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FEASIBILITY OF BIOGAS PRODUCTION FROM ORGANIC FRACTION OF MUNICIPAL SOLID WASTE OF KURNOOL CITY, ANDHRA PRADESH, INDIA

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ABSTRACT

With the declining petroleum fuel reserves, the world is looking for the alternate and sustainable energy resource, one of such sustainable sources is Biogas. Biogas refers to the gas generated when putriscible organic matter undergoes anaerobic digestion (AD) in the presence of microorganisms. It is an odourless combustible gas containing 50-70% methane which is combustible, 30-50% carbon dioxide and traces of other gases. In the present study, the amount of putriscible organic content in the Municipal Solid Waste i. e. Organic Fraction of Municipal Solid Waste (OFMSW) has been estimated by conducting survey in some selected localities in the Kurnool city. Feasibility of the production of biogas by anaerobic digestion process has been done. In Kurnool city per day 88.18 tons of organic matter is collected from the kitchen, restaurants, hotels and vegetable markets, which is a potential feed stock for the generation of 32,262 m^3 biogas per day, which can be used for power production.

Key words: Organic fraction of municipal solid waste (OFMSW), Municipal solid waste, Biogas, Anaerobic digestion.

INTRODUCTION

In earlier times, men used to lead a simple life. At the beginning of 20th century, industrial revolution occurred and from then onwards there has been a steady increase in consumerism, which has resulted in increased waste generation. Solid waste can be defined as any solid or semi solid material resulting from human activity discarded as useless or unwanted. The collection of waste is performed by the municipalities with in a local area.

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The term residual waste refers to the mixed waste that has not been separated out. Waste can be classified in several ways and the typical classification is given below.

- Biodegradable waste: food waste from kitchens, hotels and vegetable markets. paper waste, which can be decomposed.
- Recyclable material: paper, glass, metals, certain plastics.
- Inert waste: construction and demolition waste, dirt, rocks and debris.
- Wastes: waste clothing, tetra packs, waste plastics that can not be recycled
- Hazardous waste: paints, chemicals, light bulbs, fluorescent bulbs, spray cans, fertilizers and containers.

Worldwide urbanization is increasing leading to increased generation of MSW. Obviously, there has been significant increase in MSW generated in India in the last few decades. The quantity, quality and composition of MSW vary from place to place and increases with increase in population size, quality of life and standard of living. If the MSW is not properly managed it will affect public health and leads to the degradation of the environment[1]. The best method for handling of MSW is utilizing MSW for power production. Currently, there are many power plants, which produce power by burning the MSW in the form of Refuse Derive Fuel[2] but produces objectionable gases into the environment[3]. The MSW contain large quantities of decomposable organic matter, which can be used for the generation of biogas through anaerobic digestion process. This biogas can be used for cocking, lighting, heating in houses and for power production. The added benefit is the digest ate from anaerobic digestion is a very useful fertilizers in agriculture. Biogas generation from OFMSW has two benefits. Electricity is generated, which reduces the dependence on electric production from power plants which use fossil fuels.

The green house gas emissions are significantly reduced by preventing methane emission from land fills. In this context, WTE is efficient in harnessing the untapped source of energy from verity of wastes. According to Food and Agricultural Organisation (FAO) of United Nations report of 2011, there is wastage of 33% of the global food supply totaling to 1.3 billion tonnes of food waste world wide[4]. Biogas can be produced from the Anaerobic digestion of biodegradable matter present in MSW, which is a sustainable source of energy[5,6]. Biogas has lower emission rates compared to the natural gas or any other fossil fuels and pollutes the environment less. The below table shows the comparison of flue gases produced by burning the fuels[7]. The present survey is confined to Kurnool city, Andhra Pradesh.

Historical importance of Kurnool

Kurnool is the administrative capital of Andhra Pradesh. Kurnool is the one-hundred-fifty largest state in India and forth populous city of Andhra Pradesh. It is considered as gate way of Rayalaseema and largest city in the area. Kurnool served as the capital of Andhra State for three years from 1st October 1953. Kurnool lies on the banks of Tungabhadra and Hundri rivers. There is a historical K. C. canal (Kurnool-Kadapa canal), which was built primarily for transportation by the Dutch, now it is used for irrigation.

