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### STUDIES IN PURIFICATION OF BIOGAS USING ALGAE IN SEWAGE WASTE WATER

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**Abstract:** Biogas is an alternative energy source produced from the anaerobic digestion of organic matter by bacteria. It is composed primarily of methane and CO<sub>2</sub> with trace amount of other gases such as H<sub>2</sub>S. The presence of CO<sub>2</sub> decreases energy yield in biogas; however it imparts a quenching effect making it non explosive. Past studies have used expensive and environmentally harmful chemicals to purify biogas. This study involves the concentration of biogas purification system by utilizing microalgae to metabolize and remove CO<sub>2</sub> from the system. We established a model of microalgae closed batch photo bioreactor with the goal of capturing CO<sub>2</sub> present in the biogas. The biogas purification process was applied in order to increase the calorific value. For this system the growth profile of microalgae cultivated with concentrations of CH<sub>4</sub> and CO<sub>2</sub> were analyzed as well as physical chemical and biological process. Biogas which constitutes 40% CO<sub>2</sub> and 70% of CH<sub>4</sub> this result demonstrates a high tolerance of microalgae cultures to upgrade biogas by increasing the efficiency of methane in the biogas. The calorific value of the biogas after purification with microalgae cultivation and thus approaching to more calorific value of pure methane. Here we use the Chlorophyta (green algae) for the cultivation of microalgae we use the sewage water collected from municipality by which waste water treatment is carried out along with the microalgae production. For the growing of microalgae minimum 15 day is required and the nutrient and minerals is consumed by the microalgae from waste water in the presence of sun light. Whole process is carried out in photo bioreactor. After the formation of algae use the membrane technology for the filtration in which microalgae is removing from water and pure water is obtain as a bottom product. Then microalgae are used for the further making of biodiesel by trans-esterification method and alcohol by fermentation process.

**Keywords:** Purification of Biogas, Waste Water



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## INTRODUCTION

Human activity in the modern world has disturbed the composition of the atmosphere green house gas emission this has led to some of the major environmental issues of our time ozone depletion, acid rain and global warming which is potentially the most serious. Green house gas emission reduced by the production of energy from renewable sources such as bio fuels and biogas. This study demonstrates the use of microalgae in biogas purification system.

Microalgae thrive on a high concentration of CO<sub>2</sub> a pollutant of biogas plants as a nutrient of microalgae. Microalgae production facilities can thus be fed biogas from activated tannery sludge can significantly increase the quality of methane by scrub out the CO<sub>2</sub>. Conceptually the algae cultivation near the biogas plant is fairly simple. The idea is to pipe the biogas from anaerobic reactor to the closed suspended batch algae cultivation system. The inlet and outlet gas is analysed by the gas analyser Orsat apparatus. The microalgae species selected for this study exhibited growth under high CO<sub>2</sub> concentration.

## MATERIALS AND METHODS

### Raw materials:

- Cow Dunk, vegetable waste, (3-4 kg) and equal amount of water

### Materials Required:

- Plastic Bottle Capacity 30 litter having Dom shape.
- Tape or epoxy resin (M-seal) for packing.
- Tubes for inlet of raw material and outlet of digested material.
- Plastic Tubes for the flow of raw biogas
- Tubular photo bioreactor.
- Tyre tubes for the storages of raw and purified gas.
- Knobs.

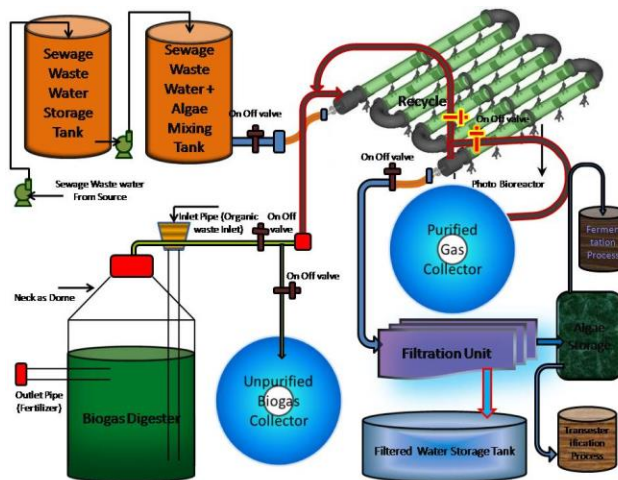


Figure: Experimental setup.

