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Estimated energy content of solid waste at commercial area of Udhampur, Jammu and Kashmir

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Abstract

The present study is an attempt to analyze the percentage generation of solid waste incommercial area of Udhampur (J&K) and to estimate the generation potentiality of energy through combustion of solid waste. The waste to energy industry has proven itself to be an environmentally friendly solution to the disposal of municipal solid waste and the production of energy.The estimation of energy content of commercial solid waste of Udhampur town is discussed in this paper. A regression equation was used for estimating the energy content of commercial solid waste. The estimation of energy content of municipal solid waste (MSW) is normally done by the use of Modified Dulong Equation (MDE). The MDE requires changing all MSW components to percentages of carbon (C), hydrogen (H), oxygen (O), nitrogen (N) and sulfur (S), which is very time-intensive effort. An easier-to-use and more practical new equation is used, which directly uses the percentages of MSW components. The observations made during the course of investigation shows that, the minimum is the percentage by weight of organic waste (vegetable and fruit waste) maximum is the energy content (kj/kg) of the waste.

Keywords: *Udhampur*, *Municipal solid waste*, *Regression equation*, *Modified Dulong equation (MDE)*, *energy content*

Introduction

With the fast depletion of the conventional resources, the growing awareness and concern regarding the environmental effects of their utilization, there has been a major thrust in the recent past to identify and develop alternate energy resources. India generates vast amounts of MSW in hundreds of tons which when converted to fuel fluff/pellets have appreciable calorific value and hence, are over the country and totally renewable. The cost of the fuel is also much lesser than that of conventional fuels. Besides that advantages MSW based project is also eco-friendly as it does not add to the environmental pollution and rather it would help cleaner environment. Keeping the above factor in focus, the Ministry of Non-Conventional energy sources (MNES), Govt. of India, has been aggressively promoting the concept of biomass/MSW based power plants in the 5-15 MW range. The national program on biomass/MSW based power generation had extended capital subsidies for first few demonstration projects (Kumar *et al.*, 2010).

In this context, solid waste appears to be the most promising energy resource as these are abundantly available, very inexpensive and renewal. Over 1000 million tones of solid waste are produced annually, which could be converted into solid, liquid and gaseous fuel to cater the needs of principal sectors *viz*; transport household, industry and agriculture. So, recycling of waste and their conversion into wealth become very vital for the development of the country. Energy recovery from the solid waste is on the upswing with a growing market share for the mass burning of fossil fuel (Agarwal *et al.,* 2004). Ramakrishna and Babu (2010) studied Electric Power Generation (EPG) by firing MSW as fuel in the boiler-steam-turbine system. The results show that the EPG is directly

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proportional to the calorific value of MSW fired. Khan and Gharah (1991) developed a linear regression equation for predicting energy content values correctly and hence this is adequate for estimating energy content for Indian cities. The estimation of energy content of municipal solid waste (MSW) is normally done by the use of Modified Dulong Equation (MDE). The MDE requires changing all MSW components to percentages of carbon (C), hydrogen (H), oxygen (O), nitrogen (N), and sulfur (S), which is a very time-intensive effort. An easier-to-use and more practical new equation is presented which directly uses the percentages of MSW components to calculate the energy content (kj/kg).

This paper is an attempt made to estimate the quantity of solid waste that can be generated in the commercial area of Udhampur town (Jammu and Kashmir) and to estimate the generation potentiality of energy through combustion of solid waste. The waste to energy industry has proven itself to be an environment friendly solution to the disposal of municipal solid waste and the production of energy.The study area is a Commercial area of Udhampur town and extends from 32^0 53'N to 32^0 56'N and 75^0 03'E to 75^0 09'E at an average elevation of 756 meters above the sea level, comprised mostly of fruit/vegetable shops and karyana shops. So, bulk of waste is of combustible and compostable nature and has great potential for energy recovery. The conversion of waste to energy is a step forward to cleaner environment with added advantage of providing some energy.Shah (1994) recommended the use of solid waste for energy generation to mitigate environmental problems. Roy (1998) suggested recycling of municipal waste as a technique to create renewable source of energy and to solve disposal problem. Qudais and Qdais (2000) analysed energy content of municipal solid waste and its potential utilization in Jordan and reported that the energy content of MSW generated in Jordan accounts for 6% of the annual imported oil consumption of the country and may result in annual saving of US$ 24 million in case of utilization. Gupta and Manhas (2008) analysed percentage generation and energy content (kj/kg) of municipal solid waste and recommended it as a best alternative source of energy *viz a-viz* waste minimization. Thus, in the present study, an attempt has been made to explore the potential recovery of the energy available in the commercial solid waste generated in the township of Udhampur (J&K).

Materials and Method

The study area was divided into four sites for the purpose of collecting data. Shops in the commercial area were divided into different types *i.e.* kiryana, tea stall and meat shops *etc*. Two samples per month of solid waste generated were taken from each types of shop. During each sampling, different types of biodegradable, non-biodegradable and inert solid waste were collected for analysis and the components of waste identified in the analysis were paper, polythene, organic *etc*. as shown in the Table. 1. The percentage by weight of different components was calculated and then the solid waste energy content (kj/kg) was calculated with the help of a regression equation which uses the percentages by weight of MSW components directly in it as follows:

EC = 37.658 + 241.054(PR) + 55.153(HF) + 174.874(PC)

Where,

EC = Energy content of waste (kj/kg).