Geographical location

Kurnool is situated between a latitude fo 15-48'' and 75'' east latitude of south of Secunderabad. It has an average elevation of 273 meters. The climate is tropical with temperature ranging from 26°C to 45°C in summer to 13°C to 31°C during winter. The average rain fall is about 762 mm.

Population growth

In 1981 population of Kurnool was 2,06,312, in 1991. It was increased to 2,33,717, in 2001 the population raised to 3,42,973 according to 2011 censes the Kurnool population is 4,78,124 and registered a growth of 39% over the past decade (Fig. 1).

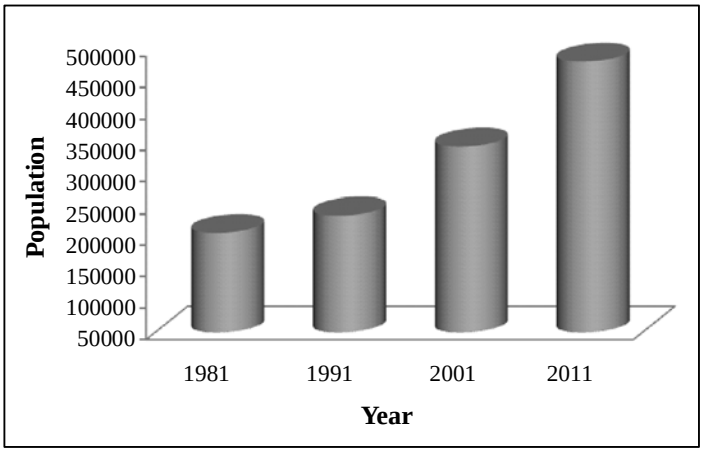

Fig. 1: Population growth

Kurnool city is divided into 50 wards comprising of one lakh houses (Fig. 1). For administrative supervision of MSW collection and transportation, city is divided into 12 divisions. A detailed study of MSW management was made by the author in his previous articles[8,9].

Fig. 2: Ward wise boundaries of Kurnool city

The details of Kurnool city is obtained from the official website of Govt. of Andhra Pradesh[10].

There are available a few such biogas production plants in India, which make use of vegetable waste. At Koyembedu Market Complex[11] and several Biomethanation plants[12] across the country. The waste from biomethanation can be used as compost for soil conditioning. A 5MW MSW-based power plant was established in December 2003 in Lucknow. Every day 500-600 tons of MSW is collected from Lucknow city, which is used to convert 115 tons of dry volatile solids, which can produce 50,000 m^3 of biogas and 75 tons of organic fertilizer[13]. Currently in Germany and Sweden, Biogas technology is in advanced stages and is being used as a vehicular fuel and to produce clean energy in the mega Watt range[14].

Table 1: Comparison of flue gas composition from burning of different fuels

S. No.	Fuel	CO (g/Kg)	HC (g/Kg)	NO_x (g/Kg)	CO_2 (g/Kg)	Particulates
1	Diesel	0.20	0.40	9.73	1053	0.100
2	Natural gas	0.4	0.60	1.10	524	0.022
3	Biogas	0.08	0.35	5.44	223	0.015

EXPERIMENTAL

In the present study, the organic matter i.e food waste, vegetable waste, fruit waste, paper, card board and yard trimmings from the houses from different selected localities

comprising all sections in the town has been surveyed. The method adapted includes collection of samples from 25 houses in each locality on different days in a week, segregation, weighing and calculating the average value of each house (Figs. 3-6). The results are presented in the Table 2.

