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

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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 into mineral form by biological reduction of microorganisms like bacteria, fungi, and protozoa. During decomposition they release carbon dioxide (CO2), 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 micrococi, 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.

\[ n(C_6H_{10}O_5) + nH_2O \rightarrow n(C_6H_{12}O_6) \]

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 (CO2), short chain fatty acids (VFA), hydrogen sulphide (H2S) and Ammonia (NH4) [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

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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].

\[
3n (\text{CH}_3\text{COOH}) \rightarrow n \text{CH}_4 + \text{CO}_2
\]

**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 (CH4) 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 10-30 days of retention time based on the volume of digester [22]. The methane production rate decreases with decrease of HRT [20].

\[ \text{HRT} = \frac{V_D}{V_F} \]

\[ V_D \text{ – Total volume of digester (m}^3\text{).} \]

\[ V_F \text{ - Volume of daily feed into digester (m}^3\text{).} \]

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.

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