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A Review on production of Biogas from Slaughter house waste and poultry litter

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ABSTRACT- *This paper gives an idea on the generation of waste from different sources and their utilization for better future. World is a huge transition that we have to make up i.e. a transition from fossil fuels to green energy. The study was carried on Biogas and its uses along with raw materials required .Different stages of production of biogas are also discussed. The raw materials that are taken into consideration was slaughter house waste and poultry litter. Slaughter house waste contains organic material as manure, rumen, blood and waste water while the effluent generated from poultry litter contains feather, breeding material, manure etc. Methane production potential was also analysed and a suitable method of improvement was concluded.*

Keywords: Biogas, anaerobic digestion, methane, organic matter, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD)

1 INTRODUCTION

The problem of Pollution and depleting natural resources is becoming more severe by day and unless we take the essential steps to shift our inclination to the non-renewable resources to renewable resources we might have to face the consequences not much farther in the future. Waste when left open to the atmosphere emits Methane and other harmful gases into the atmosphere which leads to global warming [1]. Methane has the ability to combine with ozone layer and retain maximum heat for a longer period thereby increasing the temperature of the earth. Along with global warming waste when it is disposed in various places causes air pollution, water pollution, soil pollution and also affect the immune system of humans leading to many diseases. So the waste can be utilized to generate various energies like electricity, biogas, heat [2].

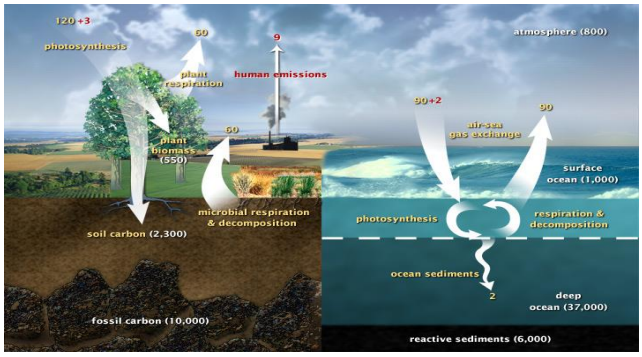

Fig 1. Cyclic process of Ecosystem

1.1 Biogas

'BIOGAS' the term itself signifies production of gas from biodegradable material [3]. Biogas is a combustible gas mainly composed of methane which can be used as cooking fuel, natural gas or to produce electricity by combustion.

Composition of biogas:-

- 60-65% Methane
- 30-35% Carbon Dioxide
- 1 % Nitrogen
- 6% Water
- <1% Sulphur Dioxide

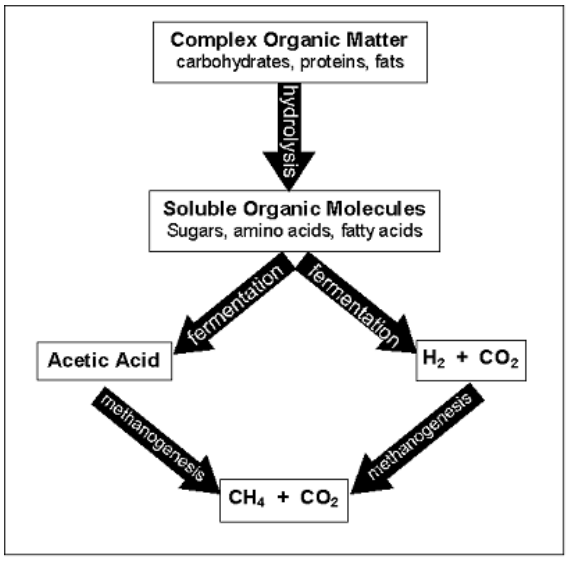

Fig 2. Flowchart of Anaerobic Digestion[4]

As discussed earlier waste generates methane which causes a great damage to the atmosphere so that methane can be turned into useful green energy. Also this energy source alters our environment. Consistent use of coal, oil, natural gas and other non -renewable product cause global warming emission, increases the affluent present in air in addition to that it also affect flora and fauna [5]. So utilization of biogas replaces the present fossil fuels and also reduces the affect caused by methane emissions due to waste.

Biogas is a process of producing methane from anaerobic decomposition of organic raw material such as agriculture waste, manure, food waste, plant materials, sewage etc. The process of production is everlasting and generates no net carbon dioxide (co_2) [6].

