SOLID WASTE AND SUGARCANE BAGASSE-A RENEWABLE SOURCE OF ENERGY IN RAJSHAHI CITY, BANGLADESH.

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Abstract Renewable energy source- Solar power, Wind power, Tidal waves, Water head –as containing nondepletable huge amount of energy, Municipal wastes and sugarcane bagasse are also a renewable energy source and energy can be harnessed easily to meet the increasing global energy crisis considering 3 "E" S. The wastes in the city are mainly non hazardous type and these are food wastes, weeds, ashes, papers, packages, plastic bags, polythene, broken glass, tins, worn cloths, casings, cover of pharmaceuticals and many other things. About 78-70% of organic food wastes with high moisture content is the major constituents of solid wastes of the city. Remarkable percentage of the waste is combustible. Bagasse is in plenty here as sugarcane grows well in Rajshahi. A study was conducted in the Rajshahi City Corporation, Bangladesh in order to measure the amount of Municipal solid wastes and bagasse and the amount of energy that can be harness from the wastes and bagasse for cooking as well as for power generation too. This paper also includes possible recommendation, as natural gas supply is still a dream in Rajshahi, People have to depend on bio-mass, Electric heater, and on LPG. So load shedding in electric supply is a common matter here, to meet the energy crisis in Rajshahi by harnessing energy from wastes. Possible electrical energy production from waste is found approximately 119.8 MWh per day and from bagasse is 544 MWh per day for 56 days.

Keywords: Renewable energy, Solid waste, Sugarcane bagasse

INTRODUCTION

Rajshahi city is the head quarters of the Rajshahi division of Bangladesh and the city is situated by the side of the mighty river Padma. It was a metropolitan city, but at present it is city corporation. The maximum temperature here is observed during the month of April to October. Monsoon normally starts from June and continues till September. The annual rainfall is amount 1400 mm. The maximum and minimum temp. And humidity is 43^0c and 4^0c, and 91% and 5% respectively. In 2000 census, the total population of Rajshahi City Corporation was recorded to be 383655 over an area of 93.95 sq. km. consisting of 30 wards. This large population releases an enormous amount of domestic wastes. It is a fact that the conventional source of energy has been depleting at an alarming rate and hence the focus on alternative renewable source of energy is increasing. In Japan and Taiwan, electricity is being generated from Municipal wastes. Huge amount of energy is present in the solid waste and has to make this waste as alternative sources of energy at the present energy crisis of the world.

SOLID WASTE IN RAJSHAHI CITY CORPORATION

Total amount of solid wastes, which are collected by the City Corporation per day, is around 100-110 tons.

Daily collected solid waste is shown in Fig.1. These are mainly food wastes (Vegetable trimming, the part of food not taken, slough of onion, garlic, green piper etc.), weeds, ashes, papers, packages, plastic bags, polythene, broken glass, tins, worn cloths, casing, cover of pharmaceuticals, and many other things. There are industrial wastes also. The wastes are gathering on roads, junction of roads, around houses, building shops, schools, colleges, etc. The wastes are produced from different sources and various components. Among the wastes, percentage of vegetable wastes, polythene & plastic wastes, other substances (containing the worn cloths, cover of pharmaceuticals etc.) for different locations of the City Corporation are shown in the Table-1.

Table –1: Different types of wastes in different locations by weight %

Location	Vegetable waste	Plastics & Polythene	Other substances
Industrial area	28.7	3.56	67.69
Commercial area	28.7	6.07	65.22
Residential area	35.72	8.17	56.1

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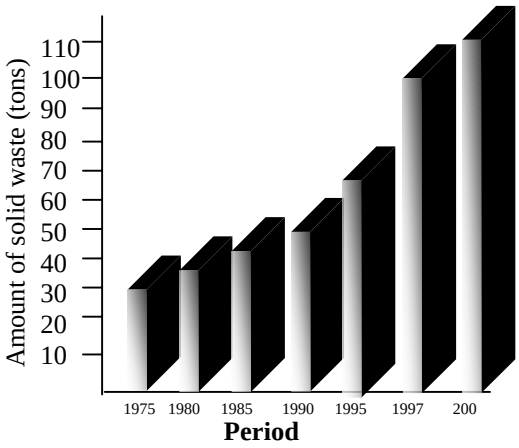

Fig.1 Total solid waste in the Rajshahi city corporation w.r.t. Period

ENERGY PRODUCTION FROM THE WASTES AND SUGERCANE BAGASSE:

From Wastes:
Calorific value of wastes, as normally collected with high moisture content, is 1386-2600Btu/lb; After drying in the air; i.e., when moisture content in wastes reaches 5-8%, then it's calorific value stands 2900-4300 Btu/lb and after drying by flue gases it's value stands 3300-6200 Btu/lb. During combustion, possible emission of So_x and No_x from wastes is very low.
Solid wastes collected daily are around 110 tons.
Waste = 110 ton = 110000 kg
Calorific value = 4750 BTU/lb.
We know, 1 kcal/kg = 1.8 BTU/lb. So that, Calorific value = 4750/1.8 kcal/kg = 2638.89 kcal/kg
Amount of Energy presents in the daily collected waste after drying in the flue gases = 2638.89 x 110000
$= 29.027 \times 10^7$kcal = $(29.027 \times 10^7 \times 4.2)$ kJ
$= 12.1 \times 10^8$ kJ

Similarly for bagasse:
For the year 2000-2001 Sugarcane collected by Rajshahi sugar mills = 87,068.79 tons
Bagasse produced 35.40% of cane.

