Environment Conservation Journal 9 (1&2) 27-31, 2008
(ISSN 0972-3099)

Percentage generation and estimated energy content of municipal solid waste at commercial area of Janipur, Jammu

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Abstract

The present study involves the analysis of percentage generation and energy content (kj/kg) of municipal solid waste. A regression equation was used for estimating the energy content of municipal solid waste and to correlate the energy content with variables derived from physical composition of solid waste. The regression equation is relatively simple than the modified Dulong equation (MDE), which is generally used for estimating energy content of municipal solid waste.

Keywords: *Municipal solid waste, Regression equation*

Introduction

Power industry has registered a phenomenal growth during the last three decades and investment in this sector has increased in a geometric proportion. Inspite of strong emphasis on the development of power sector, there has been a perpetual shortfall in the availability of power. This shortfall of energy has really become a major constraint in the develpoment of country, as it has severely affected our industrial and production enterprises.

Since the current energy crises has severely hit the socio-economic structure of developing countries including India, therefore energy output from indigenous commercial source have to be maximized and techniques have to be developed to explore the full potential of alternate sources of energy available within the country.

In this context, solid waste appears to be the most promising energy resource, as these are abundantly available, very inexpensive and renewable. Over 1000 million tones of solid waste are produced annually in our country, which can be converted into solid, liquid or gaseous fuel to cater the needs of four principal sectors viz; transport, household, industry and agriculture. So recycling of waste and their conversion into wealth have become very vital for the development of the country. Energy recovery from solid waste is on the upswing with a growing market share for the mass burning of fossil fuel (Agrawal *et al.*, 2004).

To evaluate the resource recovery and energy generating alternatives, the municipal solid waste energy content has to be essentially evaluated. The energy content of municipal solid waste is generally calculated by using modified Dulong equation (MDE). To use this method, percentage of waste components, such as food, paper, plastic and rubber etc. must be converted into percentage of carbon, hydrogen, oxygen and sulphur. But this conversion is a time consuming process.

Liu (1996) reviewed several relationships that have been applied to municipal solid waste. The limitation of the results of this analysis is that they are appropriate only for the specific type of solid waste. Khan and Ghararah (1991) developed a linear regression equation for predicting energy content values correctly and

hence this is inadequate for estimating energy content for Indian cities.

The main objective of this paper is to present the calculated energy content values for the commercial area of Janipur, Jammu by regression equation which is an easier and simpler equation than MDE for estimating energy content of municipal solid waste.

The study area (commercial area of Janipur, Jammu) is situated to the north of Jammu city, comprised mostly of fruit/ vegetable shops and kirana shops. So, the bulk of waste is combustible and compostible in nature. The waste has great potential for energy. The conversion of waste to energy is a step towards cleaner environment with added advantage of providing some energy. Roy (1998) suggested recycling of municipal solid waste as a technique to create renewable source of energy and to solve disposal problem. Reid and Tittlebaum (1993) conclude that waste to energy conversion is necessary for energy recovery and waste minimization. Shah (1994) recommended the use of solid waste for energy generation to mitigate environmental problems.Though a lot of work has been done on generation, composition and management of solid waste from India and abroad by various workers, but no work seems to have been done on the study of solid waste at commercial area of Janipur. The present study will help to generate information on the generation, composition and estimated energy content of municipal solid waste and also help us to place before the management the problems arising out of its improper disposal.

Materials and Method

Study area: Commercial area of Janipur lies to the north of Jammu city. For the purpose of waste collection, study area was divided into four sites. Waste samples were collected at weekly intervals and segregated into different components and weighed separately with the help of spring balance. The components of waste identified in the analysis were straw, leaves, cardboard, food and fruit waste, plastic and polythene waste, glass, metallic containers and inert waste were present in the waste details of the MSW components for commercial area of Janipur 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 regression.The regression equation, which uses the percentages by weight of MSW components directly in it is as follows:

$$EC = 37.658 + 241.054\,(PR) + 55.153\,(HF) + 174.87(PC)$$

Where,

EC = Energy content of waste (kj/ kg).
PC = Percentage weight of plastic and other synthetic materials.
HF = Percentage weight of straw and food waste.
PC = Percentage weight of cardboard/ paper.

