has got the name of Nandyal. It is an important town in Kurnool district of Andhra Pradesh, India.

Geographical locations:

Nandyal town lies on latitude 15”30’ North and 78”30’ east longitude. The town is spread over an area of 15.42 sq. kms. The town is located at NH40 and is well connected to Hyderabad, Kurnool, Tirupathi, Vijayawada and other cities. It is located at an elevation of 203m above mean sea level. The Kundu river, a tributary of Penna river is located in Nandyal region. The climate of the municipality is mainly hot as against the climate of the Kurnool district, which is mainly dry and hot. A maximum temperature of 44.4°C and a minimum temperature of 21.7°C. This region experiences a heavy rainfall in the district and an average annual rainfall is about 76.5cm [8]. Nandyal town map is shown in fig. 1.

Fig. 1. Nandyal Town Route Map

Population :

Nandyal municipality was constituted in the year 1899 and now it was classified as special grade municipality from 1998. Nandyal municipality population is of 2,00,516 as per 2011 census. Nandyal municipality is divided into five divisions. The town is divided into 42 wards. The total number of households is about 45,376 and percapita waste generation is of 0.28 kg/cap/day.

EXPERIMENTAL

In Nandyal municipality 90% of total household waste is through door to door collection on daily basis from 90% of the wards. The waste collected is transported to the transfer point by autos and tractors and then sent to solid waste dump yard by truck and tippers. The

dumping yard is situated at bhimavaram, which is 10kms from Nandyal town. The present existing MSW management system of Nandyal town is shown in fig. 2 and 3.

