Charateristic And Energy Potential Of Household Waste In The Urban Areas, Jessore, Bangladesh

Rezaul Karim, Md Abu Shamim Khan, SM Nur Alam, Nabila Nawshin

Abstract: The main work of this project is the characterization of household waste and its equivalent energy recovery of the household waste management in the urban areas. Primary and secondary data were used for the manuscript. In the total amount of the waste 87% is vegetable, 4% grass and wood, 1% plastic, 2% is paper and only 1% metal were found. The moisture content as discarded waste was found 68.05%. The suitability of the municipal solid waste as a possible source of energy was also put into consideration; an energy content of the solid waste was determined and observed to be 6.04 MJ/kg which is significant. Hence, it can be used to generate energy in Jessore Municipatlity. Hence, electricity energy with 1420 kW will be produced by the household waste of Jessore pourashava if household waste will be properly managed.

Index Terms: Household Waste, Energy Recovery, Moisture Content, Waste Composition

1 INTRODUCTION

DOMESTIC waste is a normal part of everyday life. Unmanaged household waste causes of environmental pollution; increased toxicity into the environment and also contaminated ground water if dumped on the ground. It is necessary to understand qualitative and quantitative characteristics of solid waste as it's improve demands alternatives of handling and treatment [1]. But well managed household waste can be resource of any city through material recovery; waste incineration to electricity and even bio-digesters. A number of processes are involved in effectively managing of domestic waste. But the energy recovery and material recycle are not emphasized in the developing countries like Bangladesh. In Bangladesh, there have been conducted various studies in different municipalities e.g. Dhaka, Chittagong, Khulna, Rajshaji etc in the context of waste management especially household. But for Jessore the study was not numerous. Moreover, house hold waste management by the authority and even by the residents is not well functioning in terms of environmental and economical issue. On the other hand, energy is another demanding and over increasing issue day bay day in Bangladesh. The energy recovery from waste can be the alternate to make up the local demand from its own resources 'waste'. The main objectives of the study are i. to know the characteristics of household waste, Jessore municipality and to estimate the amount of energy that could be produced from the domestic wastes.

- *Rezaul Karim is currently teaching as assistant professor, at Dept. of Environmental Science and Technology in Jessore University of Science and Technology, Bangladesh PH-00880765471689. E-mail: r.karim@just.edu.bd*
- *Md Abu Shamim Khan is now working as a chemist, Asia Arsenic Network, in Jessore, Bangladesh. E-mail: abuskhan2000@yahoo.com*
- *S M Nur Alam is currently teaching as assistant professor, at Dept. of Chemical Engineering in Jessore University of Science and Technology, Bangladesh. E-mail: smn.alam@just.edu.bd*
- *Nabila Nawshin completed Bachelor degree program at Dept. of Environmental Science and Technology in Jessore University of Science and Technology, Bangladesh. E-mail: nabila.nawshin50@gmail.com*

2 STUDY AREA AND METHODOLOGY

2.1 Data Collection and Analysis

Jessore area is situated under the Khulna division. It is a district of Khulna division. Latitude of the total area is $23^0$8'49.61" N and Longitude of the area is $89^0$13'13.77"E. In Jessore municipality, there are 9 wards {2] with 42,793 houses producing a huge amount of household waste. There is an only dumping place of unmanaged waste from the house hold. It is located in Hamidpur near by the Bhairab River [3]. The study was carried out at ward # 8, Jessore Municipality; Data were collected from questionnaire survey with 53 houses for 15 days. Collected household waste every day and weighted them. Weighted household wastes for 15 days and the process of weighted was separation system and weighted household waste with weight machine. Experimental data were collected from the weighted of household waste.

2.2 Waste Composition and Quantity

The composition of waste was sorted by segregation of waste into different categories considered under the study and weighing them individually. The components of each category used for the study are vegetables; paper; plastics; grass and metal; clothes; glass and others. The proportions of each category were expressed as a percentage of the period as in the equation (1) [4[below:

$$\text{proportion of specific waste component} = \frac{100\%}{\text{Wt}} \sum_{i=1}^{n} \text{Wc, i} \qquad (1)$$

Where,
Wt = Total weight of waste from all households (15 days); i = ith day on which weight of waste was measured;
n = number of days for study period (30 days);
Wc,i = weight of a specific category of waste component for a particular house measured on the ith day

The total waste generation in Jessore municipality was expressed (2) as:

$$\text{total waste generation} = \text{Wahs} * \text{N} * 365 \qquad (2)$$

Where, N = total number of house hold in Jessore (42,793)

