A STUDY OF ELECTRICITY SUPPLY GENERATION FROM FOOD WASTE

THATTE AVINASH SHRIRAM

Research Scholar, Dept. of Electrical Engineering,

Sri Satya Sai University of Technology & Medical Sciences,

Sehore, Bhopal-Indore Road, MadhyaPradesh, India,

Dr. Subhashish Boss

Research Guide, Dept. of Electrical Engineering,

Sri Satya Sai University of Technology & Medical Sciences,

Sehore, Bhopal Indore Road,Madhya Pradesh, India.

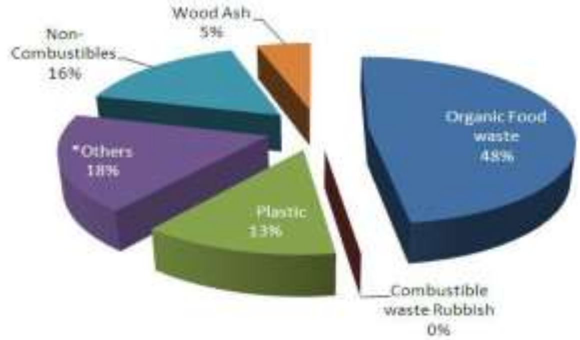
ABSTRACT

Waste has become one of the major environmental issues for every nation and is adversely affecting the lives on earth. In a developing country like India, there are many places which suffer shortage of electricity to date. Ironically they are the places which have become landfills for garbage. This paper gives a solution to the present scenario by converting food waste into electricity. This electricity is produced by the reaction between the electrodes with food waste as the medium. Different combinations and arrangements of electrodes are also taken into consideration. This is where our project plays an important role in finding an effective solution to the existing problem.

KEYWORDS: electrodes; zinc; copper; electricity; food waste.

INTRODUCTION

India is the second most populated nation on the planet, estimating to a population of about 1.21 billion, and accounts for about 17.66% of the total world population. It is same as the combined population of Indonesia, Brazil, Pakistan, and Bangladesh. Population growth and rapid urbanization has had a huge impact on the waste generation. Increase in the global population and the rising demand for food and other essentials, has led to a rise in the amount of waste being generated daily by each household.



It has been observed that more than 300 cities in India generate 45 million tons of waste presently, which is a 50% increase in one decade. From the total waste generated throughout; a majority of 48% is food waste in Fig.1. About 0.1 million tons of waste is generated in India alone everyday which is about close to 35 million ton a year. The landfills where the waste is dumped is always located away from the habitation clusters due to environmental impacts but this increasing waste means more land is required for disposing the waste , which increases the transportation cost. This waste is being recklessly dumped into villages. Everyday products that are used and thrown away are filled with hazardous and health-affecting chemicals. Indiscriminate dumping of wastes contaminates surface and ground water supplies. The waste clogs the drain, creating a breeding ground for insects. These insects spread diseases like dengue, malaria, cholera. Also the uncontrolled burning and improper disposal aggravates air pollution. Adding to this, the decomposition of waste also produces greenhouse gases. Hence proper waste management has to be undertaken to ensure that it does not affect the environment and does not cause health hazards to the people living there [1]. The present day treatment of waste involves reducing the amount of waste [1], such as Compaction, Incineration Pyrolysis gasification and Composting. Prevention of waste is a top priority when waste management techniques are concerned, but because this is humanly impossible for us with the lifestyles that we are used to, the next best is the recycling and reuse of materials. Incineration is a combustion process for burning solid wastes in presence of air at high temperature. But in this treatment, Dioxins are produced which a cancer is forming chemical. Pyrolysis involves the thermal decomposition of biomass in the absence of oxygen. The end products are gas and coke. In gasification, the chemical reaction takes place in the presence of steam in an oxygen-lean atmosphere. The products of gasification are carbon monoxide which is harmful to the living beings. Another process is composting, which is the biological decomposition of food or plant waste by bacteria, fungi, and other organisms performed under controlled aerobic conditions. All of which requires lots of time, cost and land. Hence, in this paper we provide an effective solution for both waste management and producing electricity in the most efficient and user friendly way.

WASTE TO ELECTRICITY CONVERSION

In this project food waste was taken in two forms, grinded and not grinded. Each of them was further experimented with and without chemicals. Several methods were performed out of which two gave predominantly good

A. Method I In a single container, grinded food waste was taken. Two electrodes acting as anode and cathode were dipped in the semi-solid waste. Here, a single pair of Platinum and Calomel was used. Using digital potentiometer, the voltage readings were noted down. To further enhance the voltage, we added chemicals such as Hydrochloric acid (HCl) and Potassium hydroxide (KOH).

