STUDY OF ENERGY POTENTIAL FROM MUNICIPAL SOLID WASTE OF MIRPURKHAS CITY

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ABSTRACT

The purpose of this study was to determine the energy potential of combustible portion of total generated municipal solid waste of Mirpurkhas city. Firstly, the survey was conducted for selection of suitable locations based on types of areas (residential, open areas and commercial units), living standard, occupied area and number of people in a single family. Then, the total collected waste was separated manually with the help of sanitary workers for characterization and quantification. Finally, the energy potential was estimated from combustible part of generated waste. It was found from the study that the total municipal solid waste generated from the city was about 200 tons per day. The share of paper waste was about 20% and wood waste was 15% of the total generated waste. The study revealed that 60 to 70% of the total municipal waste was the combustible waste, which can produce 130 million kcal energy (heat) per day. The produced energy can be used for industrial processes in sugar mills, cement kilns or brick kilns, instead of throwing it uselessly in open areas. The open dumping of waste was the main cause of environmental pollution in the city.

Keywords: *Waste management, energy potential, combustible waste, industrial processes*

1. INTRODUCTION

Municipal solid waste is an undesirable material discarded by human activities. It mostly consists of solid, semisolid or liquid materials, thrown away from households, commercial and industrial areas. Solid waste generation and its consequences for the public and the surroundings are global issues. The complications of the physical and chemical characteristics of solid waste are a challenge for waste managers, especially in developing countries. It requires a vibrant and effective policy for waste management and proper legislation [1-3]. Besides huge complications, municipal solid waste (MSW) contains a substantial amount of energy, which can be utilized efficiently for production of heat and electricity [4-5]. Usually, the higher heating value of MSW is between 18 and 20 GJ tonne^{-1}, and the lower heating value is between 8 and 12 GJ tonne^{-1}. Since, the bituminous coal has lower heating value of 23.9 GJ tonne^{-1}. It is clear from the statistics that the lower heating value of MSW is 42 percentage of the bituminous coal. It could be economically feasible to utilize the energy of discarded waste in environment friendly manner instead of throwing it without energy recovery [6]. The changing of living standards, decreasing utilization of un-disposable materials and unnecessary packing of different items are responsible for increasing the waste generation quantity. The problems associated with MSW management are complicated as the characteristics and composition of waste is different and there are also financial limitations on public services. It is not only the issue of land but also air and water as it pollutes every environment [7].

It was reported that the solid waste generation rate ranges from 0.283 to 0.612 kg/capita/day and the growth rate was 2.4% per year in Pakistan [8-10]. It was observed that the municipal solid waste was typically dumped over the low lying areas. The solid waste is openly burned to reduce its volume and lengthen the life span of the dumpsite. However, the dumped waste is not completely burned as it contains moisture, which produces unwanted smoke. That results unaesthetic look and unsanitary conditions in the area [11-13]. However, that land could be used for the production of more valuable things instead of dumping site for waste materials. Since, the potentially valuable recyclable materials are lost due to direct burning. Moreover, no separation of waste is being carried out for different types of wastes and the population is also unaware about the proper ways and means of waste disposal system. Consequently, direct disposing and burning of waste results environmental and public health problems in the area [14-15].

2. MATERIALS AND METHODS

2.2 Study Area

Mirpurkhas city was selected for the study of energy potential of municipal solid waste. It is the fourth largest city of Sindh province with a population of 0.4 million. The site survey was carried out in 2012, for selection of different locations in the city area. The types of areas included commercial and residential colonies. Different

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criteria were considered for the selection of locations, such as type of commercial unit, living standard, occupied area and number of people in a single family. The total collected waste was separated manually with the help of sanitary workers by means of providing different plastic bags. After the separation of waste, it was weighed and quantified. The heating value of solid waste from residential, open areas and commercial units is 4300 Btu/lb, 6500 Btu/lb and 2500 Btu/lb respectively. The efficiency of solid waste combustion depends on the waste characteristics, ignition temperature and incineration technologies. The combustion efficiency is commonly ranges from 50% to 85%. Since, 70% efficiency is being considered for complete combustion of waste through incinerator [16-17].

2.3 Estimation of Energy Potential from Solid Waste

The following equation was used for solid waste generation on hourly basis from daily data [17]:

$$\text{Total of average solid waste generation per hour } (lb/h) = \frac{\text{Average of solid waste per capita (kg/day) x 2.2046}}{\text{24 hour}}$$

The energy potential from solid waste was calculated as [17]:

$$\textit{Energy (kWh)} = \frac{\text{Total of average solid waste generation/hour} \times \text{heat value} \times \text{efficiency}}{\text{3412 Btu per hour}}$$

The value of 3412 Btu/hour is being used to obtain value in electrical energy produced that is kWh and 1 kWh equal to 3412 Btu/hour or 1.341 hp.

