"ENERGY FROM MUNICIPAL SOLID WASTE IN THE FORM OF SOLID WASTE BRIQUETTES"

By

Dr. Rai Niaz Ahmed[1], Muhammad Azhar Ali[2], Abdul Nasir[3] and Altaf Hussain[4]

ABSTRACT

The enormous increase in the quantum and diversity of waste materials generated by human activity and their potentially harmful effects on the general environment and public health, have led to an increasing awareness about the need to adopt scientific methods for safe disposal of wastes. While there is an obvious requirement to minimize the generation of wastes and to reuse and recycle them. The technologies for recovery of energy from wastes can play a vital role in mitigating the problems. Besides recovery of substantial energy, these technologies can lead to a substantial reduction in the overall waste quantities requiring final disposal, which can be better managed for safe disposal in a controlled manner while meeting the pollution control standards. This study is designed to develop a system for separating combustible / noncombustible constituents in municipal solid waste. Tubewell water was used to separate light suspended combustible materials such as paper, wood sticks, plastic bags, packing materials, fruit and vegetables peels etc from heavy settling noncombustible materials such as metal, glass and stones etc. To separate these materials a sieve (10 mesh) was placed on the top of water pond and after 15 to 20 minutes materials with low densities floated over the water and were collected into an adjacent container. A high speed cutter is installed to crush the collected material into uniform size and leave it to soak down for 24 hours and later transfer it into extruder to further form solid briquettes. These briquettes were later tested to produce heat energy for further use in steam boilers as fuel material to generate steam which in turn could be used to run steam generators for producing electricity.

Key words: energy, municipal solid waste, briquettes, steam generators

INTRODUCTION

Municipal solid waste (MSW) refers to household waste combined with a minor portion of commercial waste collected together. It is regarded as a source of renewable energy because it contains a high proportion of biomass materials such as paper/cardboard, wood, and food. From the perspective of sustainable waste management, the priority is on the reduction of waste generation followed by material recycling, both of which are highly beneficial in terms of greenhouse gas (GHG) emissions reduction[1] by saving resources otherwise required for manufacturing new products. However, some wastes are not suitable for recycling. For the nonrecyclable fractions, an energy recovery method becomes essential because it can reduce the use of fossil fuels. At the same

---

1. Professor, Department of Irrigation and Drainage, University of Agriculture, Faisalabad.
2. Lecturer, Department of Structures & Environmental Engineering, University of Agriculture, Faisalabad.

3. Assistant Professor, Department of Structures & Environmental Engineering, University of Agriculture, Faisalabad.
4. Associate Professor, Department of Farm Machinery & Power, University of Agriculture, Faisalabad.

time, it can also minimize the environmental and health problems of waste disposal, unlike the landfill alternative. The conventional technology for energy from waste (EfW) is direct combustion (incineration), but advanced technologies such refuse-derived fuel (RDF) production, gasification, and anaerobic digestion are also available. In using the energy produced from waste, combined heat and power (CHP) is the preferred option for maximizing overall energy efficiency. The potential of EfW and its impact on GHG emission reduction are significant. Estimates have shown that in the United Kingdom, the potential electricity yield from household, commercial, and industrial wastes will supply as much as 17% of the total electricity consumption in 2020 with the application of an advanced thermal conversion method that can also meet recycling targets[3] Skovgaard et al estimated that GHG emissions from municipal waste management in European Union (EU) countries will decline from 47 Mt CO_2, eq/yr in 2000 to 8 Mt CO_2, eq/yr by 2020 with an increase in recycling and EfW rates of 43 and 23% in 2020, respectively. The main source of direct GHG emissions is methane (CH_4) released from landfill sites, whereas the main sources of GHG emission reduction are recycling and EfW. The U. S. Environmental Protection Agency (EPA) analyzed the GHG emission impact of 29 types of materials using a lifecycle approach and concluded that source reduction and recycling are the best ways to reduce GHG emissions, especially for metals. In addition, they showed that the combustion of mixed MSW emits less GHG than land filling. Pakistan has scarce natural resources but a huge energy demand; thus, EfW can play an important role in the production of renewable energy while reducing GHG emissions. The rate of waste generation on average from all type of municipal controlled areas varies from 0.283 kg/capita/day to 0.613 kg/capita/day or from 1.896 kg/house/day to 4.29 kg/house/day in all the selected cities from Sibi to Karachi. It shows a particular trend of waste generation wherein increase has been recorded in accordance with city’s population besides its social and economic development. Currently solid waste in Pakistan has not been carried out in a sufficient and proper manner in collection, transportation and disposal or dumping regardless of the size of the city, therefore, the environmental and sanitary conditions have become more serious year by year, and people are suffering from living in such conditions. The scope of problems regarding solid waste management is very wide and involves the consideration of all the aspects relating to solid waste and its management, either directly or indirectly. These aspects may include rate of urbanization, pattern and density of urban areas, physical planning and control of development, physical composition of waste, density of waste, temperature and precipitation, scavenger’s activity for recyclable separation, the capacity, adequacy and limitations of respective municipalities to manage the solid waste i.e. storage, collection, transportation and disposal (SAIAN, 1995). The average rate of waste generation from all type of municipal controlled areas varies from 1.896 kg/house/day to 4.29 kg/house/day in a few major cities (Pak-EPA, 2005). It shows a trend of waste generation wherein increase has been recorded in accordance with city's population besides its social and economic development. Figure 1 presents city wise waste generation rate with respective daily and annual estimate of solid waste. In Pakistan, solid waste is mainly collected by municipalities and waste collection efficiencies range from zero percent in low-income rural areas to 90 percent in highincome areas of large cities (Pak-EPA, 2005). Collection rate of solid waste by respective municipalities ranges from 51% to 69% of the total waste generated (Figure 2) within their jurisdiction. The uncollected waste, i.e., 31% to 49% remains on street or road corners, open spaces and vacant plots, polluting the environment on continuous basis.