TABLE 1 VOLTAGE READING OBTAINED FROM TOMATO PULP AND FOOD WASTE

Date	Potentiometer readings in volts	
	Without adding chemicals	With adding chemicals
	With tomato pulp	
25th July 2015	0.067	0.132
28th July 2015	0.080	0.163
3rd August 2015	0.151	0.178
18th August 2015	0.183	0.159
	With food waste	
2nd December 2015	0.271	0.178
4th December, 2015	0.180	0.164

The above Table 1 shows different voltage readings obtained from the grinded waste with and without addition of chemicals over a period of time. It was observed that the maximum voltage produced was 0.271V. The effect of addition of chemicals could not be studied as the voltage was fluctuating. The experiment was carried out for the next method which is as follows:

B. Method II

Though from the previous experimental setup, voltage obtained was in milli volts, which was was not enough to run any load. Hence an understanding of different factors which have an effect in an electrochemical reaction was required. Our first approach was made on the material of different pairs of electrode. So, we experimented with different pairs ie. Zinc-Copper, Zinc-Aluminium, Aluminium-Copper. It was found that Zn-Cu Fig. 2, gives maximum reading and hence it was considered for the rest of the project. A pair of zinc and copper sheets dipped in a container of waste gave us a reading of 0.9V as shown in Table II. The understanding of the surface area of the electrode can be understood by the equation

$$\eta_a = a + [b * (\log(i))] \quad (1)$$

where ηa is the activation over potential, a and b are empirical constants and i is the current density from (1).The amount of voltage drop in the cell due to the electron transfer, increases linearly with the logarithm of the current density hence by increasing the surface area of the electrode ,the current density decreases which decreases ηa . Further experimentation led us to connecting three pairs of zinc and copper sheets which gave us nearly 2.34V. This was more than sufficient to run the digital clock as shown in Fig 3. Similarly twelve pairs of Zn-Cu electrodes connected in series were used to glow four LEDs in series as shown in Fig 4. But the current was in milli range. Hence we decided to try out different arrangements of electrodes which were connected in series and parallel. The first combination as shown in Fig. 5 gave voltage of 3.4V and saturation current of 5.08mA. To further enhance the readings second combination as shown in Fig.6 was implemented from which we obtained voltage of 7.2V and saturation current of 14mA. Hence we can conclude that with the increase in the number of series and parallel combination of electrodes desired voltage and current can be obtained.

TABLE 2 VOLTAGE OBTAINED FROM DIFFERENT PAIRS OF ELECTRODES

Combination	Voltage (in V)
Aluminium-Copper	0.72
Aluminium-Zinc	0.4
Zinc-Copper	0.9

Fig2 Voltage reading for a single pair of Zn-Cu electrode

Fig 3 Analog clock used as load

Fig 4 Glowing of four LEDs in series

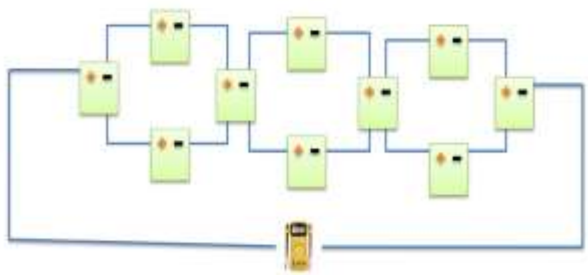


Fig 5 Series parallel combination I

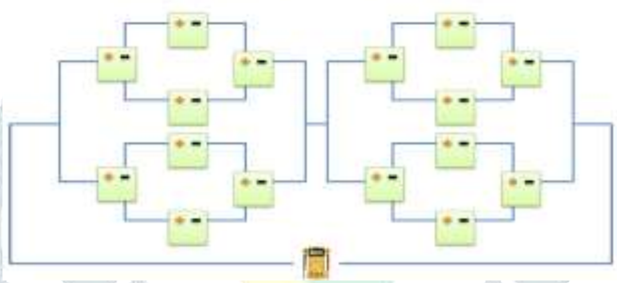


Fig 6 Series parallel combination II

Mini biogas is another way whose power plant (MBPP) is first launched in Malaysia at UniversitySains Malaysia (USM) that is capable of generating 600 kW of electricity a day from food waste in the campus. This pioneering project is aimed at building a prototype to be used by interior communities with problems pertaining obtaining regular electricity supply. Food waste provided by all cafeterias and canteens in the campus will be converted into methane which will be turned to generate electricity [5]. The plant has two tanks that can accommodate 1000kg of food and organic waste such as grass, vegetables waste, leftover rice and leftover fish. The electricity generated could be channeled to the university's power supply grid. Communities with a lot of organic waste but no connection to the grid would benefit most from MBPP, in which MBPP per se produces approximately 180 cubic metres of methane a day from readily available local waste material. This methane produced is actually equal to 180 litres of diesel per day of generated electric power, making the plant an ideal alternative for remote and island communities that depend on diesel to run generator sets for their power needs [6]. At an estimated cost of RM800,000 (US$260,000) per MBPP, and with fuel and transportation costs to a remote or island location adding up to some RM4.00 per litre, it is possible to recover the initial investment in three to six years [7,8]. This paper will present comprehensively the feasibility study on using mini biogas power plant (MBPP) which is first developed and operated in Malaysia and launched at UniversitiSains Malaysia (USM). The main objectives of this paper are two-fold; firstly to determine whether food wastes (canteen and cafeterias wastes) can produce methane gas (biogas) that can generate heat and electricity and secondly to establish how much methane gas (biogas) can be produced with the certain amount of the feedstock.