So that, Bagasse = (87,068.79 x .3540) tons = 30822.35 tons.
Calorific value = 3600-4200 BTU/lb (Moisture Content 50%-60%), that is on an average 3900 BTU/lb = (3900/1.8) kcal/kg = 2166.67 kcal/kg
Amount of Energy presents in the Bagasse of the current year = (30822.35 x 1000 x 2166.67) kcal
= (30822.35 x 1000 x 2166.67 x 4.2) kJ 2.8×10^{11}kj
A typical energy recovery system is shown in Fig. 2. Overall efficiency of the recovery system is

$\eta_{Overall} = \eta_{boiler} \times \eta_{Turbine} \times \eta_{Generator}$
$= 83\% \times 45\% \times 95\% = 35.4825$

FLOW DIAGRAM FOR ENERGY PRODUCTION FROM SOLID WASTE:

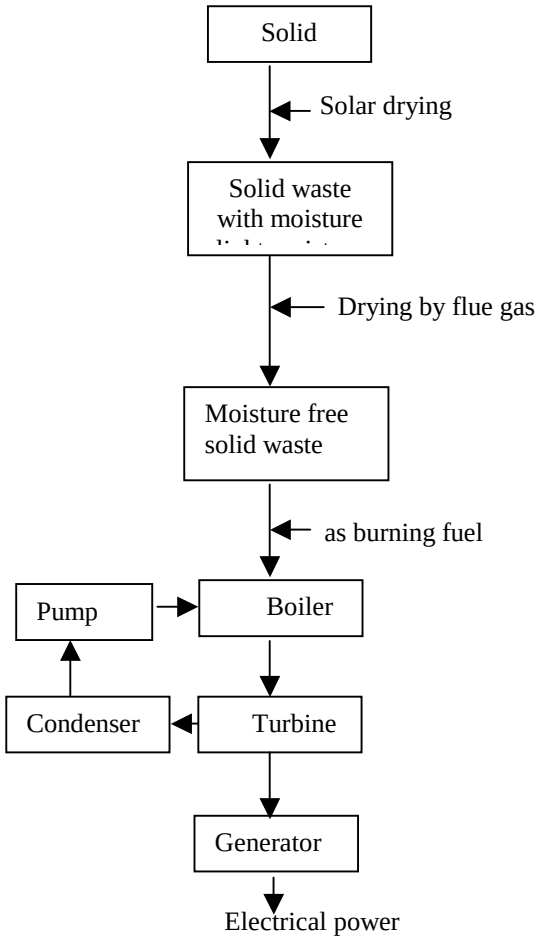

Fig. 2 Flow sheet for energy recovery system

So, by this system it is possible to convert 35.48% of the energy content in the solid waste into electrical energy.

Probable Power Generation from the Wastes and Bagasse:
From wastes: Power plant consumes wastes,
W = (110 x 1000) kg/24 hr = 4583.33 kg/hr
Heat conversion efficiency or Overall efficiency of the plant, η = 35.5%
C = Calorific value of wastes = 2638.89 kcal/kg
H = Net heat utilized = (W x C x η)
= 4583.33 x 2638.89 x .355 kcal/hr
$= 42.94 \times 10^5$ kcal/hr.
E = Energy produced per hour
= H/860 kWh. (As 1 kWh = 860 kcal)
$E = 42.94 \times 10^5 / 860 = 4992.66$ kWh.
Possible Energy production per day = E x 24
$= 4992.66 \times 24 \times 10^{-3} = 119.8$ MWh

Similarly from bagasse: From 30822.35 tons of bagasse Rajshahi sugar mills use 29922.37 tons of

bagasse in 1180.59 working hour for power and steam generation. From the rest of the bagasse 618.99 tons are send to North Bengal Paper mills and the rest are stored for next season.

Power plant consumes bagasse,

W = 29922.37 x 1000/1180.59 kg/hr = 25345.26 kg/hr

(As working hour of the mill = 1180.59 hr)

C = 2166.67 kcal/kg

H = (W x C x η) = 25345.26 x 2166.67 x .355 kcal/hr

= 19.49 x 10^6 kcal/hr.

E = Energy produced per hour = H/860 kWh.

