International Journal of Engineering Research & Management Technology

May- 2015 Volume 2, Issue-3
ISSN: 2348-4039

Email: editor@ijermt.org www.ijermt.org

"Sharpening Skills..... Serving Nation"

Special Issue: 2nd International Conference on Advanced Developments in Engineering and Technology
Held at Lord Krishna College of Engineering Ghaziabad, India

Potential of Night Soil as a Substitute of Coal in Power Generation and Utilization of Mobile Toilets Waste

Manish Sharma, Dilip Kumar
B.Tech Scholar
Department of ME
ABES Engineering College
Ghaziabad, India

Manish Saraswat
Assistant Professor
Department of ME
ABES Engineering College
Ghaziabad, India

Prof. Sandeep Garg
Professor
Department of ME
ABES Engineering College
Ghaziabad, India

ABSTRACT—
As the need of energy is increasing day-by-day hence the renewable resources of energy are the main point of research today. Besides this, human being is also suffering from the problem of sanitation and global warming and much more. It has been proved that methane gas (in major quantity) occurred by anaerobic digestion of human excreta can be used to generate electricity after combustion. This paper is about how a step can be taken towards solving the current major problems of sanitation, global warming, and energy concern. This paper also presents a key solution of open defecation as well as pathogens created by it, by using mobile toilets.
According to a student's data of hostel pit toilet as Fedral University of Technology, Owerri , human excreta in tonnes per day from case study area is 3.66 tonnes and biogas from that in two month duration can be 154.76 kg capable of running a 5kw biogas generator for 6days.

Keywords: - Human excreta, anaerobic, mobile toilets.

INTRODUCTION

Defecation is the natural process in human being; wherever the human being exists, defecation also exists.
An average person urinates approximately 2-3 liters and defecates 400- 500 gm feces per day this data is 500 liters of urine and 70-80 kg feces (approximately) annually. It means that human being produce 3500 billion liters of urine and 510 billion kg of feces annually.
There is simple way of disposing the excreta with flushing the toilets. But According to **WHO (World Health Organization)** report one billion people worldwide still practice open defecation in pits and drains as they do not have access to sanitation infrastructure. This open defecation become mix with ground water and infect it and also it produces pathogens in presence of oxygens.This problem also exists in India at a large scale .Million of people in **India** goes to open defecation in lack of sanitation infrastructure.
So using the Mobile toilets may be a solution of open defecation .As these toilets are mobile in nature, human excreta can be collected at one place to produce biogas and fertilizers. And then biogas can be used to produce electricity and heat at a large scale.

IJERMT

This will help in reducing global warming and much disease by reduction of greenhouse gases and pathogens. First plant built in 1859 at leper colony in India. It is used in 1895 to power street lights in Britain. First used for Municipal Solid Waste in US in 1939.

ELEMENTS IN HUMAN EXCRETA

Human excreta are the composition of two basic components, urine and feces .Urine and feces has different properties when they kept apart.

Urin contains 80% of total nitrogen in human excreta and remaining is in feces. There are two another component in urine also, one is phosphorous and second is potassium in amount of two-third of excreta.

Feces contain 70% to 75% of carbon of human excreta .it also has moisture, phosphorous and others .A data according to a research is provided below:

Elements (g/ppd)	Urine	Feces	Urine+ Feces
Nitrogen	10.7-11.3	1.2-1.7	11.9-13.0
Phosphorous	1.0-1.3	0.4-0.5	1.4-1.8
Potassium	2.4-2.7	0.9-1.3	3.3-4.0
Organic Carbon	6.5	21.6	30.1
Wet wt.	1,200	70-140	1,200-1,400
Dry wt.	62	38	100

Table 1: Table of human excreta content

Feces also contain some amount of indigestible food matter such as cellulose, cholesterol and other fats. The odour of feces is caused by the chemicals indole, hydrogen sulphide and mercaptans which are produced by bacterial action.