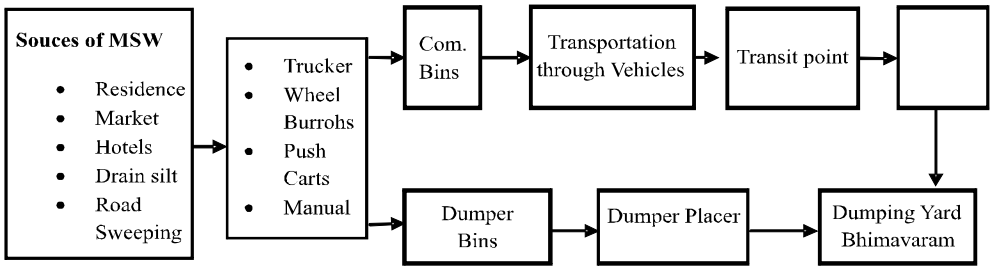

Fig. 2. MSW Management System in Nandyal Town

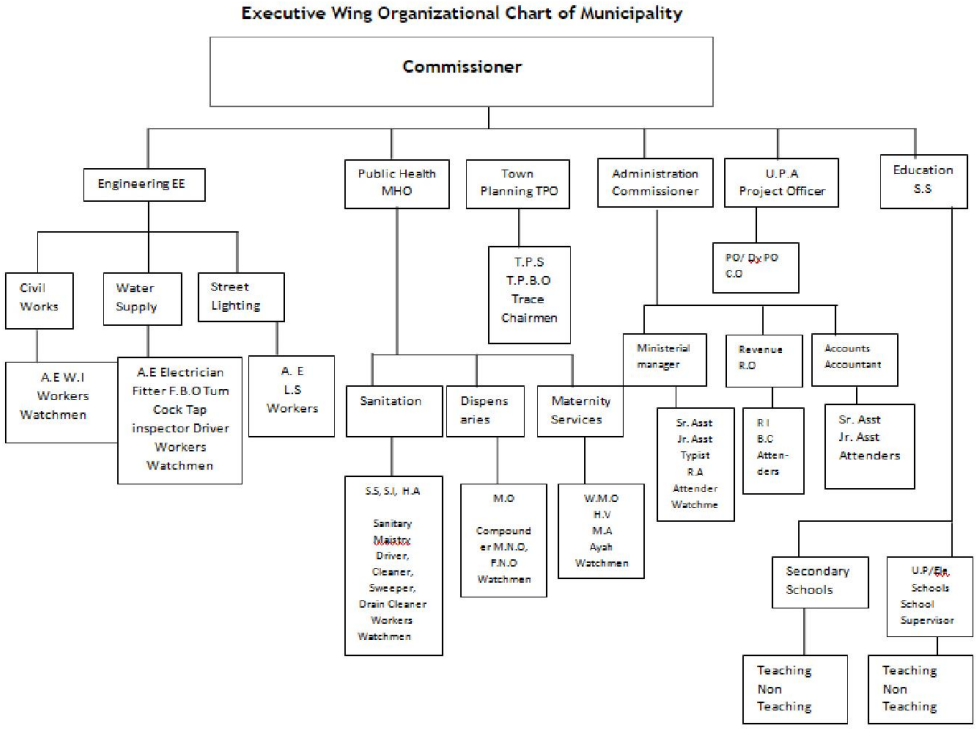

Fig. 3. Organisation of Nandyal Municipality

Apparatus :

Digital temperature recorded bomb calorimeter is used for calculating calorific value of the MSW. Elico digital pH meter (DPH500) is employed for pH measurements. Bulk solid density operators is used for measuring bulk density of MSW.

Calculation of total amount of MSW per day:

The total amount of MSW per day is calculated by the number of trips made by the tippers to the dumping yard by taking the average over a period of 14 days.The tippers are weighed in the weigh bridge with and without MSW. An average of 65 metric tons of MSW per day is being transported to the MSWY.

Estimation of MSW from Different Areas of Houses in Nandyal Municipality :

50 houses have been selected for house to house survey of MSW in 10 selected localities of Nandyal municipality. The process of collection of samples has done on alternative days in a week to predict average value of MSW generation. The samples were weighed and separated. The moisture content of the samples is determined by means of hot air oven maintained at 80°C to avoid the loss of volatile matter in the sample. The calorific value of the dried samples is determined by bomb calorimeter. A sample survey has been done in all five divisions of Nandyal municipality to ascertain combustible, decomposable and inert portion in MSW. The Figures. 4 and 5 represent the Dumping of MSW at MSW Yard Bhimavaram.

Estimation of MSW from Dump Yard :

100kgs of MSW is collected from various parts from the dumping yard. The large pieces of wastages are cut into small pieces. The sampling is made from the dumping yard by standard procedures and as per MSW management and handling rules, 2001 MoEF [9]-[10]. The following quartering method is employed to collect 10 kgs of the sample. The MSW sample is mixedand divided into four sections. One of the section is again mixed and again divided into four sections. This process is repeated to get about 10 g of MSW sample which is taken as representative sample. It is then segregated and cut into uniform size. The moisture content and calorific value of the dried combustible component are determined by using hot air oven and bomb calorimeter. The dried and segregated sample is sent for MoEF recognized lab for elemental analysis [11]. The related pictures are shown in the fig. 6, 7.

Push carts used for MSW collection

Tractors used for MSW collection

Fig. 4. Collection of MSW from residential areas of NMC

Fig. 5. Dumping of MSW at MSW Yard Bhimavaram

Fig. 6. Determination of Calorific value by Bomb Calorimeter

Fig. 7. Pellet Sample Making of dry MSW

Results and discussion

The percentage composition of MSW from house to house collection in the selected different localities and the moisture content of the samples is represented in the table 1.

Table 1. Percentage of Various Components in the Garbage Collected from Five Residential Areas

S. No.	Description of the Item	Srinivas Centre	Market Yard	Bommala Satam	Nune Palle	Sanjeev Nagar	Average
1	Food, Veg. & Fruit waste	58.14	65.8	48	55.4	47.2	54.9
2	Paper and Card board	12.14	8.5	15.2	4.8	4.2	8.96
3	Plastic and Packings	7.2	6.0	12.0	12.8	16.2	10.84
4	Leaf and Wood	1.5	3	2.2	6.2	2.2	3.42
5	Textiles and Clothes	7.8	5.8	4.8	8.3	9.2	7.18
6	Coconut and it's shells	5.0	6.0	5.2	6.2	6.4	5.76
7	Dust and Ash Particles	4.5	6.0	9.8	4.2	7.9	6.48

8	Glass	0.8	0.5	1.4	0.9	0.5	0.82
9	Metals	2.9	0.4	2.0	1.2	2.8	1.86

Table 2 represents the results obtained from the collected samples of different locations of five divisions of Nandyal municipality.