Fig. 3: Weighing of the waste collected

Fig. 4: Weighing of the waste collected

Fig. 5: Segregation of the waste collected

Fig. 6: Weighing of the segregated waste

Table 2: Average weight of decomposable matter from each house

S. No.	Locality	Food waste, vegetable waste, fruit waste (Kg)	Yard trimmings (Kg)	Paper, card board & cloth (Kg)
1	Jammichettu & Kummarigeri	0.561	0.054	0.051
2	Old marker	0.620	0.062	0.040
3	Balaji colony	0.514	0.120	0.036

Cont…

S. No.	Locality	Food waste, vegetable waste, fruit waste (Kg)	Yard trimmings (Kg)	Paper, card board & cloth (Kg)
4	Nehru Nagar	0.715	0.093	0.039
5	Narasingarao pet	0.673	0.084	0.029
	Average	0.616	0.083	0.039

The amount of organic solid from each house on average is = 0.738 Kg per day. There are about 1,00,000 houses in the city, which generates 73.8 MT organic waste per day. There are about 300 hotels and restaurants in the city, which produce nearly 7.5 MT of waste food materials. In addition to this vegetable waste generated from vegetable markets and Raitu Bazars is also studied. The amount generated is found to vary on different days like weak days, festivals and seasons. The average values are presented in the Table 3.

Table 3: Weight of vegetable waste and fruit waste

S. No.	Location	Amount (Kg)
1	Market yard	6,000
1	C-Camp Raitubazar	500
2	Kottapet Raitubazar	175
3	Venkataramana Colony Raitubazar	125
4	Main vegetable market	85
	Total	6,885

The consolidated amount of decomposable organic matter generated from different sources is presented in the Table 4.

Table 4: Consolidated decomposable organic matter

S. No.	Source	Amount (MT)
1	House hold waste	73.80
2	Hotels & restaurants	7.50
3	Vegetable & fruit markets	6.88
	Total	88.18

The amount of food, vegetable, paper waste and yard trimmings amounts to 88.18 MT. The moisture content of the 10 representative samples have been determined in hot air oven maintained at 105^{o}C. The results are presented in Table 5.

Table 5: Determination of moisture

S. No.	Samples	Initial weight (Kg)	Weight after 24 hrs (Kg)	Percentage moisture
1	Sample1	10.54	1.94	81.53
2	Sample2	9.70	2.29	76.34
3	Sample3	11.20	2.56	77.12
4	Sample4	10.08	1.41	85.95
5	Sample5	8.75	2.28	73.91
6	Sample6	10.89	2.45	75.63
7	Sample7	12.07	2.34	80.58
8	Sample8	10.86	3.05	71.91
9	Sample9	11.05	1.80	83.64
10	Sample10	8.75	2.17	75.18

The average moisture content is 78.18% that means the volatile solid is 21.82%. In the total organic matter of 88.18 MT, there are 17.71 MT of dry organic solids, which is a potential source for the generation of Biogas, which can be used for the heating or raising steam for power production.

RESULTS AND DISCUSSIOIN

From the various researches, it is noticed that the efficiency of anaerobic digestion process mainly depends on the composition and nature of the feedstock[15]. OFMSW contains verities of components, which vary with the season and location. From the results obtained from the available organic decomposable waste, it is viable to generate biogas in a sustainable way. Values from the literature showed that 367 m^3 of biogas can be produced per ton volatile solids[16]. Therefore, from 88.18 MT of volatile solids 32,262 m^3 of biogas can be generated per day from the organic waste from food, vegetable, fruit and other biodegradable waste from kitchen, food waste from hotels and restaurants and vegetable

and fruit waste from markets and Raitu bazaars. This biogas has the total energy content of 2,01,637 kWh[17]. During the survey by the author the following observations were made.

- The garbage is collected as a mixed garbage from the houses.
- There is no system to collect wet and dry garbage separately.
- Most of the time the food waste is being dumped in the drains.
- The food waste from hotels and restaurants is used for feeding pigs.
- Vegetable and fruit waste is being dumped in the dumping yard.

It is concluded that there is a huge potential for the production of biogas from the anaerobic digestion of decomposable organic matter generated from kitchen, hotels, restaurants, vegetable and fruit markets. It is suggested to the KMC authorities to develop a system of collecting segregated waste and utilise the MSW as a good and sustainable source of energy with the environmental perspective.

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