1.2 Stages and biogas production

- Hydrolysis: conversion of bio-polymer to manomers
- Acidogenesis: conversion of monomers to volatile fatty acids (VFA) and CO_2
- Acetogenesis: conversion of volatile fatty acids to acetate and H_2
- Methanogenesis: conversion of acetate and CO_2 plus H_2 to methane gas

1.3 Process of biogas production

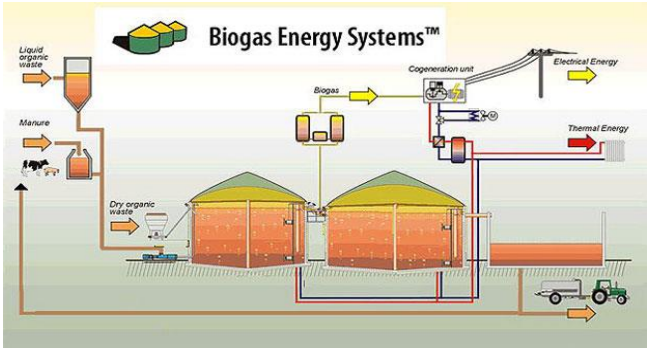

Fig 3: Process of Biogas production system

1.3.1 Hydrolysis

As earlier discussed the main substrate are organic material containing long chain of carbon component. To extract energy from these sources they should be transformed into manomersie sugar, ammonia etc [7]. So the slurry is first mixed with double the amount of water in order to decompose or break the compound into H^+ or OH^- ions to get access over its energy [8].

1.3.2 Acidogenesis

A lucid biological reaction that take place in which conversion of monomer produced in above process into volatile fatty acids takes place and the by-product generated are hydrogen sulphide (H2S), ammonia and carbon dioxide. The acidogenic fermentation of organic slurry is an impressive way to inaugurate valuable intermediate chemicals [9]. Recently these carboxylic acid constitute a valuable resources for biodegradable polymer production (polyhydroxyalkanoates,PHA).

1.3.3 Acetogenesis

This again refers to a process of conversion of Volatile fatty acids (VFA) into acetic acid, carbon dioxide and hydrogen which is a chemical reagent for production of chemical compound [4]. Digestion of compound may be mesophilic orthermophillic depending upon temperature .if temperature of fermenter is at an ambient temperature of 25^0c to 45^0c is called as Mesophilic condition and if it is at elevated temperature up to 70^0c it is referred as thermophilic condition.

1.3.4 Methanogenesis

The very last and efficient process of anaerobic decomposition is methanogens production of methane from slurry. In this process Acetic acid is converted into methane having a high potential that can be used for electricity, cooking food etc [10]. This is not at all the effluent generated from Biogas energy system can be used as manure after undergoing lime treatment that kills over a large number of faecal microorganism which if not treated cause damage to human being.

1.4 Objective of paper

The focus of paper is to determine the methane content generated from anaerobic decomposition and poultry litter. A large amount of waste is created from these two sources .The paper aims to determine the energy potential generated as well as its uses mentioning the way of treatment of waste.

2. MATERIAL AND METHODS

2.1 Collection of waste

An enormous quantity of waste and waste water is developed through sequence of action taking place in cattle slaughterhouse. A research found out that an infinite amount of waste is produced from these sources. On an average each slaughter house processes 50 animals per day [11]. The trash collected are Blood, Rumen, Manure and residue water which is used for hygienic purpose .If these were left directly into runoff before being prior treatment it may lead to health and environment threat. So these waste are collected to determine methane content. Also water that passed down directly contains large quantity of organic material thus all raw material including waste water is collected.

It was also found out that every year it was approximated that 10 %broiler production increases .since poultry farming exercise became commercialised in the last few decade, immense amount of poultry waste are available

for anaerobic decomposition. An investigation also found out that world largest agro based industry is poultry industry. Even though these industry experience a large problem associated with waste accumulation such as manure, litter which may cause dilemma if directly disposed in environment [2-4].
So these waste are also collected which include beeding materials, litter, feather, manure split feed.

