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# Analysis of Biomass Feedstock before and after the Anaerobic Digestion Process

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**Abstract – The production of biogas depends on several factors such as feedstock, pH value, temperature, organic loading rate, volatile fatty acid etc. In the present work a 25L capacity single stage anaerobic digester has been designed and fabricated with its accessories. Cauliflower waste of 1.3kg (dried in sunlight), 1.7kg of fresh cow dung, and 14L of water mixed properly have been used for anaerobic digestion at mesophilic condition at 37ºC. Complete analyses of biomass feedstock before and after the digestion process have been carried out. After 21 days of observation, it was found that the total solid of the feedstock has decreased from 8.08% to 6.72%. A decrease of percentage of volatile solid from 6.9% to 5.43% and the pH value of the digester becomes 4.73 from 7 have also been observed and discussed**.

**Index Terms – Biomass, Biomass feedstock. Anaerobic digester, Analysis of feedstock.**

## 1. INTRODUCTION

The petroleum price increases due to its rapid demand in industrial sector, corporate sector, and domestic sectors and due to its limited fossil fuel reserve. The emission after burning the fossils fuel is the major reason for global warming and various health related problem for humanity. It has been estimated that there will be a shortage of crude oil within 40 to 70 years [1]. To overcome this problem many researchers are working on renewable energy sources for getting reliable alternative energy option. There are available renewable energy resources like solar, wave, tidal, hydro, wind, biofuel, wind, biomass etc. But most of them have site specific issues and costlier compared to conventional resources. Biomass is one of the viable options which can be converted into gaseous fuel. Bomass is easily available from various sources like municipal solid waste, agriculture waste, industrial waste vegetable market waste etc. Biogas is produced from biomass by anaerobic digestion process through four steps hydrolysis, acidogenesis, acetogenesis, methanogenesis [2]. Raw biogas contain 50-70% methane, 30-50% carbon dioxide, the other gases like hydrogen sulphide, hydrogen, oxygen, nitrogen, carbon monoxide [3]. The composition of biogas production is dependent on several factors like temperature, pH value, loading rate etc. Mesophilic condition is the ideal condition for biogas production but the bacteria are more active in thermophilic condition and production of biogas is increased [4]. But there is a need of external heat source to maintain the high temperature. Hydrolysis and acidogenesis occurs efficiently at pH 5.5-6.5 and methanogenesis occurs efficiently at pH 6.5-8.5 [5]. The optimum range of pH is 6.8 to 7.2 [6]. The C/N ratio varies from 20-30 for optimum biogas production [7]. Pretreatment generally increases the production of biogas [8]. Mechanical pretreatment like cutting, grinding etc. are used to reduce the size of biomass. Thermal pretreatment less than $100^0$C increases the biological activity of some hydrolysis bacteria [9]. Chemical pretreatment is required for maintaining the pH of the reactor [10]. The biogas can be used as a cooking fuel, lighting, power generation and can be used as a vehicle fuel by improving the methane content 95% by purification [11].

## 2. EXPERIMENTAL SET-UP

A cylindrical batch type (stainless steel made) anaerobic digester of 25L capacity has been designed and fabricated based on the literature review for the experiment shown in figure 1.

Fig. 1: Photographic view of the anaerobic digester

The digester is surrounded by a water jacket of capacity 15L. A 1000W thermostatic heater has been used for heating the water within the water jacket. Water temperature is measured by a temperature indicator. A pressure gauge is attached at the top of the digester to measure the gas pressure inside the digester with a range of 0.1 kg/cm$^2$ to 0.5 kg/cm$^2$. The inlet and outlet feedstock valve are attached at the top and below the digester. A valve regulated nozzle is fitted at the top of the digester as a gas outlet. Water displacement method is used to collect gas produced.

## 3. PREPARATION OF FEEDSTOCKS

Vegetable waste, cow dung and water have been used for this experiment as biomass feedstock. Cauliflower waste was collected from local market and cow dung was collected from a cow owner. The collected vegetable waste was dried in the sunlight for 7 to 8 days after cutting it into small spices about 10 to 15 mm as shown in figure 2. After drying them in the sunlight the cauliflower waste has been grinded by a mixture grinder. Cauliflower waste (1.3kg), fresh cow dung (1.7kg) and water (14 L) were mixed properly. It has been observed that after absorbing the water the volume of the mixture is increased by 2L. Hence the volume occupied by the feedstock becomes 19L. 25% of the total volume that is 6L (25% of 25L) was left for gas production. The analyses of the mixture have been done and pH of the mixture has been checked before poured it into the digester.