PR = Percentage weight of plastic and other synthetic materials.

HF = Percentage weight of hay, straw, food waste and wood.

PC = Percentage weight of paper and cardboard.

The standardized co-effient (241.054) is high for plastic and other synthetic materials which showed that plastic and other synthetic materials generate maximum energy from the waste.

Results and Discussion

In the course of present study on solid waste generated in the commercial area of Udhampur (J&K), it has been observed that at Site-I (Bus stand area) energy content (kj/kg) was found to be

maximum during January-March (9681.16 kj/kg) and a minimum during July–September (8816.91 kj/kg). The Site-II (Court road area) showed the maximum value of energy content during January-March (10630.85kj/kg) and minimum during July–September (9680.679 kj/kg).The value at Site-III (Mukherjibazar area) was found to be the maximum during October - December (8926.355 kj/kg) and minimum during July–september (8506.78 kj/kg).The Energy content (kj/kg) at Site-IV (Goal market area) was maximum during July-September (9634.812 kj/kg) and a minimum during October-December (9077.08 kj/kg).Among all the four sites of present studies (Table.1), the maximum organic waste was found at Site-III during July-September (65.67%) where the energy content was minimum (8506.78 kj/kg) whereas energy content was maximum (1063.85 kj/kg) during January-March at Site-II where organic waste was minimum (39.58 %). The observation reveals that the minimum is the percentage by weight of organic waste (vegetable and fruit waste) maximum is the energy content (kj/kg)

Table-1: Percentage by weight of municipal solid waste components generated at for four sites of commercial area of Udhampur (J&K) and their computed energy contents (kj/kg)

Site-I (Bus stand Area)

TYPES OF WASTES	Paper/ cardboard	Jute/ textile	Wood waste	Organic waste	Plastic waste	Polythene waste	Thermocol waste	Other wastes	Energy content
JAN-MAR	20.22	1.53	4.1	54.75	3.93	5.7	1.67	0.97	9681.16
APR-JUNE	18.48	1.31	3.74	58.03	4.56	4.03	1.56	0.71	9234.24
JULY-SEPT	16.06	1.21	3.02	63.91	4.21	3.36	1.41	0.87	8816.91
OCT-DEC	19.26	1.39	2.94	58.67	4.04	5.01	1.48	0.67	9455.62
AVERAGE	18.51	1.36	3.45	58.84	4.19	4.53	1.53	0.81	9296.98

Site-II (Court road Area)

TYPES OF WASTES	Paper/ cardboard	Jute/ textile	Wood waste	Organic waste	Plastic waste	Polythene waste	Thermocol waste	Other wastes	Energy content
JAN-MAR	25.76	2.41	2.66	39.58	5.77	5.47	3.55	1.1	10630.85
APR-JUNE	22.45	1.96	2.72	49.7	5.85	4.63	2.31	0.64	10081.18
JULY-SEPT	20.34	1.55	2.23	54.99	5.71	3.71	2.26	0.53	9680.68
OCT-DEC	25.23	2.1	2.81	44.49	5.98	4.25	2.87	1.04	10389.45
AVERAGE	23.45	2.01	2.61	47.19	5.83	4.52	2.75	0.83	10195.54

Site-III (Mukherji Bazar Area)

TYPES OF WASTES	Paper/ cardboard	Jute/ textile	Wood waste	Organic waste	Plastic waste	Polythene waste	Thermocol waste	Other wastes	Energy content
JAN-MAR	15.9	1.92	1.59	58.47	3.34	5.82	1.76	0.64	8904.15
APR-JUNE	15.07	0.82	1.58	64.82	3.17	4.61	1.19	0.41	8565.26
JULY-SEPT	14	0.84	1.55	65.67	3.36	4.28	1.66	0.46	8506.78
OCT-DEC	15.74	1	1.58	60.36	3.29	5.97	1.66	0.59	8926.36
AVERAGE	15.18	1.15	1.58	62.33	3.29	5.17	1.57	0.53	8725.64

Site-IV(Goal Market Area)