2.2 Waste analysis

The amount of total Nitrogen (N), Volatile Solid (VS), Dry Matter (DM), Protein, lipids, Carbohydrate and raw fibre was analysed from the waste accumulated in the above phase. The pH of waste was also measured in order to determine carbon and nitrogen content .Waste water was also treated to determine pH, BOD, COD and suspended solid[5].
The table showing different parameter obtained from cattle slaughter house—

Table-1: Characterization of poultry slaughter house effluent

COMPONENT	CONCENTRATION
Total Solids (mg/l)	2000
Volatile Solids(mg/l)	1800
pH	6.7
Total Coliforms(MPN per ml of effluent)	2.40×10^{10}
Thermotolerant Coliforms(MPN /ml of effluent)	7.70×10^{9}
Ammoniacal N (mg/l)	164.5
Total P (mg/l)	18.1
K (mg/l)	83.6
Chemical Oxygen Demand (mg o_2 /l)	2319.0

The data depicts that total solid generated from effluent was approximated as 2000mg/l while the volatile solid generated was 1800 mg/l. The treatment of waste determine the amount of chemical oxygen demand present as 2319. The schedule depicts that the raw material is a high energy feed [6].
The content of nutrient obtained from poultry litter is as follows:-

Table-2 : Nutrient Content Of Poultry Litter

Composition	Average (%)	Range (%)
Dry matter	78.3	69-84
Composition of dry matter		
TDN(calculated)	55	26-84
Crude protein	23.9	31
Crude fiber	26.9	14-46
NPN(protein equivalent)	5.7	10-11
Calcium	21.5	10-47
Potassium	2.1	1.0-3.5
Phosphorous	1.6	1.1-3.9
Magnesium	1.7	1.3-2.1
Sulphur	0.44	0.3-2.1
Copper	0.21	0.01-0.41
Arsenic	0.036	0.0011-0.0060

The protein content was estimated as 23.9,there can be appreciable range in protein content .The above table also illustrate that about one fourth of crude protein is in the form of Non Protein Nitrogen(NPN). The Total Digestible Nutrient (TDN) of waste poultry presented, suggest that relatively small energy feed in comparison to some other feed [7-9].The high Ash content (21.5) shows the amount of filth in the litter. The biggest disadvantage is that high ash content dilutes nutrient content. Poultry litter ensuing can be enhanced by mixing ground grain or fodder to it at the time of ensilage. Fermentation can also be improved by adding 10-25% grains to residue at the time of ensiling which ultimately increases energy value of feed [5-6].

2.3 Treatment of waste

The prior treatment of substrate differs at different plants, depending upon redidue to be digested, as well as the final use of biogas and digestate produced. More than one treatment phase can be involved

2.3.1 Removal of grit and Non-Renewable content

Intermingling of the manure with re circulating sludge before the heat exchanger allow the manure to be heated before introducing it into digester.
Grinding the input substrate reduces the particle size thus increasing the digestibility of waste that is hard to break down.
Adding of materials with a small content of dry solid by for example, centrifuging.
Blending of the waste water permits homogenous fluid and consistent temperature and avoids scum and grit accumulation.

2.3.2 Sanitation

In case of material obtained from animals ,such as waste from cow slaughter house and poultry litter ,food waste and manure ,prior to digestion stage sanitation stage occur ,which usually involves heating the material up to 70^0c for one hour or sterilisation [6]. This treatment assures the removal of pathogens and also loosens the

bond structure resulting in more deterioration and thus biogas produced.

2.3.3 Start –up inoculum

When the biogas reactor is started up, microorganism from the residue need time to adjust to the substrate that the biogas plant is going to treat[4-5]. In a biogas plant, the environment will differ from the original environment and it is necessary for the organism to adjust to enable a consistent and stable process. During the adjustment period, the organism in the inoculant that is suitable to survive in the new environment will enhance and become established.

Microorganisms that are added via the new slurry may also exhibit a certain role in the process. The larger the environment from which the inoculant is taken differs from the environment in the digestion tank the start -up period will be longer[11]. To achieve a fast and steady start-up of the process the microbial community should be established already from the beginning based on adaptation to a similar substrate.

2.4 Methane production potential

Slaughterhouse waste and poultry litter seems to be beneficial for multiple use including biogas production, fertilizer for agriculture and utilization as animal feed. The convenient way of waste management that will lead to generation of energy –rich biogas ,degradation of greenhouse gases emission and pollution control is Anaerobic Decomposition of these waste .this method also help in eradicating large amount of COD and BOD from slaughter house waste effluent .The methane potential of slaughter house is more than any other manure and waste i.e. in the range of 120-160 m3 biogas per tonne of waste ,but the limitation lies upon the fact that carbon to nitrogen (C:N) ratio of slaughter house waste is quite low (4:1) which can be increased by adding substrate like food manure ,poultry litter ,crop residue etc[1-4].

