# REVIEW ON BIOGAS PRODUCTION FROM CO-DIGESTION OF COW DUNG AND FOODWASTE WITH WATER HYACINTH

***K.K. Dinesh Kumar, **S.Rajakumar,**

**Dept.of mechanical engineering,Regional office Anna University Tirunelveli, Tamilnadu,India*
***Assistant professor, Dept.of mechanical engineering, Regional office Anna University Tirunelveli, Tamilnadu,India*



## ABSTRACT

*With Increasing Energy Demand in the World and to keep Environment Friendly, biogas technology has attained a notable position for the future scope. This paper tells about a comprehension review on anaerobic digestion of cow dung and food waste with Water hyacinths to enhance biogas productions. Water hyacinths are treated as waste in rivers, ponds, but they have high potential in biogas production. Food wastes are having rich organic nutritive value and high calorific value. By anaerobic digestion water hyacinths are mixed with cow dung which acts as the inoculums for the digester. Kitchen waste is added as the daily feed substrate to the digester. The digested slurry from the digester is rich in nitrogen, phosphorus, and potassium content, so they can be used as fertilizers and the biogas obtained is used for alternate for LPG.*

***Keywords:*** *Anaerobic Digestion (AD), kitchen waste (KW), water hyacinths (WH), Hydraulic retention time (HRT).*

## 1. INTRODUCTION

Water hyacinths (Eichhornia crassipes) are aquatic plants freely floating on the rivers, lakes, ponds. They grow rapidly and cause major problems in water bodies [1] they are rich in biogas potentials. By using single substrate there is imbalance in nutrients so by mixing with other substrate we can improve biogas production [2]. Cow dung is rich in Methanogens and easily available. Generally water hyacinths are mixed with cow dung due to low C/N ratio [3]. Kitchen waste is easily degradable and high moisture content by using this feed we can minimize the size of digester [4]. Biogas consists of methane (CH4) and carbon dioxide (CO2) and some traces of Hydrogen Sulphide (H2S) and moisture. The obtained biogas is used for cooking applications.

## 2. DECOMPOSITION

Decomposition is the complex and continuous process, thus organic form is converted in to mineral form by biological reduction of microorganisms like bacteria, fungi, and protozoa. During decomposition they release carbon dioxide ($CO_2$), energy, water, nutrients [5]. There are classified into two types they are aerobic and anaerobic decomposition. In aerobic decomposition reaction take place in presence of oxygen but having disadvantage of some microorganisms cannot be decomposed effectively. So we prefer anaerobic decomposition.

**Anaerobic Decomposition**

Anaerobic Decomposition is the breakdown of complex organic molecules into useful form of energy by microorganisms in absence of oxygen. Biogas is colorless, odorless gas that like LPG which burns blue flame [6, 7]. The anaerobic process is depends on various environmental factors like pH, temperature, C/N ratio, loading rate, retention time.

## 3. VARIOUS STAGES OF ANEROBIC DIGESTION

There are four stages of Anaerobic Digestion they are Hydrolysis, Acidogenesis, Acetogenesis, Methanogenesis.

**Hydrolysis /liquefaction Phase**

In the first phase, insoluble substrates are converted into soluble organic compounds by adding water (hydrolytic). The water contains some hydrolytic microorganisms like micrococci, bacteroids, and streptococcus. These microorganisms secrete various enzymes like cellulose, lipase, protease, amylase, xylanse, which act as the catalyst for the reaction [8].the end products obtained from the hydrolysis reaction are amino acids, glycerol, long chain fatty acids, and soluble sugars.

$$n(C_6H_{10}O_5) + nH_20 \rightarrow n(C_6H_{12}O_6)$$

**Acidogenesis Phase**

In the second phase, the end products from the hydrolysis phase such as like Amino acids, long chain fatty acids, and soluble sugars are used as the feed for fermentative bacteria like streptococci, bacillus, Escherichia coli and the end product are organic acids like acetic acid, Propanoic acid, carbon dioxide ($CO_2$), short chain fatty acids (VFA), hydrogen sulphide ($H_2S$) and Ammonia ($NH_4$) [10, 11]. Both hydrolytic and Acidogenetic microorganisms are grow rapidly than Methanogens [12].