The standardized co-efficient (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

During the course of present study on solid waste at commercial area of Janipur (Jammu), it has been observed that at Site-I energy content was found to be maximum during January- March (10505 kj/ kg) and

minimum during the months of April- June (6332.2 kj/ kg). The site-II showed the maximum value of energy content (8010.4 kj/ kg) during the months of April- June and minimum value (7059.8 kj/kg) were observed in the months of January- March.The energy content values at Site-III and at Site-IV were observed to be maximum during the months of April- June (8536.89 kj/ kg) and January- March (8173.94 kj/ kg) respectively.

Table-1: Percentage by weight of municipal solid waste components for four sites of commercial area of Janipur, Jammu and their computed energy contents (kj/kg)

Site-I

	Straw	Thread/ Cotton	Cloth/ Bits	Food/ Waste	Fruit/ Veg	Meat Waste	Wood Waste	Card Board	Plastic Waste	Energy Content
Jan-Mar	5.56	1.62	3.32	11.87	22	11.2	13.5	25.83	5.06	10505.1
April-June	8.03	0.59	0.67	9.00	19.21	8.56	6.71	12.43	4.03	6332.2
July-Sep	6.18	0.07	0.76	14.9	33.93	6.14	10.2	17.53	2.69	7892.1
Oct-Dec	3.30	0.10	0.53	9.62	26.9	8.98	12.2	24.07	4.33	8812.4

Site-II

	Straw	Thread/ cotton	Cloth/ bits	Food/ waste	Fruit/ veg.	Meat waste	Wood	Card-board	Plastic waste	Energy content
Jan- Mar	3.92	0.51	0.81	22.76	9.51	25.50	11.70	9.68	4.04	7059.8
April- June	3.96	0.67	0.38	19.66	10.40	20.60	7.26	17.57	5.10	8010.4
July- Sep	3.18	0.41	0.42	8.67	29.01	18.80	10.70	14.64	4.66	7806.3
Oct- Dec	4.07	1.12	0.85	14.58	8.878	26.30	7.07	16.67	3.19	7559.0

Site-III

	Straw	Thread/ cotton	Cloth/ bits	Food/ waste	Fruit/ veg.	Wood	Card-board	Plastic waste	Energy content
Jan- Mar	8.74	0.41	0.43	22.39	13.62	9.89	24.1	3.58	8328.5
April- June	3.91	0.61	0.29	19.65	20.71	9.24	20.2	7.89	8536.9
July- Sep	3.80	0.76	0.88	21.11	22.94	5.74	19.9	3.33	7669.0
Oct- Dec	6.97	0.25	0.71	29.33	13.08	6.74	19.0	7.86	8526.1

Site-IV

	Straw	Thread/ cotton	Cloth/ bits	Food/ waste	Fruit/ veg.	Meat waste	Wood	Card-board	Plastic waste	Energy content
Jan- Mar	2.71	0.54	0.91	17.39	13.77	23.90	3.38	21.17	2.94	8173.9
April- June	4.47	0.28	0.85	12.67	22.30	28.90	6.36	10.27	2.25	6773.1
July- Sep	5.72	0.54	0.66	33.03	18.01	15.90	5.24	14.88	1.74	7647.7
Oct- Dec	1.91	0.16	0.82	16.70	12.47	29.52	5.27	17.32	4.48	8015.6

At first three sites precentage by weight of plastic/ polythene was observed to exhibit the maximum value during the months which showed maximum value of energy content viz. 5.06% (January- March) at site-I;

5.10% (April- June) at Site-II and 7.89% (April- June) at Site-III. At Site-IV percentage of plastic/ polythene waste was observed to exhibit the maximum value during the months of October- December (4.48%) as compared to percentage of plastic polythene during the months of January- March (2.94%) which was observed to exhibit the maximum value of energy content, but the percentage of other synthetic materials e.g. cloth bits and cotton/ thread waste was observed to exhibit the maximum value of 0.53% and 0.91% respectively during January- March as compared to 0.16% and 0.825% of cloth bits and cotton/ thread waste respectively during October- December. This observation showed that plastic/ polythene waste and other synthetic material contains maximum energy content.

