Biogas Production from Water Hyacinth in Co-Digestion with Sugarcane Bagasse & Cow Dung Slurry

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Abstract

The over-dependence on fossil fuels as primary energy source has led to various problems such as greenhouse effect, human health problems and degradation of environment (climate change). Due to recent rise in oil and natural gas prices, renewable sources of energy are gaining more importance and leading the way is methane gas obtained from biomass waste fermentation. This study investigates the possibility of producing biogas from water hyacinth in co-digestion with sugarcane bagasse and cow dung – replacing firewood as a source of fuel. In this work, different proportion of water hyacinth and sugarcane bagasse are used keeping the amount of cow dung constant for anaerobic digestion and analysed for biogas yield after 15th, 20th and 25th day of inoculation.
Keywords: Renewable Energy, Biogas, Water Hyacinth, Sugarcane Bagasse, Cow Dung, Co-Digestion

I. INTRODUCTION

Current energy source for the world are fossil fuels. As population is increasing day by day, utilization rate of those fossil fuels are also increasing and an end point may exists as those fossil fuels are nonrenewable. Hence there is need of new alternative energy source which will be more economically competitive with fossil fuels. For example, the world has gone through the wood age, the coal era, and will likely be done with the petroleum and natural age. Yet we still have wood and coal around but they are not economically competitive with oil and natural gas.

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Biogas technology is proved to be the best alternative energy source and waste treatment and management way, as disposal of wastes has become a major problem especially in the large cities of many developing countries. The effluent of this process is a residue rich in essential inorganic elements needed for healthy plant growth known as bio-fertilizer which when applied to the soil enriches it with no detrimental effects on the environment. (Fadairo et al., 2014)

In greenhouse gases reduction, renewable energy plays an important role as it is a ‘‘carbon neutral”. Anaerobic digestion (AD) is an environmental friendly biological process in which microorganisms work synergistically to convert organic wastes into biogas and a stable product (soil conditioner) for agricultural practices without any detrimental effects on the environment. (Patil et al., 2012)

II. MATERIALS & METHODS

A. Materials

Water hyacinth (Eichhornia crassipes) is a noxious weed that has attracted worldwide attention due to its fast spread and congested growth, which lead to serious problems in navigation, irrigation, and power generation. Water hyacinth (WH) is one of the important aquatic species, commonly covers the surface of rivers and lakes and causes a series of environmental problems due to its rapid growth. It is also considered as a noxious weed as it grows very fast and depletes nutrients and oxygen rapidly from water bodies, adversely affecting flora and fauna. On the other hand, when looked from a resource angle, it appears to be a valuable resource with several unique properties. (Fadairo et al., 2014)

Fig. 1: Different Parts of Water Hyacinth (Eichhornia Crassipes). a) Leaves b) Baby Plant c) Rhizome d) Flower [4].

Bagasse is the fibrous matter that remains after sugarcane are crushed to extract their juice and is a byproduct generated in the process of manufacture of sugar. For each 10 tonnes of sugarcane crushed, a sugar factory produces nearly 3 tonnes of wet bagasse. Currently, the bagasse production in the India is about 8.6 million tons per year. (William et al., 2016)

Fig. 2: Sugarcane Bagasse [3]

Cow dung which was considered as a waste or product with little or no value in the past, is now gaining value with the recent research which shows that cow dung can produce methane gas in large quantity. Traditionally cow dung has been used as a fertilizer, though today dung is collected and used to produce biogas. This gas is rich in methane and is used in rural areas to provide a renewable and stable source of energy.

Fig. 3: Cow Dung [7]

B. Methodology

Water hyacinth plants are collected from Pashan Lake which is located at 12 km away from Pune city in Pashan village, Sugarcane bagasse is collected from Sakharwadi Sugar Industry at Sakharwadi village in Phaltan Taluka, Pune district and cow dung is collected from dairy at Sukhsagar nagar, Pune.