Objectives:

Separation of MSW (combustible and non-combustible) by using floating method

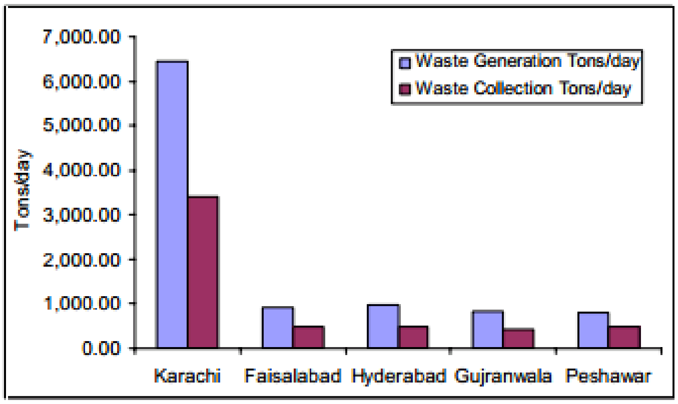


Figure 1 Rate of Generation and Collection of SW in a Few Major Cities of Pakistan

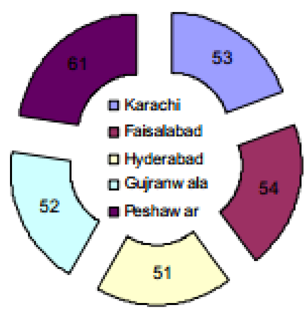


Figure 2 Solid Waste Collection Rate in a Few Major Cities of Pakistan

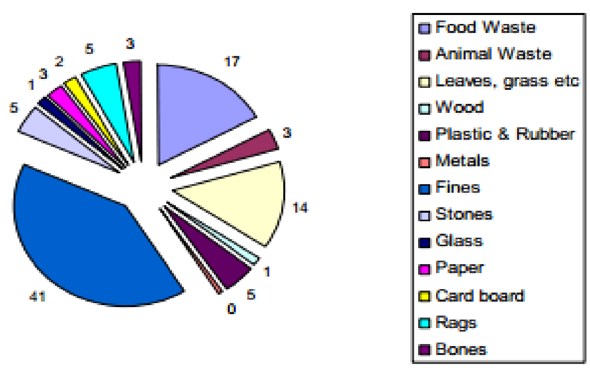


Figure 3 Physical Composition of Solid Waste in Pakistan (% Weight)
Source: EPMC Estimates, 1996

Materials and Methods:

The study was taken up in three phases and the procurement of materials was made accordingly as and where required.

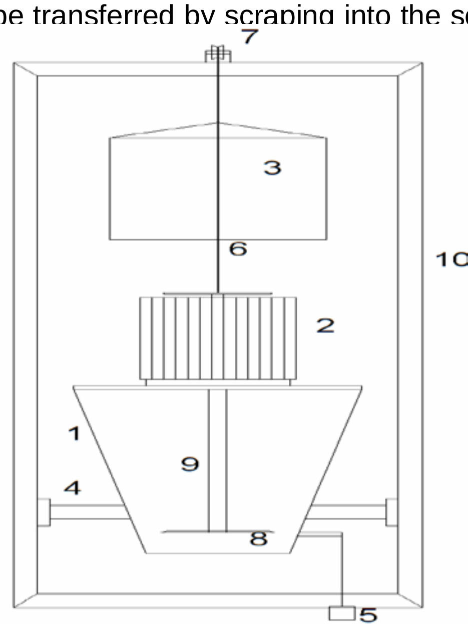
Phase I

Construction of two ponds measuring (8 ft x 5 ft each) to collect municipal solid waste (MSW)

Procurement of materials:

Items	**Quantity**	**Remarks**
Bricks	2000 Nos	to build walls of water ponds
Cement	10 bags	to build walls of water ponds
Sand	100 ft^3	to build walls of water ponds
Sieve	7 ft x 5 ft	to separate dust MSW
PVC Pipe	20 ft	Inlet and outlet water paths
Stop valves	4 Nos	to control water flow
M S Sheet	8 ft x 4 ft	gates for outlets

MSW will be introduced into the primary water ponds for 15 minutes and later lower density materials will be transferred by scraping into the secondary water pound and the high density materials [illegible] ond will be transferred through the base outlet for re[illegible] ansferred into the mechanical shaker installed for siz[illegible] dy for briquette formation.