Further the total average solid waste kg/day was observed to be 585.57 kg, which contain average 7977.98 kj/ kg of energy content. Also, the average energy content was observed to exhibit the maximum values at Site-I (8385.25 kj/kg) and minimum values at Site-II (7608.92 kj/kg) (Table-2).

Table-2: Seasonal variation in average solid waste (kg/day) and average energy content (kj/ kg) at four different study sites of commercial area, Janipur (Jammu)

	Average solid waste					Average energy content				
	Jan.- Mar.	Apr.- June	July- Sept.	Oct.- Dec.	Average	Jan.- Mar.	Apr.- June	July- Sept.	Oct.- Dec.	Average
Site-I	620.47	661.83	697.24	578.9	639.61	10505	6332	7892	8812	8385.25
Site-II	644.49	788.58	953.67	822.64	802.34	7059.8	8010.42	7806	7559.08	7608.92
Site-III	363.23	320.57	517.61	394.73	399.03	8328.5	8536.9	7669	8526.17	8265.16
Site-IV	455.19	488.71	670.99	390.38	501.32	8173.9	6773.1	7648	8015.61	7652.59
Average	520.84	564.92	709.88	564.66	585.58	8516.8	7413.1	7754	8228.21	7977.98

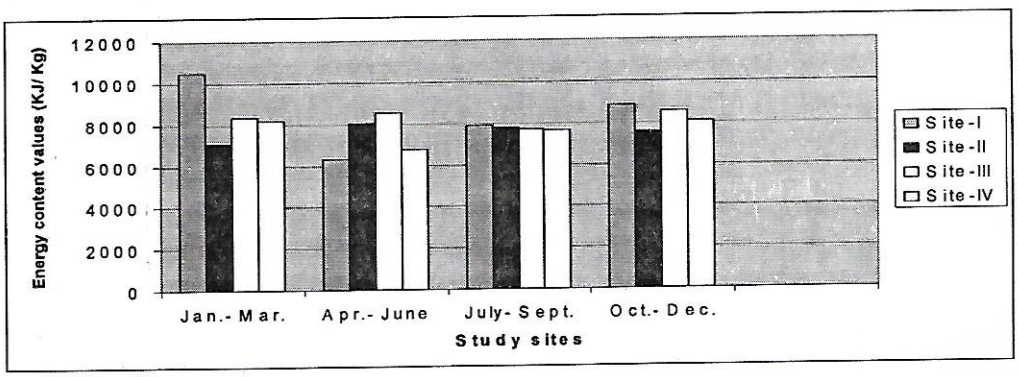

Fig. 1: Seasonal variation in energy content values at four study sites

During the course of present study it was also observed that solid waste collection system as employed in the study area was not satisfactory as it is open type. Further the number of storage bins were not enough as a result of which most of the waste is dumped near roadside or in the open plots e.g. solid waste at the Site-II of the study area is dumped near the children park thereby exposing children to various serious health hazards. Though the bulk of waste was organic in origin yet its decay provides breeding grounds

for flies and other disease causing vectors, thereby posing threats to the health of people residing in the vicinity. So, in order to avoid the harmful effects arising out of improper solid waste disposal, proper management should be done to maintain the beauty of the area. One of the useful methods of proper solid waste disposal is the conversion of waste to energy. It is a step towards cleaner environment with added advantage of providing some energy. Even though it will not make any significant dent in the overall energy situation, but waste conversion might make some contribution to overcome the present day energy crisis.

Tripathi *et al.* (2006), suggested vermicomposting for purposeful and systematic dealt with the problem of solid waste. Wal (2007) in an article on solid waste management disclosed a new technique for the conversion of plastic into substitute diesel. Vijifder (1985) also recommended the implementation of new methods for disposal of solid waste.

Conclusion

From the present study, it is concluded that waste obtained from commercial area of Janipur, Jammu, has a good potential of energy and this can be utilized for the production of energy in various forms. Improper solid waste disposal is creating environmental pollution and health hazards. The conversion of waste to energy seems to be on the right social tract.

Acknowledgement

The authors are greatly thankful to the University of Jammu, Jammu for providing necessary facilities to undertake these studies.

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