Some other elements which founds in very few amount are Mg (.23-.45gm/ppd), Zn (8-17mg/ppd), Cu (1.4-1.5mg/ppd), Ni (0.25-0.35mg/ppd), Cd (.02-.03mg/ppd) and much more.

ANAEROBIC DIGESTION OF EXCRETA

Excreta will have to pass from four step process for anaerobic digestion. These are:-

Hydrolysis:-Complex organic materials are transformed into liquefied monomers and polymers in presence of bacteria. Final products of this stage may be amino acids, monosaccharides and fatty acids.Hydolysis is a slow process which limits the overall rate of production of methane gas .this process is carried out in presence of exo-enzymes. An exoenzyme, or extracellular enzyme, is an enzyme that is secreted by a cell and functions outside of that cell. For humans and other complex organisms, this process is best characterized by the digestive system which breaks down solid food via exoenzymes. The small molecules, generated by the exoenzyme activity, enter into cells and are utilized for various cellular functions. Ex:-

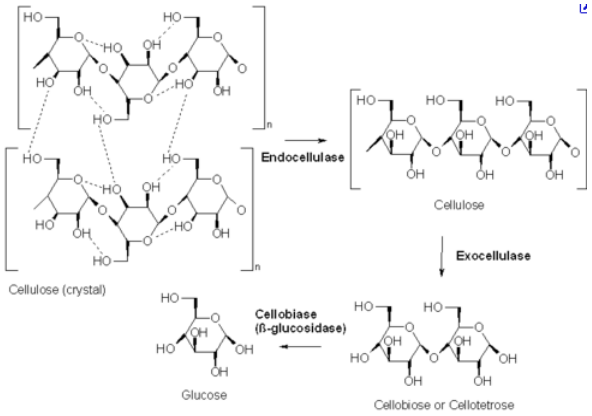

Fig.1- conversion of cellulose in glucose

Acidogenesis:- Acidogenic bacteria convert monomers of amino acids and sugars into ethanol, acids, acetate, ammonia, H2 and CO2.this step is carried out in absence of oxygen. Presence of oxygen or any oxidant may be toxic. Fortunately bacteria available in this process absorb all the free oxygen, Which help in increasing the rate of production. In this stage pH value is approximately 4-5.

Acetogenesis: - Final products of this stage are hydrogen, carbon dioxide and acetic acid. Inputs are fatty acids and alcohols. Biological oxygen demand and chemical oxygen demand are reduced and pH value decreased. Hydrogen scavenging bacteria lower the partial pressure which is necessary for this stage.

Methanogenesis:- This is the last stage in which acetic acid and hydrogen give methane gas and carbon dioxide in presence of methanogenic bacteria. In this step methane gas is formed by two ways.
These are:-

- Acetic acid gives methane and carbon dioxide. Two-third of whole methane is produced from acetic acid.

  $CH_3COOH \rightarrow CH_4 + CO_2$

- Hydrogen and carbon dioxide react with each other and give methane. It contributes in one-third of whole methane.

  $4H_2 + CO_2 \rightarrow CH_4 + 2H_2O$

Methane gas is flammable product which gives carbon dioxide after combustion. Higher the methane occurred; higher will be the energy release.

.

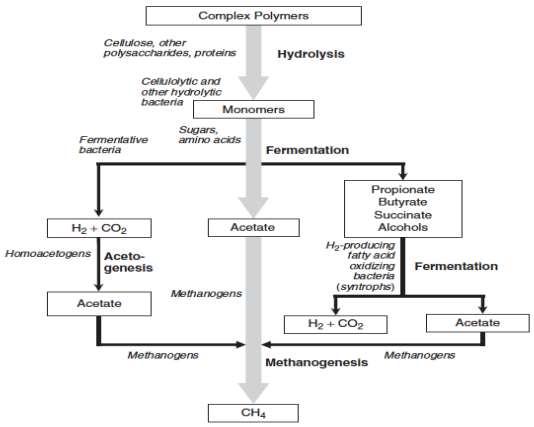

Fig.2- Processes in anaerobic digestion

All climatic conditions are suitable for anaerobic digestion for completion. But at low temperatures (less than15^0) there is a decrement in rate of anaerobic reactions. To overcome the situation a heating system is required. Large variations in temperature also affect the rate anaerobic reactions. Therefore slurry chambers are installed underground to prevent these changes with help of temperature buffer capacity of soil.