Table 2. Composition of MSW in Different Localities of Five divisions of Nandyal

S. No.	Location	Combustible (%)	Biodegradable (%)	Inert
1	SBI Colony	12.5	82	5.5
2	NGO Colony	19.2	70	10.8
3	Sai Baba Nagar	13.2	7.2	12.8
4	Sanjeev Nagar	21.5	6.5	13.5
5	BommalaSatram	14.5	80	5.5
6	Kranti Nagar	12.8	80	7.2
7	Mulasagaram	11	78	11
8	NunePalle	14.2	82.5	4.33
9	Jagadjanani Road	17.3	70.2	12.5
10	Sreenivas Centre	11.5	69.5	19
11	Average	14.77	74.9	10.33

Table 3, 4 shows the results of the calorific value of the dried combustible and noncombustible MSW samples collected from the MSWY, determined in the laboratory.

Table 3. Calorific Value of Dried Combustible MSW Samples from MSWY

Sample	Weight of Sample	Weight of Water in calorimeter	Water equivalent of Calorimeter	Initial Temp (°C)	Final Temp (°C)	Rise in Temp (°C)	Calorific Value (Kcal/Kg)
I	0.95	19.38	2443	0	1.8	1.8	4628.8
II	0.98	1942	2448	0	1.85	1.85	4621.2
III	0.92	1990	2510	0	1.78	1.78	4856.3
IV	0.90	1970	2480	0	1.80	1.80	4960
V	0.96	1965	2472	0	1.79	1.79	4609.2
VI	0.88	1950	24.55	0	1.69	1.69	4714.7
VII	0.86	1953	2458	0	1.70	1.7	4858.8
VIII	0.94	1948	2449	0	1.82	1.82	4741.6
Average Calorific Value Of Combustible Matter							4748.3

Table 4. Moisture and Calorific values of non Biodegradable Combustible Components from MSWY

S. No.	Item	% By Weight	% Moisture	Weight of Dry Component (MT)	Calorific Value (Kcal/Kg)	Heating Value (Kcal/Kg)
1	Plastic	10.12	8.4	28.2	4725	1332.4
2	Synthetic Coke	8.0	6.2	24.7	4710	1163.3

3	Rubber, Elastic Materials	8.5	9.8	29.8	4690	1397.7
4	Polythene Covers	12.2	7.2	17.3	4705	813.9
Average Value						4707.3

Table 5 represents the comparison of the Calorific values obtained from the experiments by the author and values obtained from MOEF recognized lab.

Table 5. Comparison of the calorific value of MSW samples

Calorific Value (Kcal/Kg)	**Heating Value of combustible constituents**	**Experimental Value from Bomb Calorimeter**	**MOEF Lab Analysis Report**
HCV	3721	3703	4103
Latent heat of Water Formed	253.5	253.5	253.5
NCV	3467.5	3449.5	3849.5

Total weight of dry combustible from 65MT of total mixed garbage = 55.25MT

Total weight of dry noncombustible from 65MT of total mixed garbage = 9.75MT

The energy recovery potential and power generation potential is calculated from the standard calculations [12].

Calculation of Energy Recovery Potential:

Energy recovery potential of dry combustible MSW

= NCV × Weight of combustible MSW in MT × 1000/860

= 3467.5 × 55.25 × 1000/860

= 2,22,266.7 KWh

Energy recovery potential of dry noncombustible MSW

= NCV × Weight of noncombustible MSW in MT × 1000/860

= 4453.8 × 9.75 × 1000/860

= 50,493 KWh

Calculation of Power Generation Potential:

Power generation potential of dry combustible MSW

= 1.16 × NCV × Weight of combustible MSW in MT/24

= 1.16 × 3467.5 × 55.25/24

= 9.25 MW

Power generation potential of dry noncombustible MSW

= 1.16 × NCV × Weight of noncombustible MSW in MT/24

= 1.16 × 4453.8 × 9.75/24

= 2.098 MW

The results obtained from the present work, the MSW generated from nandyal municipality has a high potential of generation of electric power. At present the authorities of Nandyal municipality are transferring the MSW to the district head quarters, Kurnool for

production of electric energy. The increase of population leads to generation of large quantities of MSW, it is suggested to establish a MSW power plant in Nandyal town as an alternate source for power generation.

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