Studies On Energy Recovery From Municipal Solid Waste; A Case Study At Solapur, Maharashtra, India

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Abstract:

The generation of Municipal Solid Waste (MSW) is expected to rise tremendously in the coming decade due to the rapid urbanization and growth in population. On average, 75%–85% of the weight of MSW is converted into RDF (Refuse Derived Fuel). The RDF values in the MSW range from 4800 – 6800 Btu/lab along with the other benefits like its higher heating value, more homogeneous compositions, lower pollutant emissions, reduced excess air requirement during combustion, easier storage, handling, and transportation.

In present investigation, the efforts were made to identify different compositions of organic solid wastes which have remained neglected as an alternative source of energy. These waste samples from Solapur city were collected, segregated, dried, crushed and pellets were prepared which were further tested for their energy contents. The results reveal that, in market waste the calorific value was 1754 Kcal/Kg, in paper waste 543 Kcal/Kg, in household waste it was 927 Kcal/Kg and in municipal solid waste after separating digestible leaf litter was 1940 Kal/Kg. It is concluded that the municipal organic waste based fuel pellets are good supplementary fuel energy source for small scale energy needs.

Keywords: *Biomass energy, Calorific Value, Energy recovery, Municipal Solid Waste, fuel Pellets, Solid waste management.*

Introduction:

Municipal solid waste management is one of the major problems in almost all major cities all over the world. A variety of technologies have been tried to manage the problem of solid waste, still the problem remains unsolved. Major cities like Mumbai have made several efforts to resolve this problem by setting up a pilot plant in Mumbai, India. In Mumbai, an indigenous Municipal Solid Waste (MSW) technological solution has been tried which provided for producing fuel pellets from the combustible portion of Municipal Solid Waste (MSW).

Refuse derived fuel (RDF) is one of the products of a mixed waste processing system in which certain non-biodegradable, recyclable and non-combustible materials are removed and the remaining combustible material is converted for use as a fuel to generate energy (EPA, 1995). Typical RDF processing includes ferrous and other metallic material removal, shredding, screening, crushing, and even eddy-current separation or air classification of metals like aluminum, tin and copper recovery. Some further operations involve to grind/shred, grind and mix material to generate a homogeneous fuel. It is also common for processors to press and extrude the organic portion of the solid material into pellets (Lockwood, *et al*., 1993).

The RDF pellets so produced are better, non-renewable and chief coal substitute with comparative advantages over the coal as well as these are a clean, energy efficient, eco-friendly form of solid fuel for coal based industries and the power generation.

The energy content in MSW is dependent on the physico-chemical composition and it varies from composition to composition, season to season and city to city. On an average, 75%–85% of the weight of MSW is converted into RDF and approximately 80%–90% of the BTU value is retained in the process of such conversion. This leaves dry RDF with a higher heating value of 4,800–6,400 Btu/lb, which is approximately half of the Btu value of the same weight of coal (NREL/TP-431-4988A 1992). The main benefits of converting MSW to RDF are to obtain higher heating value. The RDF in dry solid form is more homogeneous physical and chemical compositions, lower pollutant emissions, reduced air requirement during combustion, and finally, easier for their management including storage, handling, and transportation.

The production of RDF pellets as a coal substitute from the combustible stuff of the organic portion of municipal solid waste. It is a viable technology solution towards generating energy from waste for the small scale industries having wood based or coal based thermal applications, including the power generation. Thus, the municipal solid waste can be used as an alternative source of energy (Mustafa, *et al*., 2008). The Department of Science & Technology (Govt. of India) in collaboration with CMC Limited, initiated a pilot project on Integrated Waste Management (IWM) in Mumbai in order to offer a viable technological solution for the management and disposal of its Solid waste. It provides and provides options for making metropolitan city cleaner (Pawan Sikka, 1994).

Calorific value is the quantity of heat produced by unit mass of fuel on its complete combustion, expressed in Joules/kg. or Kcal/Kg. The calorific values are used to express the energy value of fuel used it to measure the energy content of different organic material wastes. The calorific value is estimated to find out the fuel value for the comparison of the energy content of different organic materials. If more is the calorific value, more is the amount of energy available from that fuel.

Methodology:

The municipal waste used in the current research was brought directly from the waste dumping site. The MSW had a high moisture content; it was contaminated and heterogeneous in composition. Therefore, the MSW had to be dried to reduce the moisture content in the material and shred for size reduction. Then the waste was segregated manually for removal of recyclable materials, stones and inorganic constituents. Then this was waste again separated through magnetic separation for removal of ferrous and non-ferrous materials. The MSW was shredded, classify and powdered. Before pelletization, municipal waste has to be processed for size reduction, adding binder agents and reducing the moisture content (P. Krizan, *et al*., 2011). Both of these parameters belong to the group of parameters which have great impact on the pelletization process. After that, secondary shredding was carried out and pellets were prepared by using PVC pipe size (2 inch X 15 cm). The pellets were prepared by using starch as a binding agent. The calorific value of the pellet samples was measured by using the acid digestion method and energy content was calculated.