2.3 Determination of Moisture Content

After segregation of household waste all the wastes are weighted separately and collected data before drying of the sample. After weighted all the samples then samples put into an oven with 105^{0}C temperature for 3 hours. First one hour put into the oven with 150^{0}C temperature. After one hour elements are weighted and again put into the oven with same temperature. This process was done several times before reaching in a fixed weight of the elements. After drying all the elements of household wastes are put into the desiccators for reaching room temperature and weighted and collected data. Then the Moisture content X_W is calculated by the following equation [4] :

$$\text{moisture Content} = \frac{(a-b)}{a} * 100 \quad (3)$$

Where, a = the weight before drying; b = the weight after drying

2.4 Energy Content (EC)

Energy content can be obtained from the wet weight and dry weight of the household waste. Moreover after findings of chemical composition of household waste that helps to identify of the energy. By using Dulong equation (4) and chemical composition of household waste such as finding C, H, O, S, we can find the total amount of energy from total household waste [4]. Dulong equation is:

$$\text{Energy Content (E)}, \frac{\text{KJ}}{\text{Kg}} = 337\text{C} + 1428\left(\text{H} - \frac{\text{O}}{8}\right) + 9\text{S} \quad (4)$$

According to Yusuff et. al 4014, the overall efficiency of a mass-fired combustor plant can be obtained by the equation (5):

$$E_o = \eta * M_f + E \quad (5)$$

Where,
M_f = mass flow rate of waster generation in Kg/S
E = Energy content in kJ/Kg
E_0 = Energy out in kJ/Kg
η = efficiency in %

3 Result and Discussion

3.1 Total Household waste

From the study by Karim and Nawshin (2014), it was found that the potential amount of total waste generation in Jessore municipality is approximately 21457.27 kg/day or 7846.5 ton/year from 42,975 households [5]. So the mass flow rate of waste generation could be 0.248 kg/S.

3.2 Composition of Household wastes

From the segregation analysis of the household, the main composition of the household waste was found from the previous analysis. It was found that the vegetable waste, easily biodegradable, is approximately 87% by weight. The other parts are found in very low amounts as grass and wood (4%) which is found from garden side of the house or wood.

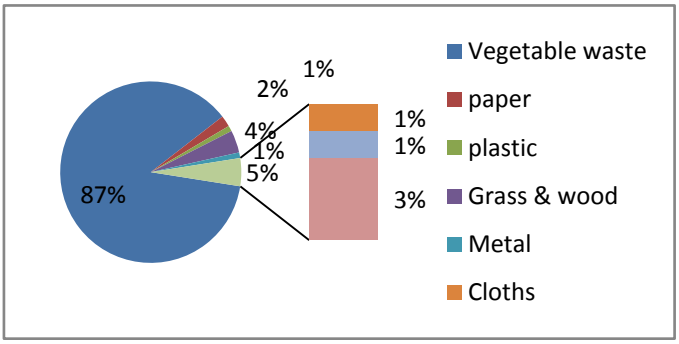

Figure 1: Percentage composition of HW in Jessore [5]

3.3 Moisture Content (MC)

Specific amount of samples are selected for drying. The data of household waste before and after dried are analyzed and found moisture content of the household waste of ward # 8 no of Jessore Pourashava.

Table 1: Weight and Percentage of Household Waste before and After Drying

Component	Wt before dry (g)	Wt after dry (g)	Wet wt of THW/ day (kg)	% of mass in wet basis	Dry Wt of THW /day (kg)	% of mass in dry basis
Vegetable waste	25	7	18692	90%	5234	25.05 %
Paper	25	23	359	2%	330	1.58%
Plastic	14	13	255	1%	237	0.13%
Grass & wood	25	15	927	4%	556	2.66%
Other	25	20	660	3%	528	2.53%
Total	114	78	20893	100 kg	6885	31.95 kg

Total wet mass: 100 kg; Total dry mass: 32.95 kg, so moisture content X_W is

$$XW = \frac{(100 - 31.95) * 100}{100} = 68.05\%$$

3.4 Chemical Composition of HW

Every element has some chemical properties which are found in the elements. When elements are analyzed with chemical then found the chemical properties. Chemical composition of the waste sample in Jessore Municipality is estimated based on the typical data on ultimate analysis of the combustible components in municipal solid wastes by using the reference Tchobanologhous et al., 1972 cited in Wadie et al, 2012 [6] and [7].

Table 2: Chemical Composition of Household Waste

Component	Wet mass (Kg)	Dry mass (Kg)	C	H	O	N	S	Ash
Vegetable waste	18692	5234	2512	334	1944	135	20	288
Paper	359	330	144	20	144	1	1	20
Plastic	255	237	142	17	55	----	--	23
Grass & wood	927	556	267	34	211	20	2	23
Other	660	528	139	16	11	3	1	359
Total	20893	6885	3204	421	2365	158	23	713

3.5 Recycling Matters (RC)

From the study, it is found that some people use non-biodegradable materials as recycling materials and some do not. Some materials used as recycling matter are plastic, metal, glass etc. From the survey it is found that metals and plastics were also used as recycling matter. Plastic materials used as recycling matter where its percentage was 35%. And 21% percentage materials were metals [5].