Collected water hyacinth is cleaned and washed with clear water and chopped into small pieces of 2-4 cm size. Smaller sized water hyacinth is then crushed into the mixer (grinder) to prepare its slurry with addition of water. After preparation of water hyacinth slurry it is added into the digester along with the sugarcane bagasse and cow dung in decided proportions. Initial testing is carried out for samples of various ratios. The tests performed are:

1) pH
2) Total Solids
3) Volatile Solids

Fig. 4: Anaerobic Digester with different Ratio of Water Hyacinth, Sugarcane Bagasse & Cow Dung

Fig. 5: Initial Testing of Samples

III. MEASUREMENT OF GAS

Amount of gas generated from the digester after digestion of inoculam is measured in terms of volatile solids. Measurement of gas generated is done after particular interval and recorded. Initial gas generation rate is measured on 25th day of inoculation. Afterwards at interval of 5 days i.e. on 30th and 35th day of inoculation gas generation rate is measured and recorded. The biogas yield is found out by expression given by Central Public Health and Environmental Engineering Organisation (CPHEEO):

- Total waste quantity: W (tonnes)
- Total Organic / Volatile Solids: VS = 50 %, say
- Organic bio-degradable fraction: approx. 66% of VS = 0.33*W
- Typical digestion efficiency = 60 %
- Typical bio-gas yield: B (m^3) = 0.80 m^3 / kg. of VS destroyed

IV. BIOGAS YIELD

Table – 1
Biogas Yield of Different Ratios of Water Hyacinth and Sugarcane Bagasse with Cow Dung Slurry

Day	*Biogas Yield, lit / kg*		
	Ratio A (3:1.5:0.5)	*Ratio B (1.5:3:0.5)*	*Ratio C (1.5:.5:0.5)*
15th	*374.4*	*422.4*	*393.6*
20th	*379.2*	*427.2*	*398.33*
25th	*384*	*432*	*403.2*

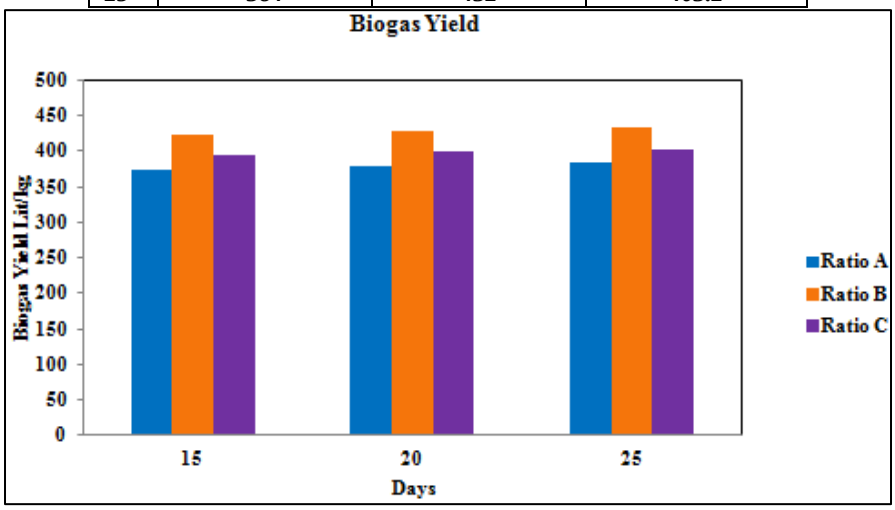

Fig. 6: Variation of Biogas Generation Rate

It is observed that as the time increases the gas generation rate also increases. The maximum amount of gas generated is 432 lit / kg of VS for ratio B (Ratio of 1.5:3:0.5) on 25th day and minimum is 374.4 lit / kg of VS for ratio A on 15th day.

V. CONCLUSION

Based on the study carried out with water hyacinth, sugarcane bagasse and cow dung following conclusions are obtained:

1) It is observed that water hyacinth; sugarcane bagasse and cow dung has the potential of biogas production and gives better efficiency when used in different ratios. Ratio B i.e. 1.5:3:0.5 gives the maximum yield of biogas as compared to other ratios.
2) It is also found that biogas production rate for combination of water hyacinth and sugarcane bagasse with cow dung gives better results for biogas yield as compared to water hyacinth used alone.

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