Anaerobic reactions are performed in presence of bacteria. There are two type of bacteria, one is mesophilic which works well at moderate temperature(generally the temperature range for this type of bacteria is around 30^{0}C to 40^{0}C ,and second is thermophilic these work well at higher temperature than that mesophilic which is 45^{0}C to 65^{0}C. But mean temperature for mesophilic and thermophilic bacteria are 37^{0}C and 55^{0}C respectively.

The pH value also plays an important role in anaerobic reactions. High production of biogas by anaerobic digestion and also the stability of AD process depend on pH value. The acceptable range of pH value for high production is 6.0-8.0. Also there are different ranges of pH value preferred by different reactions. Like During digestion, hydrolysis and acidogenesis process show high reaction rate at acidic pH values (pH 5.5 – 6.5) and Methanogenesis process shows high reaction rate at base phase of pH values (pH 6.5 – 8.2). An alkalinity level of approximately 3 000 mg /L has to be available at all times to maintain sufficient buffering capacity.

FINAL PRODUCTS OF ANAEROBIC DIGESTION OF EXCRETA:

The mixture of methane gas and carbon die oxide is the final product of anaerobic digestion which may be used to produce electricity or as a fuel in transportation. The live example of biogas as fuel is bio bus which has invented UK. This eco-friendly vehicle can travel up to 300km (186 miles) on one tank of gas, which takes the annual waste of about five people to produce. A single passenger's annual food and sewage waste would fuel the Bio-Bus for 37 miles

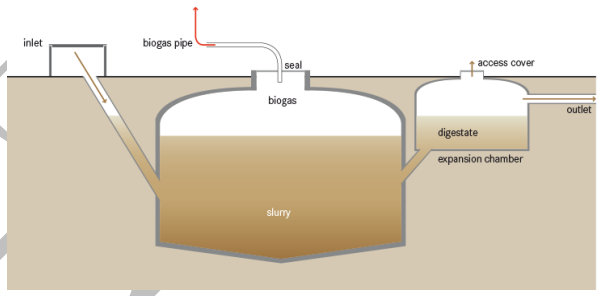

Fig.3- Human excreta plant

Digestate can be used as a fertilizer as it contains all necessary elements required for growth of crops and plants.

MOBILE TOILETS: A SOLUTION FOR OPEN DEFECATION AND EXCRETA COLLETION

In India and many countries, there is a problem of open defecation. It may be due to lack of sanitation infrastructure, or due to some situations like curfew, elections, construction sites, public occasion and so much. This leads to open defecation and hence help in global warming and creation of pathogens after aerobic digestion.

If human excreta can be used to produced power and still not in use then it is waste of power.

A mobile toilet is a toilet situated in a moving van which can make a link between excreta power plant and to the location where it is in need. Mobile toilet van has a water tank and a tank for slurry collection.

Mobile toilet may helpful in slum areas for defecation. After using van it will move to power plant where whole slurry will be transferred to excreta chamber. And then it passes from anaerobic digestion process where methane gas is a final product and gives energy in form of heat after combustion.

INDIA'S 12th PLAN OF POWER GENERATION

According to "Government of India, ministry of power" there is a need of 1095 billons units in year 2016-17 for coal based plant. And as power from hydro plant is not 100% efficient, assuming that power from hydro plant is 30% less than design energy, therefore to meet with estimated power now consumption is 1155 BU.

The total estimated medium-term potential (2032) for power generation from renewable energy sources such as wind, small hydro, solar, waste to energy and biomass in the country is about 1,83,000 MW. The grid interactive Installed Capacity from renewables is likely to increase from about 3,500 MW at end of 9th Plan, 10,258 MW at the end of 10th Plan to 22,600 MW at the end of 11th Plan. As on 31.03.2011, the grid interactive Installed Capacity from renewable is 19,975 MV.