### Methods:

- Collect the raw material from village area (cow dung and apicultural waste), Kitchen waste from Kitchen bin etc.
- Keep the 30 liters of bottle then take equal amount of raw material and water in it.
- Keep the digester in sunlight.
- Then wait for the formation of biogas.
- As the Biogas formation will start initial Tyre tube gets swells and the pressure of that tube gets increases.
- Within 20 days biogas will form and store at storage tyre tube.
- Then the tubular photo bioreactor is half filled with the sewage waste water and pre cultured microalgae.
- Then the flow of biogas get start through the tubular photo bioreactor and the batch is semi batch reactor.
- The raw biogas is flow continuously into the bioreactor in the presence of sun light.
- Cautiously reading is taken by the taking of biogas sample in the bladder.

- That biogas filled bladder take place for the gas chromatography for calculating the composition of the biogas.

### Efficiency of absorption of Carbon Dioxide

The capacity for CO<sub>2</sub> fixation followed the method reported by Devigny and Deshuses (1999) and Jacob-Lopes *et al.*, (2009). Following the same pattern for the analysis of the purification capacity of biogas through cultivation of microalgae, the sample was collected in biogas input and output of microalgae cultures to determine the biogas composition before and after passing through the culture.

$$\text{Equation 2: Efficiency of CO}_2 \text{ capture } E_{capCO_2} (\%) = \frac{\text{Influent co}_2 - \text{effluent co}_2}{\text{Influent co}_2} \times 100$$

### Efficiency of enrichment of Methane Gas

The efficiency of biogas enrichment was calculated by equations. After the purification taking the reading of biogas sample by the gas chromatography by this we calculate the enrichment of methane gas in the final biogas sample by flowing equation.

$$\text{Equation 3: Efficiency of biogas enrichment, } E_{nrCH_4} (\%) = \frac{\text{Effluent CH}_4 - \text{Influent CH}_4}{100 - \text{Influent CH}_4} \times 100$$

### pH of the Waste water

The pH of the cultures was analyzed daily during the experimental period and the pH of the biogas and treated water is also calculated by the pH meter periodically.

### Amount of water is to be recycle

By the calculating the parameters i.e. COB and BOD and the nutrient present in the water and find out the waste water is suitable for use or not comparing with the standard values of parameters. From these we can conclude treated sewage waste water after the filtration is recycle to the digester or other uses.

### Gas Chromatography

The following Gas chromatographic conditions were established by trial and error and were kept constant throughout the experimentation.

### Conditions

Sample Temperature	90 °C
Equilibration Time	10 min
Needle Temperature	110 °C
Transfer Line Temperature	120 °C
Inject Time	0.06 min
Withdrawal Time	0.4 min
Pressurization Time	1.0 min
Sample Mode	Constant
Pressure	20 psi

### GC Conditions

#### Oven Temperature

Initial Temperature	40 °C
Initial Hold	4.5 min
Ramp	40 °C/min
Final Temperature	205 °C
Final Hold	1 min