TYPES OF WASTES	Paper/ cardboard	Jute/ textile	Wood waste	Organic waste	Plastic waste	Polythene waste	Thermocol waste	Otherw astes	Energy content
JAN-MAR	17.56	1.02	2.15	56.05	4.57	4.38	2.35	0.65	9134.37
APR-JUNE	19.94	1.1	1.45	52.82	5.48	4.57	2.47	0.46	9621.83
JULY-SEPT	19.08	1.07	2.1	54.77	5.49	4.62	2.47	0.59	9634.82
OCT-DEC	16.56	0.99	2.28	56.18	4.78	4.63	2.3	0.76	9077.08
AVERAGE	18.29	1.05	2	54.96	5.08	4.55	2.4	0.62	9367.02

of the waste.This shows that synthetic waste such as plastic and polythene and wood, paper and textile waste contain more energy content (kj/kg) compared to organic waste (vegetable and fruit waste). Among various types of waste generated during the course of study, organic waste (percentage by weight) exhibited the maximum percentage in all the study sites during all seasons *i.e*. January-March, April-June, July-September and October- December. A critical evaluation of Table 2, Fig.1 showed that the average solid waste (kg/day/site) generation and energy content do not follow a set pattern of increase or decrease at different sites and in different seasons. Average solid waste observed to be 66.52 kg with maximum value of 77.96 kg at Site-I comprise 9296.98kj/kg of energy content followed by 63.63kg of waste with 8727.64kj/kg of energy at site III and then by site II which exhibit the average value of 62.38 kg comprising 10195.54 kj/kg of energy. The average energy content was found to be maximum during January-March (9587.63 kj/kg) followed by October–December (9462.13 kj); April–June (9375.63 kj/kg) and then by July–September (9159.8 kj/kg). Site-II exhibited the maximum energy content (10195.54 kj/kg) among all study sites whereas the minimum energy content (8725.64 kj/kg) was recorded at Site-III. The overall average energy content was found to be 9396.29 kj/kg.

Table. 2: Seasonal variation in average solid waste (kg/day) and average energy content (kj/kg) at four different study sites of commercial area, Udhampur (J&K).

	Average solid waste					Average energy content				
Month / Sites	**Jan-Mar**	**Apr-Jun**	**Jul-Sep**	**Oct-Dec**	**Average**	**Jan-Mar**	**Apr-Jun**	**Jul-Sept**	**Oct-Dec**	**Average**
Site I	67.08	81.23	92.47	71.06	**77.96**	9681.16	9234.24	8816.91	9455.62	**9296.98**
Site II	48.23	73.77	73.68	53.85	**62.38**	10630.85	10081.18	9680.68	10389.45	**10195.54**
Site III	53.53	73.77	70.79	56.41	**63.63**	8904.15	8565.26	8506.78	8926.35	**8725.64**
Site IV	47.41	73.77	70.79	56.41	**62.1**	9134.37	9621.83	9634.82	9077.08	**9367.02**
Average	**54.06**	**75.64**	**76.93**	**59.43**	**66.52**	**9587.63**	**9375.63**	**9159.80**	**9462.13**	**9396.29**

A critical observation of the study area revealed that the Municipality has not provided dustbin/metallic bins in commercial area for the collection of waste generated. Open dumping is the regular practice as a result of which all the waste generated in the area finds its way into drains and finally into Devika, the sacred Ganga of Udhampur, thereby polluting it heavily. The biodegradable waste components of solid waste disposed off in the vacant plots or area serve as breeding ground for the flies, insects, fungus and other disease causing agents. Besides this, it gives an ugly look to the area and unpleasant odour to the residents of adjoining area. Solid waste generated at Site-I is dumped off in an open area near roadside, thereby, exposing the population to various health hazards. The waste is then transported for its final disposal at the confluence

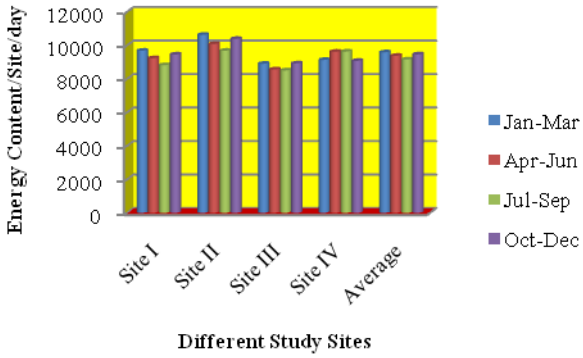

Fig. 1: Seasonal Variation in energy content values at four study Sites

of Dudder nallah and the river Tawi. Similarly, the solid waste from Site-IV is dumped off near Govt. (Boys) Hr. Sec. School located in the study area. At the study site- II and III, most of the waste is

thrown by shopkeepers directly into drains. So, in order to prevent the harmful effects of improper solid waste disposal on the inhabitants of the area, proper hand planed scientific management should be done to maintain the beauty of the area. One of the beneficial methods of proper solid waste disposal on the inhabitants of the area is the conversion of waste to energy. It is a step towards cleaner environment with added advantage of providing some energy.

Uchendu (2008) reported 5.9 million tonnes per year generation of municipal solid waste in Nigeria and discussed the problems of waste disposal with its short and long-term effects. He also suggested a sustainable system for waste disposal. Gupta and Manhas (2008) analyzed the percentage generation and energy content (kj/kg) of municipal area of Janipur, Jammu and highlighted that it has good potential of energy and this can be utilized for the production of energy in various forms. Tripathi *et al.*, 2006, suggested vermicomposting for scientic disposal of solid waste.

Conclusion

From the present study, it is concluded that waste generated in the commercial area of Udhampur (J&K) has good potential of energy and this can be used for the production of energy in various forms. The conversion of waste to energy is one of the best ways to dispose solid waste on proper and scientific lines.

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