The concentration of protein rich substrate in the slurry may lead to formation of sulphide during Anaerobic Decomposition , which ultimately leads to formation of sulphide during A.D ,which ultimately leads to rich concentration of sulphides in the digester resulting in more methanogens .In addition to that concentration of ammonia also increases which results in increase in PH of digester.

The instant and noticeable benefit from the production of methane is the energy value of biogas itself. Efficiency of the biogas production is determined by various factors.

Table-3 : Potential gas Production of Swine ,Dairy,Poultry and beef Manure (68 degree Fahrenheit atmospheric pressure

PARAMETRES	SWINE (150 Pounds)	DAIRY (1200 Pounds)	POULTRY(4 Pound birds)	BEEF(1000 Pounds)
Gas yield, cubic feet per pound volatile solid destroyed.	12	7.7	8.6	15
Volatile solids voided pounds per day.	0.7	9.5	.044	5
% reduction of volatile solid.	49	31	56	41
Potential gas production cubic feet per animal per day.	4.1	22.7	0.21	31
Energy production rate.	103	568	5.25	775
Available energy Btu per hours per animal.	70	380	3.5	520

The amount of biogas generated per pound of Volatile Solid crushed or degraded by bacteria is known as “GAS YIELD”. During Anaerobic Decomposition only small amount of volatile solid are destroyed. The mixture of gas contain CO2,Methane and a trace of hydrogen sulphide and hydrogen gas ,but approximately 60% of overall composition contains of methane. About one –third of energy is required to maintain a certain a temperature of digestor and only two –third are available for us [1-2].

3. CONCLUSION

Slaughterhouse waste was very suitable as compared to poultry litter. The waste produced contain a high methane potential when treated anaerobically .The waste water that is produced from the slaughter house and poultry litter has a high potential of generating 2.472 m3/m3 of biogas .It was also found out that if slaughter house waste is fed with poultry litter that would be a best way as more amount of methane is produced and that too maintain C: N ratio.

4. REFRENCES

[1] Garba, B. Zuru, A and Sambo, A.S (1996). Effect of slurry concentration on biogas production from cattle dung. Nigeria journal of Renewable Energy .4(2) : 38-43.

[2] Itodo, L N; Lucas EB; Kucha E1(1992). The Effect of Media Material and its Quality on Biogas Yield. Nigerian Journal of Renewable Energy 3, Nos. 1 and 2 pp. 45-49.

[3] Godliving, Y; Mtui, S (2007).Trends in Industrial and Environmental Biotechnology Research in Tanzania, African Journal of Biotechnology Vol. 6 No. 25 pp 2860-2867.

[4] Jain, MK; Sigh, R; Taure, P(1981).Anaerobic Digestion of Cattle Waste, Agricultural Waste 3, pp. 65-73.

[5] Ganiyu, O . (2005). Isolation and characterization of amylase from fermented cassava waste water. African journal of Biotechnology 4 (10): 117-1123.

[6] Turkenburg WC, Beurskens J, Faaij A, Fraenkel P, Fridleifsson I, Lysen E, et al. Renewable energy technologies. World Energy Assess. Energy Chall Sustain 2000:221.

[7] McKendry P. Energy production from biomass (part 2): Conversion technologies. Bioresour Technol, 83; 2002. p. 47–54. http://dx.doi.org/10.1016/ S0960-8524(01)00119-5.

[8] Demirbas A. Biofuels sources, biofuel policy, biofuel economy and global biofuel projections. Energy Convers Manag 2008;49:2106–16. http://dx.doi. org/10.1016/j.enconman.2008.02.020.

[9] Deublein D, Steinhauser A. Biogas from waste and renewable resources: An Introduction. Germany: Wiley-VCH; 2008.

[10] Kranert M, Kusch S, Huang J, Fischer K. Anaerobic Digestion of Waste. In: Karagiannidis A, editor. Waste to Energy Oppor. Challenges Dev Transient Econ. London: Springer-Verlag; 2012. p. 107–36.

[11] Appels L, Baeyens J, Degrève J, Dewil R. Principles and potential of the anaerobic digestion of waste-activated sludge. Prog Energy Combust Sci 2008;34:755–81. http://dx.doi.org/10.1016/j.pecs.2008.06.002.