Experimental Analysis:

The 10 mg dried, powdered pellet of each sample taken in a round bottom flask. Simultaneously 10 ml distilled water was taken in another round bottom flask to treat it as blank and then 3 ml of 5% KIO_3, 20 ml Conc. H_2SO_4 was added in each flask. These flasks were arranged for reflux digestion and refluxed for 2 hours at a temp. 105^0C. After 2 hours digestion the digested samples were cooled and again 10 ml 10% KI solution was added and final volume 250 ml was adjusted by using distilled water. Then 50 ml of each sample was taken in conical flask and titrated against 0.1 N $Na_2S_2O_3$ by using a starch indicator. Simultaneously, blank was run using the same procedure and the calorific values of pellets were calculated by using the following formula,

$$\text{Calorific Value (Kcal/ Kg)} = \frac{(B-S) \times 0.1 \times 12.05646 \times 250 \times 1000}{\text{Wt. of Sample in gm} \times 50}$$

Where,

B = Burette Reading for Blank (ml),

S = Burette reading for Sample (ml),

0.1 = Normality of $Na_2S_2O_3$,

12.05646 = Equivalent conversion factor,

250/50 = Total final volume/Volume of sample titrated (ml).

Results and discussion:

Municipal wastes are the cheapest and easily available biomass wastes, many times are available with no cost too. In Indian cities the calorific value of municipal solid has ranged between 1745Kcal/kg to 2340 Kcal/kg (Pawan Sikka, 1994). The calorific value of municipal organic waste studied was 1940Kcal/Kg. The calorific value of market waste was 1754 Kcal/kg, household waste had 927 Kcal/kg and Paper waste had 543Kcal/Kg respectively. The calorific value of MSW after pelletization is high as compared to its parent composition waste. MSW pellets are compact, economical and have tremendous market potential in non-coal producing zones. The problem of coal in respect of availability, quality, higher prices etc. can be overcome by using these fuel pellets (Reed, 1980).

The analyses of waste characterization, moisture content and calorific values of waste represented in fig. 1 and fig. 2.

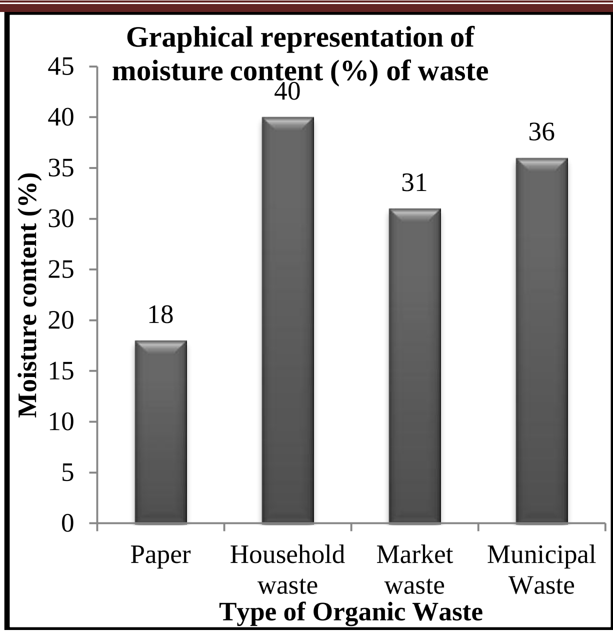

Fig. 1. Moisture content (%) of different components of MSW.

The results reveal that the composition of municipal solid waste holds high moisture whereas isolated paper have low moisture (Fig. 1).

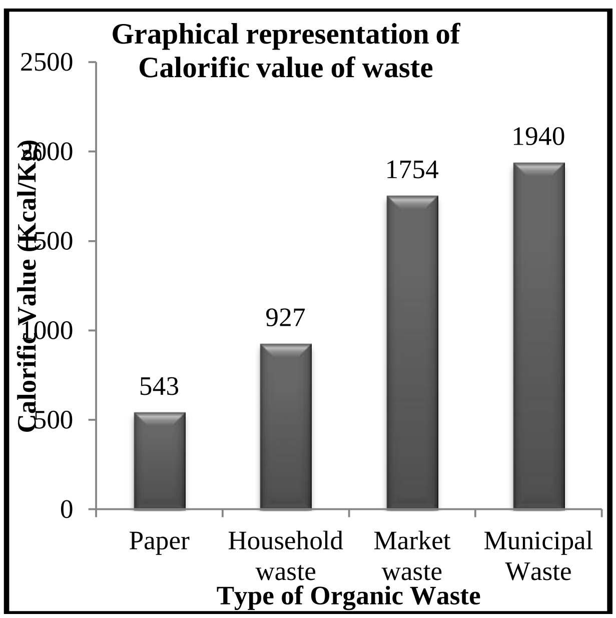

Fig. 2. Calorific Value (Kcal/Kg) of each type of waste

The energy content in composite municipal solid waste is higher due to the woody nature of this waste. The market waste is fibrous has relatively higher calorific value as compared to paper waste and household refuses (Fig.2). Calorific values of all these wastes are indicators of the suitability as a fuel for harnessing energy content.

Conclusion:

The organic materials cause pollution, if not treated properly and need to be treated. Most of these have considerable calorific value; hence can be used as additional fuel. Refuse Derived Fuel (RDF) pellets from MSW have high energy content and it is an effective method of disposal and utilization of energy, employment and economic benefits to the society.

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