#### Detector (FID)

Detector Temperature	240 °C
Air Flow	400 mL/min
Hydrogen Flow	40 mL/min
Range	1

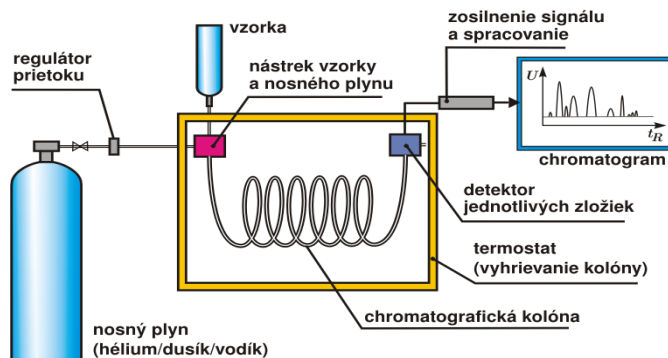
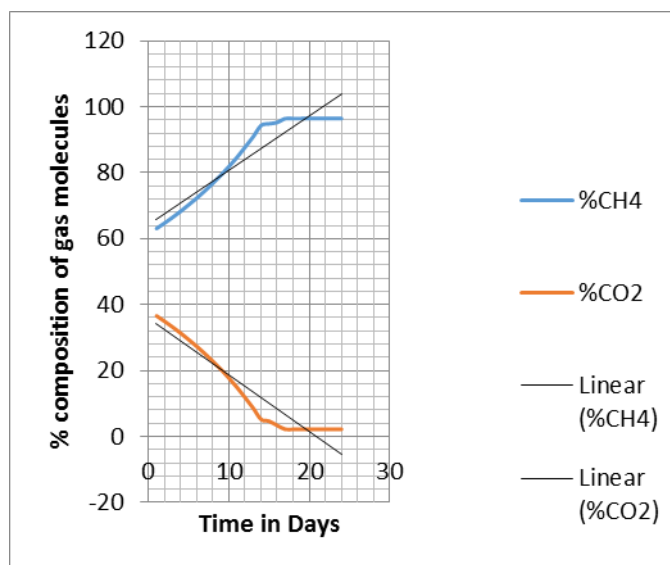


Figure: Diagram of a gas chromatograph.

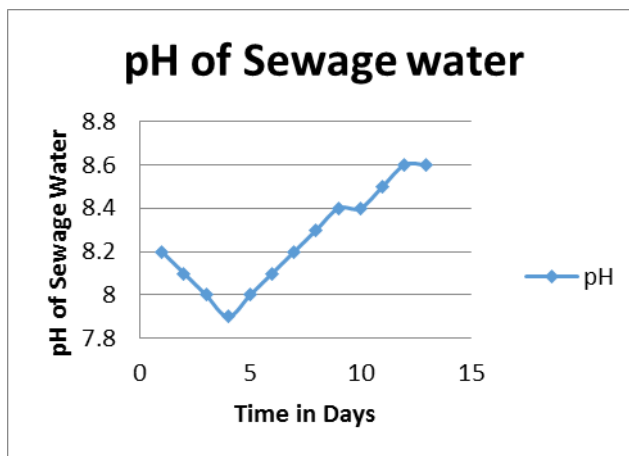
The following graph is time in days versus percentage of gas in which the percentage of enrichment of methane gas and depletion of carbon dioxide is plotted with respect to time. As the growing of microalgae is takes placed purification of biogas is going on. by using the gas chromatography technology I elaborate and calculate the composition of methane gas in outlet biogas composition in a particular time intervals and plot the following graph



Graph : Composition of Biogas after Purification

## pH of Microalgae in Sewage Treated Water

The pH of the culture is monitor daily by taking reading regularly. The pH of microalgae cultures in the photo bioreactor is maintained up to 8.2 initially by adding the sodium hydroxide (NaOH) as per the requirement. The pH remained stable for cultures when reach maximum biomass.



## CONCLUSIONS

### Purification of biogas

By taking the sample of the biogas continuously and obtain the chromatogram form which the composition of biogas is obtain initial composition of the biogas is 63.099% of methane gas 36.587% of carbon dioxide and the 0.313% of hydrogen sulphide. And after the purification the composition of biogas is 96.4227 % of methane gas 2.2022 % of carbon dioxide and 0.4788% of hydrogen sulphide.

When the biogas is used as a fuel the main point which has to be considering i.e. calorific value and by calculating first run before purification of biogas calorific value is 9207.319 k Cal/kg and after purification of biogas 14943.379 k Cal/kg. In second run before purification of biogas the calorific value is 9706.6269 k cal/kg and after the purification of biogas calorific value is became 23221.3674 k Cal/kg.

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