3. RESULTS & DISCUSSIONS

It was found from the study that the municipal solid waste was composed of heterogeneous mixtures. It was openly thrown away in low lying areas of the city. The solid waste was categorized based on different constituents as shown in Table 01.

Table 01: Solid Waste category & constituents of Mirpurkhas Solid Waste [18-20]

S. No.	Category of Solid Waste	Waste constituents
1	High-grade paper	Office and computer paper
2	Mixed Paper	Mixed colored papers, magazines, glossy paper, and other paper and newsprint Mixed colored papers, magazines, glossy paper, and other paper and newsprint
3	Newsprint	Newspaper
4	Yard Waste	Branches, twigs, leaves, grass and other plant material
5	Food Waste	All food waste excluding bones
6	Glass	Clear and colored glass
7	Plastics	All types of plastics
8	Ferrous metals	Iron, steel, and tin and metal cans
9	Non-ferrous metals	Primarily Aluminum, Aluminum cans, copper, brass and lead
10	Wood	Timber, wood products, pallets and furniture
11	Rubber	Tyres, footwear, wire cords, gaskets
12	Textiles	Furniture, clothing, and footwear
13	Miscellaneous	Other organic and inorganic materials, including rock, sand, dirt, ceramics, plaster, bones ashes, etc.

The total quantity and the collected solid waste results are given in Table 02. It was found from the study that about 200 tons of solid waste was being generated from Mirpurkhas city. Out of this total generated waste about fifty percent was being collected by the municipal staff (sanitary staff), while the rest of the waste left out at the open areas. The municipal authorities have found four final disposal sites out of the city, where they carry out the collected solid waste and performed open dumping. The transport fleet comprised of thirty vehicles which were open from top and the solid waste was manually loaded over them by the sanitary workers.

Table 02: Total quantity of the collected solid waste

S. No.	Item	Volume/Quantity
1	Total Waste Generation	200 tons per day
2	Collection per day	100 tons per day
3	Left out waste	100 tons per day
4	No. of disposal sites	04 sites
5	No. of sanitary workers employed	246
6	No. of vehicles in use	30

It was found that paper waste was dominant substance of the generated solid waste stream, which was about 20 percent of the total. The share of plastic waste was about 20 percent. Since, the vegetable waste, kitchen waste and wood waste were 15 percent each, while the glass waste was about 5 percent of the total. The composition of the solid waste found in the generated solid waste is shown in Figure 1.

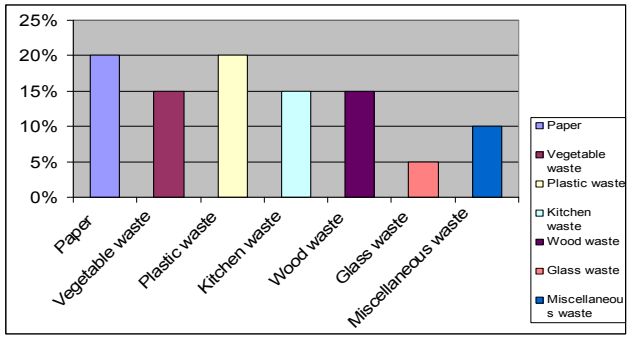

Figure 1: Composition of Solid Waste in Mirpurkhas

It was also found from the study that combustible solid waste was about 60 to 70% of the total generated waste. The energy or heat can be produced from that part of waste. The energy from combustible waste can be used by

sugar industries, brick kilns and cement factories in the vicinity of Mirpurkhas city. The study revealed that combustible waste contains approximately 130 million kcal energy (heat) per day, which can reduce the fuel consumption as well as environmental pollution in the area.

4. CONCLUSION

The total collected waste was separated manually with the help of workers for characterization and quantification. The energy potential was estimated from combustible part of generated waste by analytical methods. It was found that the total municipal solid waste generated from the city was about 200 tons per day. The share of paper waste was about 20% and wood waste was 15% of the total generated waste. It was discovered that 60 to 70% of the total municipal waste was the combustible waste, which can produce 130 million kcal energy (heat) per day. It is concluded that the produced energy from solid waste can be effectively used for heat and energy production in sugar mills, cement or brick kilns in the vicinity of the city, instead of dumping into open areas.

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