HUMAN EXCRETA; A SUBSTITUTE OF COAL

In India there is 55% of total electricity is based on coal, from which the contribution of electricity from coal is 99,503 MV to the total electricity produced.

As the demand of electricity is regularly increasing with increasing population. To fulfil this demand coal consumption also increasing. And as per the reports, coal is finishing at fast rate. One day it will totally finish. Therefore the alternative of coal is a point of concern worldwide.

Solar power may be the option but it has some limitations. Solar energy can't be continuous whole day or whole year. Also there many options like hydro power, wind power, nuclear power, but they have some drawbacks, which may be hazardous and hence these can't be used at a large level.

There is a best alternative option to coal that is human excreta. As the use of it in power production will help in solving some environmental issues like global warming, pollution, spreading of disease.

The population of India is around 120 crore. And if a person defecates 400 - 500 gm. feces per day.

Then total mass of feces is $4.8*10^{11}$ gm or $4.8*10^{06}$ tonnes a day.

According to a report, 3.66 tonnes of human excreta can give 720 Kwh. Then $944.26*10^{06}$ Kwh of electricity or $944.26*10^{03}$ of electricity.

MERITS OF EXCRETA POWER AND MOBILE TOILETS:-

1. Open defecation can be solved will help of mobile toilets.
2. New jobs will be there, due to establishment of power plant and moving vans.
3. It will help in reduction of global warming. As formation of carbon dioxide in anaerobic digestion is approximately 12% less than in aerobic digestion. And also there is no
4. Production of other harmful gases in anaerobic digestion.
5. The waste after production of methane gas can be used further as a fertilizer because elements like K, N ,P Mn and more still present in that waste.
6. No need of power grid as excreta plants can be installed individually.
7. Disease due to creation of pathogens and the pollution will be reduced.

DEMERITS:-

1. It may not be acceptable to some people for working in such type of plants.
2. People may reject it due to religious points.
3. They may reject to use biogas occurred from excreta plant.
4. It will not be easy to establish a plant in public area as there may odour problem.
5. Higher care will be required for methane gas as it is toxic.

IJERMT

CONCLUSION

As per various reports on coal consumption, coal demand is increasing and coal is decreasing at a faster rate. And coal combustion also produces greenhouse gases, which are very harmful to earth and to all living and nonliving things. If an alternative will not be provided for coal, the condition may more disastrous. Hence power production from human excreta is the alternative

REFERENCES:-

1. Dr. P.K. Jha, "Recycling and reuse of human excreta from public toilets through biogas generation to improve sanitation community health and environment".
2. Estimation of the electric power potential of human waste using student's hostel soak-away pits retrieved from www.ajer.com, vol-02, issue-09, pp-198-203.
3. The value of feces retrieved from http://ceadserv1.nku.edu/longa//haiti/kids/feces_value.html
4. Government of India ministry of power, "Report of the Working Group on Power for Twelfth Plan (2012-17)."
5. Yvonne Vögeli, Christian Riu Lohri, Amalia Gallardo, Stefan Diener, Christian Zurbrügg, "Anaerobic digestion of bio-waste in developing countries."
6. Dr. Cristina Cavinato, Universita ca' Foscari Venezia, "Anaerobic digestion fundamentals I."
7. Biogas from human waste retrieved from www.appropedia.org/biogas_from_human_waste
8. Feces can change the world: Using human excreta as fertilizer retrieved from www.foodtank.com/.../Feces-can-change-the-world-using-human-excreta-as-fertilizer.
9. Anaerobic digestion retrieved from http://en.wikipedia.org/wiki/anaerobic_digestion
10. Composition of human excreta-A case study from southern Thailand retrieved from www.sciencedirect.com/science/article/pii/S0048969701009731

IJERMT