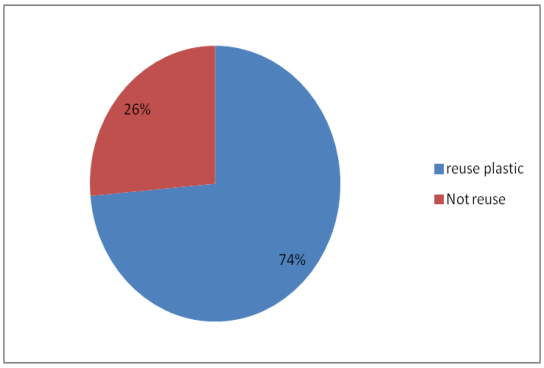

Figure 2 Percentage Of Plastic Use As Recycling Matter.

3.6 Energy Characteristics

The mass of moisture in the household solid waste sample is:
=Wet mass – Dry mass
= 20893 kg – 6885 kg
=14008 kg

Converting moisture content reported in table 1 to hydrogen and oxygen in the table -3.

Table 3: Total Amount of hydrogen and oxygen

hydrogen= 2/8 x 14008 = 1556 kg	Oxygen=16/18 x 14008 =12451 Kg
Total mass of hydrogen = 1556 + 421 = 1977 kg	Total mass of oxygen = 12451 + 2365 = 14816 kg

Table Error! No text of specified style in document.**:** Total Amount and Percentage of Chemical Properties

Component	Mass (kg)	% by mass
Carbon	3204	15.33
Hydrogen	1978	9.47
Oxygen	14817	70.92
Nitrogen	158	0.76
Sulfur	23	0.11
Ash	713	3.41
Total	20892	100

The energy content from the waste of Jessore municipality can found by using equation (4) as

E, KJ/Kg = 337(15.33) + 1428 (9.47 - 70.92/8) + 9(0.11)
= 5166.21 + 863.94+ 0.99 = 6031.14 kJ/Kg

The overall energy efficiency for the mass-fire combustor from 6031 kJ/Kg energy content and 7846.5 ton per year (or kg/S) Jessore municipality can be carried out by using the equation (5). Simulation can be carried out by assuming different operating efficiencies for the mass-fired combustor power plant [8]. . Hence, the potential for electrical energy generation for a fuel mass flow rate of 0.248 kg/S, heating value of 6031.14 kJ/kg and assumed overall efficiency values that range between 15% to 95% can be projected as shown in table 5 and figure 3.

Table 5: Electrical energy out generated with corresponding assumed efficiency (η).

Efficiency (%)	Electrical Output generated (kW)
0.15	224.35
0.25	373.92
0.35	523.49
0.45	673.06
0.55	822.63
0.65	972.20
0.75	1121.77
0.85	1271.33
0.95	1420.90

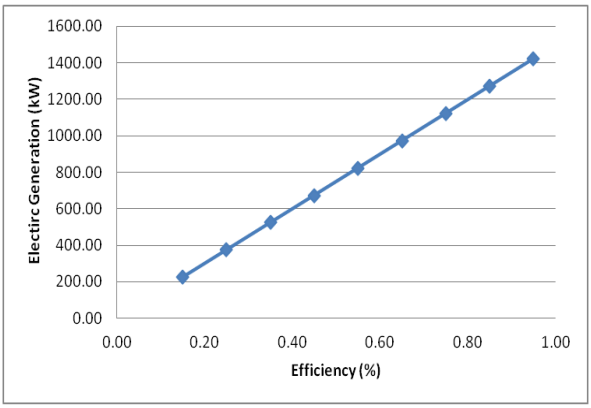

Figure 3: Relationship between simulated electrical energy outputs against power plant assumed efficiencies

4 CONCLUSIONS

In this study shows that every day, Jessore Pourashava produced 21497.27 Kg household waste per day and produced 7846.5 ton waste per year. In the total amount of the waste 87% is vegetable waste, 4% waste is grass and wood, 1% plastic, 2% is paper waste, and only 1% is metal which are found from the household waste in Jessore Pourashava If we dry 20893 Kg waste then we will get 6885 kg wastes per day. This waste can be converted to the energy by the using chemical composition. If we properly manage our household waste in a segregation system then we will find energy from the household waste. If we use these wastes then we will be found 6031 KJ/Kg energy per day, will be produced thermal value of energy is 1420 MW/yr with 95 % efficiencies of mass fired combustor.

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