A Review on Bio-Gas Generation from Anaerobic Digestion of Paper Sludge and Factors Affecting the Bio-Gas Generation

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Abstract- *Biogas has become a promising energy substitute to fossil fuels. Lignocellulosics, being cheap and renewable resource, could be very well used as a feedstock for biogas generation. Biogas originates from bacteria in the process of biological breakdown of organic material under anaerobic conditions. Anaerobic digestion is a microbial process for production of biogas, which consists of primarily methane (CH4) & carbon dioxide (CO2). The present review paper focuses on bio-gas generation from anaerobic digestion of paper sludge and various factors affecting the bio-gas generation.*

Keywords- Biogas, paper waste, cow dung and anaerobic digestion.

I. INTRODUCTION

Scarcity of petroleum and coal threatens the supply of fuel throughout the world also problem of their combustion leads to research in different corners to get access the new sources of energy, like renewable energy resources. Solar energy, wind energy, thermal and hydro sources of energy, biogas are all renewable energy resources. But, biogas is distinct from other renewable energies because of its characteristics of using, controlling and collecting organic wastes and at the same time producing fertilizer and water for use in agricultural irrigation. Deforestation is very big problems in developing countries like India, most of the part depends on charcoal and fuel wood for fuel supply which requires cutting of forest. We need an eco-friendly substitute for energy [1].

Biogas can be produced from nearly all kind of biological feedstock types, within these from the primary agricultural sectors and from various organic waste streams from the overall society [2]. The largest resource is represented by animal manure and slurries from cattle and pig production units as well as from poultry, fish etc. In India million tonnes of animal manure are produced every year. If handled properly, manure can be valuable resource for renewable energy production and a source of nutrients for agriculture [4].

There has been an increased interest in the development of technologies for exploiting lignocellulosic biomass for energy/power generation. Besides other forms of energy obtained from renewable sources, biogas has been looked upon as a totally controlled and promising source that can be produced from agricultural and animal wastes [3].

II. ANAEROBIC DIGESTION

Anaerobic digestion is a complex biological process in which microorganisms break down biodegradable organic matter i.e. cattle manure, kitchen waste, sewage sludge, poultry dropping, agriculture residues and other organic garbage in the absence of oxygen and thus produced biogas[5].Anaerobic digestion involves biochemical decomposition of complex organic material by various biochemical processes with release of energy rich biogas and production of nutrious effluents[6].The three important biological process (microbiology) are:

Hydrolysis

In the first step the organic matter is enzymolysed externally by extracellular enzymes, cellulose, amylase, protease & lipase, of microorganisms. Bacteria decompose long chains of complex carbohydrates, proteins, & lipids into small chains. For example, Polysaccharides are converted into monosaccharide. Proteins are split into peptides and amino acids [6].

Acidification

Acid-producing bacteria involved in this step, convert the intermediates of fermenting bacteria into acetic acid, hydrogen and carbon dioxide. These bacteria are anaerobic and can grow under acidic conditions. To produce acetic acid, they need oxygen and carbon. For this, they use dissolved O_2 or bounded-oxygen. Hereby, the acid-producing bacterium creates anaerobic condition which is essential for the methane producing microorganisms. Also, they reduce the compounds with low molecular weights into alcohols, organic acids, amino acids, carbon dioxide, hydrogen sulphide and traces of methane. [6].

Methanogenesis

Methane-producing bacteria, which were involved in the third step, decompose compounds having low molecular weight. They utilize hydrogen, carbon dioxide and acetic acid to form methane and carbon dioxide. Under natural conditions, CH_4 producing microorganisms occur to the extent that anaerobic conditions are provided. They are basically anaerobic and very sensitive to environmental changes, if any occurs [6].

III. BIOGAS GENERATION

Nwankwo et al., [7] reviewed on production of biogas from paper waste blended with cow dung. Two digesters were used, one charged with paper waste alone and the other with cow dung and paper waste. Cumulative biogas yield for paper alone was while4.78m3 /kg that of paper blended with cow dung was 7.33m3 /kg. Suvi Bayr et al., [8] reviewed on Thermophilic anaerobic digestion of pulp and paper mill primary sludge and co-digestion of primary and secondary sludge. Anaerobic digestion of pulp and paper mill primary sludge and co-digestion of primary and secondary sludge were studied for the first time in semi-continuously fed continuously stirred tank reactors (CSTR) in thermophilic conditions. Anaerobic digestion of primary sludge was shown to be feasible with organic loading rates (OLR) of 1-1.4 kg VS/m3d and hydraulic retention times (HRT) of 16-32 d resulting in methane yields of 190-240 m3CH4/t VS fed. Co-digestion of primary and secondary sludge with an OLR of 1 kg VS/m3d and HRTs of 25-31 d resulted in methane yields of 150-170 m3CH_4/t VS fed. Yunqin Lin et al., [9] reviewed on mesophilic batch anaerobic co-digestion of pulp and paper sludge and monosodium glutamate waste liquor for methane production in a bench-scale digester.A bench-scale anaerobic digester, 10 L in volume was developed. Peak value of methane daily production was 0.5 m3/ (m3d). Kemppainen et al., [10] reviewed on ethanol and biogas production from waste fibre and fibre sludge-the fibreetoh concept. The two feedstocks, waste fibre fractionated from solid recovered fuel, and pulp and paper mill fibre sludge, provide all-year-round supply of biomass. Average biogas production rate was 655 m3/ kg of VS added.

IV. VARIOUS FACTORS AFFECTING ANAEROBIC 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 possess high stability but have a disadvantage of low methane (CH4) yield [11].

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 [12].

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 [13].

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 [14].

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. The methane production rate decreases with decrease of HRT [14].

V. CONCLUSION

Anaerobic digestion uses the energetic potential of the substrate for biogas production. The effluent from pulp and paper mills can contain a high amount of organic compounds depending on the production process. This review paper has shown that paper wastes which abound everywhere could be a very good stock for biogas production. This waste can be utilized to generate energy instead of burning them in the environment which constitute nuisance to the environment. The study also shows that blending paper waste with cow dung or any other animal waste will give steady gas flammability throughout the digestion period of the waste since animal wastes are good producing wastes.

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