(As 1 kWh = 860 kcal)

= 19.49 x 10^6/860 = 22668.32 kWh

Possible Energy Production from the bagasse

= (22668.32 x 24) kWh = 54.40 x 10^4kWh = 544 MWh

IMPROVED FUTURE SOLID WASTE MANAGEMENT SYSTEM

Flow sheet of present solid waste management system is shown in Fig. 3. Solid waste generation rate in this city is very high. From Fig. 1 we can easily observe that total amount of solid waste generation is being increased from year to year. So, in order to recover energy from this huge waste, an improved solid waste management system is required. Solid waste management system in the Rajshahi City Corporation can be improved in future by the following ways:

1. To collect waste from the very first source of waste generation, that is, we have to make arrangements for separate waste boxes for different types of solid waste at every source. Then food wastes may be supplied directly to bio-gas plant and other waste directly to Boiler house for power generation purpose. At the time of waste collection some money value of waste may be given to the source owner, so that they feel interest and become careful to collect different waste to the right waste boxes.
2. To take mass publication by available media like TV, Radio, Posturing, Leaflet etc with a view make people conscious about waste and its management.

City Corporation can earn a large amount of money by supplying this gas to the consumer for their fuel. Burning solid waste at Boiler house can generate electricity. As the waste are used as a raw material for power generation, so waste will be properly utilize and thus disposal problem will be eliminated.

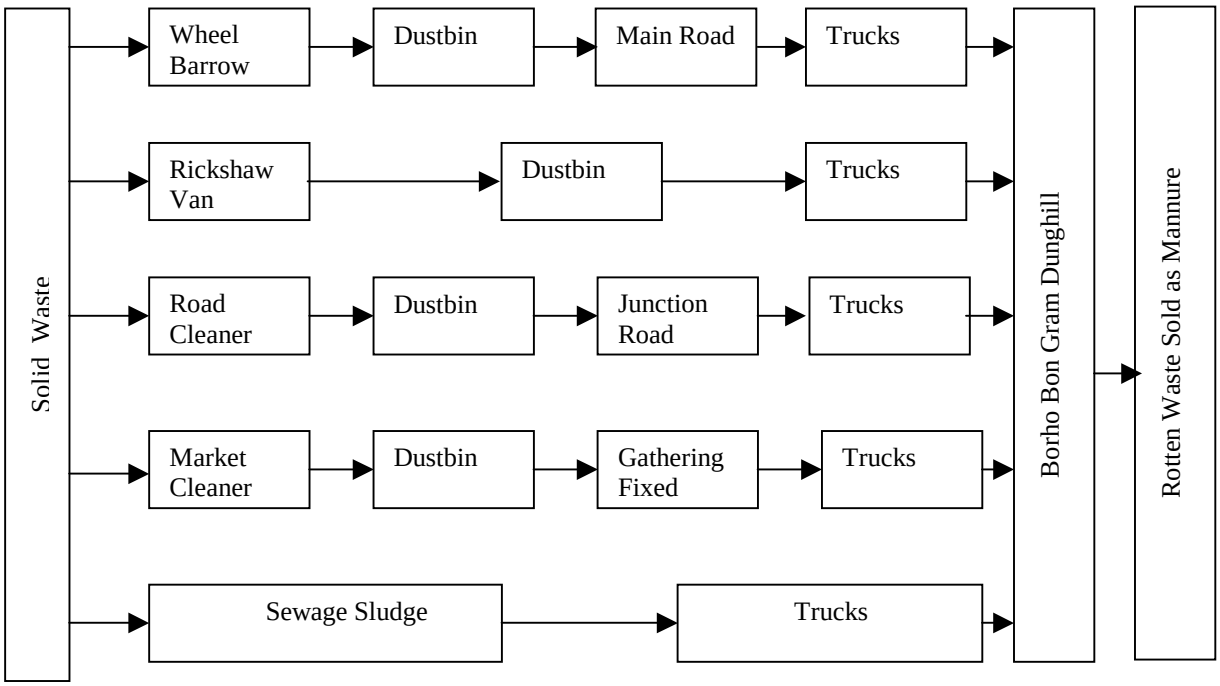

Fig. 3 Flow sheet of present solid waste management system

DISCUSSION

From the Table-1 it is observed that in densely populated residential area vegetable waste are in larger amount than in commercial and industrial area. Plastic and Polythene are more in residential area than in commercial and industrial area. It is justified. Remarkable percentage of vegetable wastes is present in the solid waste in every place and energy can be produced from these vegetable wastes certainly either by biogas plant or by direct combustion. Other substances contain high carbon and huge amount of energy can be harnessed from these wastes. It is also noticeable that polythene and plastics content are also a great percent in the wastes. In a controlled atmosphere energy can collect from this polythene and thus can reduce atmospheric pollution. From Fig.1 it can be easily realize that the increasing Municipal waste will create a severe disposal problem in future if does not use in effective way. So, by using this waste, disposal problem can be greatly minimized.

CONCLUSIONS

Solid waste is a renewable source of energy. Atmospheric pollution may be greatly reduced. Energy crisis of the Rajshahi City may be minimized and if this process is used anywhere in the world both energy crisis and atmospheric pollution can be reduced globally also.

RESULTS

1. Amount of heat energy present in the daily collected waste is approximately 12.1×10^8 kJ and in sugarcane bagasse is 2.8×10^{11}kJ

2. Approximately 35.48% of the heat energy from the waste may be converted into electrical energy.

3. Possible Power generation from wastes is 119.8 MWh per day and possible power generation from bagasse is 544 MWh per day for 56 days.

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