SOLID WASTE TO ENERGY POLICY IN INDIA

Policy interventions in this sector began as early as in 1960s but focused initiatives were taken in 1990's after the outbreak of plague in Surat. The Ministry of Health and Family Welfare initiated a National Mission on Environmental Health and Sanitation in 1995. A draft policy paper was prepared on funding issues and requirements for Municipal Solid Waste Management by Central Public Health Engineering Organisation (CPHEEO). The 12th schedule of the Constitution (The 74th constitutional amendment of 1992) clearly assigns solid waste management as the primary function of municipal authorities. State laws governing the municipal authorities also stipulate management of solid waste as an obligatory function of the municipal authorities. It was only after the direction issued by Hon. Supreme Court of India in a public interest litigation spl CA No 888 of 1996, the Municipal Solid Waste (Management and Handling) Rules was finalized by the Ministry of Environment and Forests (MoEF and notified in 2000). These rules define MSW, mandate that all municipal authorities in the country shall manage MSW in a time bound manner and the State Government ensure implementation of the rules. The Ministry of Environment & Forest is now in the process of issuing the Municipal Waste (Management and Handling) Rules, 2014.

The Ministry of Urban Development also plays a prime role in SWM and supports various projects under the Jawaharlal Nehru National Urban Renewal Mission (JnNURM) and Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) schemes. JnNURM was launched by the Government of India in 2005, envisaging an investment of more than Rs.1,00,000 crore during a period of 7 years from 2005-06 to 2011-12 with a Central Government share of Rs. 66,000 crore. JnNURM is a reform driven, fast track programme to ensure planned development of identified cities with focus on efficiency in urban infrastructure/service delivery mechanisms and covers 65 cities and towns. For the remaining urban areas, the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) has been launched. These rules were followed up by the National Environment Policy (NEP) in 2006. A set of rules on plastic waste management were notified under the E(P) Act, 1986 to regulate littering and manufacturing of plastic carry bags.

The scheme is applicable to both, Private as well as Public Sector entrepreneurs and organizations as well as Non-Governmental Organizations (NGOs), for setting up of waste-to-energy projects on the basis of Build, Own & Operate (BOO) and Build, Own, Operate & Transfer (BOOT) etc. Some of the salient features of the progress made during the year 2014-15 are as follows:

• A total of nine projects with an aggregate capacity of 9.54 MW based on Urban and industrial wastes have been completed during the year up to 31.12.2014.

• Agricultural Wastes/Residues based 1.00 MW capacity grid connected power project has been commissioned at Fazilka- Punjab.

• Work is in progress at 11 MW, 10 MW and 12 MW power generation projects based on municipal solid wastes at Hyderabad, Pune and Ghazipur – Delhi respectively. These projects are expected to be commissioned during the year 2014-15.

• A total of twenty one projects based on urban/ industrial wastes with an aggregate capacity of about 21 MW are under installation. These include projects based on Paper, starch industry wastes, poultry litter and biogas at distilleries.

•As part of the new initiative taken for development of biogas upgradation systems for converting biogas into Natural Gas (Bio-CNG) quality fuel for commercial use, two projects of 2.76 MWeq.for production of 14.5 tonnes/day Bio-CNG have been commissioned in Satara, Maharashtra and Anand, Gujarat. Page79

• Twelve projects of about 5.65 MWeq. for production of bio-CNG based on mix of urban and agricultural wastes are in progress at Pilibhit, Kolkata, Surat, Hanumangarh, Barnala, Amritsar, Kanpur and Ambala are expected to be completed during 2015.

Planning commission report (2014) has suggested population based Technological options to Manage MSW in a Variety of Towns and Cities

CONCLUSION

Waste should be taken in semi-solid or completely in liquid form; else the solid waste or peels etc should be lightly grinded before use. Addition of chemicals does not increase the voltage but speeds up the rate of reaction. The electrodes must be immersed in separate containers in method II as opposed to method I, because when many cells are immersed in single container it acts a single cell. The electrons move randomly and hence won't give the desired results. Immersing in separate containers constitutes every container acting as a cell hence gives the actual result. Depending on the load requirements, the cells can be arranged in series parallel combination. Zinc and copper combination gives the best result among the rest. The electrodes are taken into consideration depending upon their surface area, more the surface area more flow of electrons. Adding to this, the electrodes should be kept close to each other, as a result of which the current increases and therefore increases the rate of reaction. Rate of discharge proves how reliable the waste as a source is.

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