$$n\,(C_6H_{12}O_6) \rightarrow n\,(CH_3COOH)$$

**Acetogenesis Phase**

Acetogenesis bacteria are slow growing, sensitive to organic loadings, requires long lag periods and having pH is about 6 [13]. In these phase bacteria like syntrophomonas wolfeii are convert acetic acid into acetate, carbon dioxide (CO2). The purpose of this phase is because of low pH the concentrations of hydrogen will increases and will lead to accumulation of volatile acids, which cannot be degrade by Methanogens [14].

**Methanogenesis Phase**

In the last phase the end products from above phase of hydrogen (H2), carbon dioxide (CO2), acetate and other intermediate products from hydrolysis and acidogenesis phase are used as the substrate for methanogenic bacteria and form methane (CH4) and carbon dioxide (CO2) and some traces of hydrogen sulphide (H2S) and moisture as the end products [15].

$$3n\ (CH3COOH) \rightarrow n\ CH4 + CO2$$

## 4. VARIOUS FACTORS AFFECTING ANEROBIC DIGESTION

**Temperature**

There are two types of operating temperature that affecting AD process they are Thermophilic (55-70˚C) and Mesophilic (35-40˚C). In Thermophilic condition the biogas obtained are more toxicity and low stability growth, but they have an advantages of higher loading rate and high methane production. In Mesophilic condition have high bacteria content and posses high stability but have a disadvantage of low methane ($CH_4$) yield [16].

**pH**

The pH should be maintained 7 (neutral) for the growth of microorganisms. During the starting phase the pH value is lower by increase in hydrogen concentrations. The optimum pH required for biogas production is 6.5-7.5 [17], the values of the pH will depend up on the input substrate that given as feed to digester. By controlling the pH level, ammonia (NH4) concentrations can also be reduced.

**C/N ratio**

The optimum range of C/N ratio for biogas production is from 20-30:1. Carbon provides sufficient energy for microorganisms and nitrogen helps in building the structure of the cell. If C/N ratio is higher, then nitrogen will deplete earlier than carbon and if C/N ratio is lower than nitrogen concentration is more and this nitrogen content will degrade the biogas production, by formation of , ammonia (NH4) [18 ,19].

**Loading Rate**

Organic loading rate is the amount of organic waste materials feed into digester daily for anaerobic microorganisms. Rate of methane production decreases with increasing organic loading rate [20], only underfeeding should be maintained, because when excess loading rate is feed to digester some undecomposed materials are settled down which affect the decomposing rate of microorganisms [21].

**Retention Time**

Retention time is the average time required for the digested material inside the digester. They are two types they are solid retention time (SRT) and hydraulic retention time (HRT). Both SRT and HRT are differing from process to process but in most cases they are equal. For Mesophilic digestion microorganisms required about 10-30days of retention time based on the volume of digester [22]. The methane production rate decreases with decrease of HRT [20].

HRT= VD/VF

VD – Total volume of digester ($m^3$).

VF - Volume of daily feed into digester ($m^3$).

## 5. CONCLUSION

Biogas is an old methodology and developing technology in recent energy trends. This paper reviewed that mixture of cow dung and water hyacinths are initially feed to the digester as starter by this mixture this will improve the biogas yield. Kitchen waste is have high calorific value and high organic content is used as daily feed this will give good biogas yield and we can save the LPG gas consumption of the household applications and provide the subsequent manure for gardening applications.

## ACKNOWLWDGMENT

This work was gratefully supported by our second author providing necessary guidelines to present this review paper. We thank Mr. Ramakrishna, project Co-Ordinator, Vivekananda Kendra, Kanyakumari to understand the basic science of Biogas Technology.