Phase II

In this phase crushed material will pass through a screw type compactor (extruder) where a high powered screw driver will compact this shredded material into high density dry briquettes.

Phase III

These briquettes will be tested for energy production efficiency to apply for producing steam in the steam boilers to help generate electricity.

Results and Discussions:

Water Ponds: (Primary & Secondary)

Two ponds each dimensioning (7 x 5 x 4) ft^3 constructed with bricks using cement sand ratio 1:4 with concrete floor using cement sand and gravel ratio 1:2:4. The low density material outlet height was kept at 2 feet from the base with the over flow width of total length of primary pond measuring 7 feet. The high density waste and water outlet in the primary tank dimensioning (2 ft x 1.5 ft) was fixed with an adjustable gate. The water holding capacity of each pond is 70 ft^3 and the amount of solid waste which can be handled in one batch is 50 ft^3.

Mechanical Shredder:

A mechanical shredder for shredding low density solid waste @ 300 ft^3/hr capacity was employed and the material for briquette formation was prepared.

1. Shredders drum dimensioning (24 inch diameter & 30 inch height)
2. Electric motor (5 hp & 1450 rpm)
3. Concrete weight for hanging motor assembly
4. Bearings (UC 225) for unloading the shredded materials
5. Pedal for unloading shredded material
6. Steel rope for hanging motor assembly
7. Pulley
8. Tungsten blade (6 inch length & 1/8 inch thickness) use to crush solid material
9. Mild Steel Shaft (1.5 inch diameter and 18 inch length) directly coupled with motor shaft

10. Angle iron (2 inch x ¼ inch) for frame of shredder drum and motor

Screw Drive Compactor (Extruder):
The product was introduced into the hopper of the extruder which allowed the low density solid waste crushed product to pass through a screw compressing the material to form briquettes of the size 1 inch diameter @ 550 lbs/hr.
Briquettes Energy Calculations:
Each briquette of one inch diameter and 3 inch cylindrical length was burnt for calculating the calorific value and it was found that for every kilogram of briquettes 3800 to 4200 Kcal could be produced to heat water for steam to generate electricity.

Calculations:
Total amount of available MSW in city Faisalabad = 1500 tons/day

Total combustible solid waste = 750 tons/day

Calorific value (C.V) of solid waste briquettes = 4000 Kcal/kg (average)

Calorific value (C.V) of steam = 660 Kcal/kg

Steam generated by 750 tons of briquettes = 750 x 4000 x 0.7/660 = 3180000 kg/day

Total calorific value of steam available = 3180000 x 660 = 2.09 x 10^9 Kcal/day

1 Kilowatt hour = 860 Kcal

Total Electricity available = 2.09 x 10^9 x 0.6/860 = 1464 MW[7]

Conclusions:
1. On daily bases 5.66 m^3 of solid waste (low density) can be handled with this model

2. 0.28 m^3 (250 kg) briquettes will be prepared by the extruder per day

3. 250 kg briquettes per day will enable us to produce 400 Kilowatt electricity.

   Mega Conclusion;
   If the total low density solid waste of Faisalabad amounting to 750 tons is processed into briquettes and used to produce steam 2.09 x 10^9 Kcal steam will be available for generating electricity of 1664 MW.

REFERENCES
1. Bjo¨rklund, A.; Finnveden, G. Recycling Revisited—Life Cycle Comparisons of Global Warming Impact and Total Energy Use of Waste Management Strategies; *Res. Conserv. Recyc.* **2005**, *44*, 309-317.

2. EPMC, Data Collection for Preparation of National Study on Privatization of Solid Waste Management in Eight Selected Cities of Pakistan" by Engineering Planning and Management Consultants (EPMC), Lahore (1996).

3. GOP (Govt. of Pakistan), Data Collection for preparation of National Study on Privatization of Solid Waste Management in Pakistan (1996).

4. International Journal of Environmental Sciences Volume 1, No 2, 2010.
5. Pak-EPA, Guidelines for Solid Waste Management, Pak-EPA in collaboration with JICA, Ministry of Environment, PEP and UNDP (2005).

6. Skovgaard, M.; Hedal, N.; Villanueva, A.; Addersen, F.M.; Larsen, H. Municipal Waste Management and Greenhouse Gases; European Topic Centre (ETC)/Resource Waste Management (RWM) Working Paper 2008/1; ETC: Copenhagen, Denmark, 2008.

7. http://www.think-energy.net