Fig. 2: Dried and grinded cauliflower as feedstock

## 4. ANALYSIS OF FEEDSTOCK AND DISCUSSION

### 4.1 Proximate analysis before digestion

The proximate analysis of the feedstock was done at School of Energy Studies, Jadavpur University. A Petridis of 40gm was taken for the analysis. The sample of feedstock 73.45gm is poured into the Petridis. After heating the sample for overnight at 105$^0$C using an air oven and the weight of the sample measured as 5.94gm. The total solid of the sample was measured as 8.086%. After that the sample was taken to a crucible and put into the muffle furnace at 600$^0$C for 1hr. The weight of biomass becomes 1.0417gm and the volatile solid was measured as 6.9%. Centrifuge has been done at School of Environmental science under Chemical Engineering Department, Jadavpur University to measure the dissolved and suspended solid present in the biomass feedstock. The sample of the feedstock were taken into two 15ml containers and centrifuge were done at 2000 rpm upto the separation of solid and liquid shown as figure. 3. The liquid portion has been separated by a micropipette. The upper liquid portion is called dissolved solid and the lower portion is called suspended solid. The total dissolved solid were calculated as 1.31187% and total suspended solid were measured as 5.997% after heating separately at 105$^0$C for overnight.

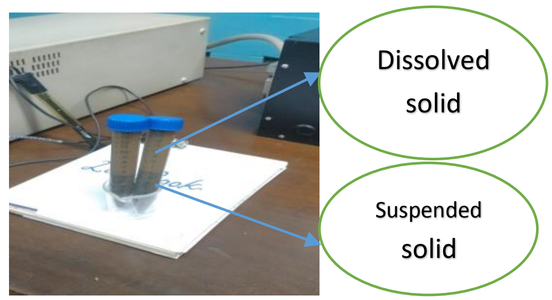


Fig. 3: Containers after centrifuge of the feedstock.

### 4.2 Proximate analysis after digestion

After 21 days of observation, a sample of 36.44gm was taken for the analysis. The total solid was measured at air oven by heating at 105$^0$C for overnight. The total solid was measured as 6.723% and volatile solid measured at muffle furnace at 600$^0$C temperature for 1hr. The volatile solid was measured as 5.43%. The ash content of the sample was measured as 1.15%. The same procedure has been followed for separating the suspended solid and dissolved solid by rotating at 2000 rpm for 10 minutes in a centrifuge, discussed at section 4.1. The total suspended solid was measured as 4.79% and total dissolved solid was measured as 1.164%. It was observed from the Table. 1, that the initial total solid is decreased from 8.086% to 6.723% after 21days. This total solid has been converted to gas and reduced its value. It was also observed that the percentage of total dissolved solid and suspended solid is decreased after the digestion process. There was decreased of percentage of volatile solid has been observed from 6.9% to 5.43%.

Table :1 Property of sample before and after digestion

| Property | Data before digestion | Data after digestion |
|---|---|---|
| Total solid(TS) | 8.086% | 6.723% |
| Volatile solid(VS) | 6.9% | 5.43% |

| | | |
|---|---|---|
| Ash content | 1.416% | 1.15% |
| Moisture | 91.9% | 93.277% |
| Total suspended solid | 5.99% | 4.79% |
| Total dissolve solid | 1.31% | 1.164% |

## 5. CONCLUSION

A lab-scale batch type reactor has been designed and fabricated with its accessories. Preparation of biomass feedstock from vegetable waste has been made to perform the experimental analysis. Detailed analysis of feedstock before and after the digestion has been carried out. Experiment study has been done using cauliflower waste at constant temperature of $37^0$C and pH value of 7. It has been obtained that the initial total solid decreased from 8.086% to 6.723% after 21days. The total solid is converted into gas and reduced its value. It was also observed that the percentage of total dissolved solid and suspended solid is also decreased after the digestion process. There was decreased of percentage of volatile solid from 6.9% to 5.43%. It was observed that the pH value of the digested materials after 21 days is 4.73. Which indicate the digester becomes acidic that leads to lower production of biogas in later days.

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