## REFERENCES

1. Anushree Malik. Environmental challenge vis a vis opportunity: the case of water hyacinths, 33,122-138, 2007.
2. Water hyacinths as a resource in agriculture and energy production: A literature review, 27,117-129, 2007.

3. El-shinnawani MM, Biogas production from crop residues and aquatic weeds resources, Conservation and Resources, 3, 33-45, 1989.
4. Leal M.C.M.R., Freire D.M.G., Cammarota M.C., and Sant'Anna G.L. Effect of enzymatic hydrolysis on anaerobic treatment of dairy wastewater, Process Biochem, 41, 1173–1178, 2006.
5. Juma NG. The pedosphere and its dyanamics: a system approach to soil science,Canada,1998;315
6. Durgba PN, Zhang R.Treatment of dairy wastewater with twostage anerobic sequencing batch reacter systems-thermophilic vs mesophilic , bioresour technol 1998;68:225-33.
7. Veeken AHM, Hamelers BVM. Effect of substrate –seed mixing and leachate recirculation on solid state digestion of biowaste. Water sci technol, 41,255-62, 2000.
8. Cirne DG, Lehtomaki A, Bjornsson L, Blackall LL. Hydrolysis and microbial community analyses in two-stage anaerobic digestion of energy crops. J Appl Microbiol 2007; 103:516–27.
9. Ralph M., and Dong G.J., Environmental Microbiology Second. A John Wiley & Sons, inc., Publication, 2010.
10. Kalyuzhnyi S, Veeken A, Hamelers B. Two-particle model of anaerobic solidstate fermentation. Water Sci Technol 2000; 41:43–50.
11. Gujer W, Zehnder AJB. Conversion processes in anaerobic digestion. Water Sci Technol 1983; 15:127–67.
12. Mosey FE, Fernandes XA. Patterns of hydrogen in biogas from the anaerobic digestion of milk sugars. Water Sci Technol 1989; 21:187–96.
13. Xing J, Criddle C, Hickey R. Effects of a long-term periodic substrate perturbation on an anaerobic community. Water Res 1997;31:2195–204.
14. Bjornsson L, Murto M, Mattiasson B. Evaluation of parameters for monitoring an anaerobic co-digestion process. Appl Microbiol Biotechnol 2000;54:844–9.
15. Schnürer A., and Jarvis Å., Microbial Handbook for Biogas Plants, Swedish Waste Management 03, 2010.
16. Bowen EJ, Dolfing J, Davenport RJ, Read FL, Curtis TP. Low-temperature limitation of bioreactor sludge in anaerobic treatment of domestic wastewater. Water Sci Technol 2014; 69:1004–13.
17. Liu C., Prediction of methane yield at optimum pH for anaerobic digestion of organic fraction of municipal solid waste, Bioresource Technology, 99, 882-888. 2007.
18. Bardiya N., and Gaur A. C., Effects of carbon and nitrogen ratio on rice straw biomethanation, J.Rural Energy, 4, 1–4, 1997. 22.
19. Malik R. K., Singh R., andTauro P., Biol.Waste, 21, 139, 1987.
20. E.Maranon, L.Castrillon, G.Quiroga, Y.Fernandez-nava, Co-digestion of cattle manure with food waste and sludge to increase biogas production, 32, 1821-1825, 2012.

21. Schnürer A., and Jarvis Å., Microbial Handbook for Biogas Plants, Swedish Waste Management 03, 2010.
22. Muzenda E., Bio-methane Generation from Organic Waste: A Review Proceedings of the World Congress on Engineering and Computer Science, 2, 1-6, 2014.
23. Kumar S. Studies on efficiencies of biogas production in anerobic digester using water hyacinths and night soil alone as well as in combination. Asian J chem,17,934-938,2005.
24. Patel V, Desai M, Madamwar D, Thermochemical pretreatment of water hyacinths for improved biomethanation, Applied biochemistry and biotechnology,42,45-50,1993.