INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

SPECIAL ISSUE FOR
NATIONAL LEVEL CONFERENCE
"RENEWABLE ENERGY
RESOURCES & IT'S APPLICATION"

STUDIES IN PURIFICATION OF BIOGAS USING ALGAE IN SEWAGE WASTE WATER

PROF. S. V. KHEDKAR, PAYAL N. BHAUTIK

Department of Chemical Engineering, College of Engineering and Technology, Akola.

Accepted Date: 12/03/2016; Published Date: 02/04/2016

Abstract: Biogas is an alternative energy source produced from the anaerobic digestion of organic matter by bacteria. It is composed primarily of methane and CO2 with trace amount of other gases such as H2S.The presence of CO2 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 CO2 from the system. We established a model of microalgae closed batch photo bioreactor with the goal of capturing CO2 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 CH4 and CO2 were analyzed as well as physical chemical and biological process. Biogas which constitutes 40% CO2 and70% of CH4 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 micro-algae are used for the further making of biodiesel by trans-esterification method and alcohol by fermentation process.

Keywords: Purification of Biogas, Waste Water

Corresponding Author: PROF. S. V. KHEDKAR

Co Author: MS. PAYAL N. BHAUTIK

Access Online On:

www.ijpret.com

How to Cite This Article:

S. V. Khedkar, IJPRET, 2016; Volume 4 (8): 49-58

PAPER-QR CODE

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 CO2 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 CO2. 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 CO2 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.

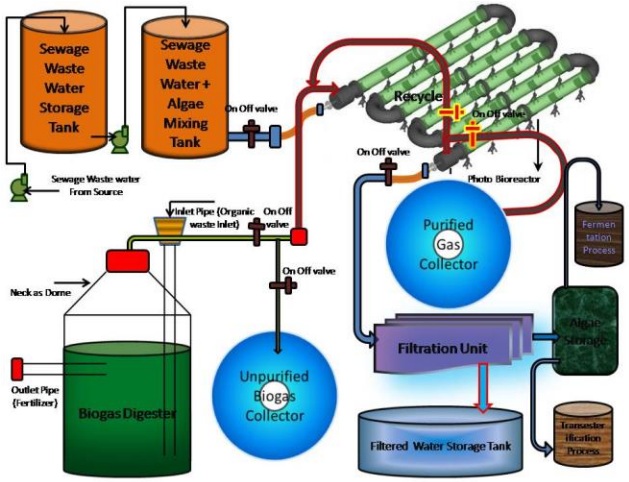


Figure: Experimental setup.

Methods:

- Collect the raw material from village area (cow dunk and apicultural waste), Kitchen waste from Kitchen bin etc.
- Keep the 30 litters 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 from 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 CO2 fixation followed the method reported by Devinny 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.

$$\text{Equation 2: Efficiency of CO2 capture } E_{capCO2}\,(\%) = \frac{\text{Influent co2} - \text{effluent co2}}{\text{Influent co2}} \times 100$$

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.

$$\text{Equation 3: Efficiency of biogas enrichment, } Enr_{CH4}\,(\%) = \frac{\text{Effluent CH4} - \text{Influent CH4}}{100 - \text{Influent CH4}} \times 100$$

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

Attenuation	-6 (or 1)

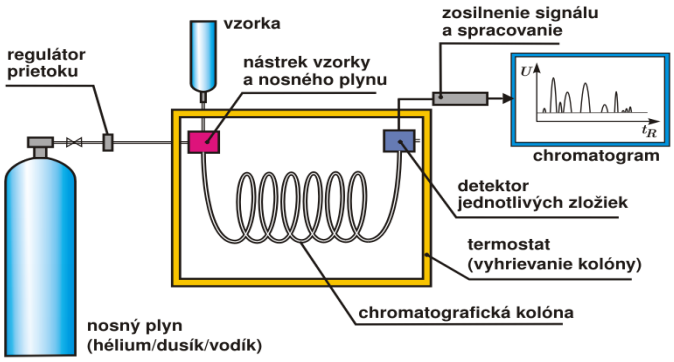
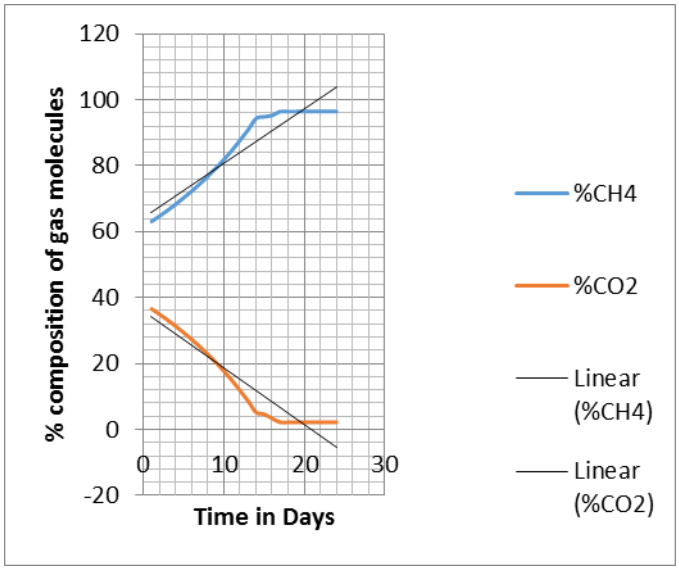


Figure: Diagram of a gas chromatograph.

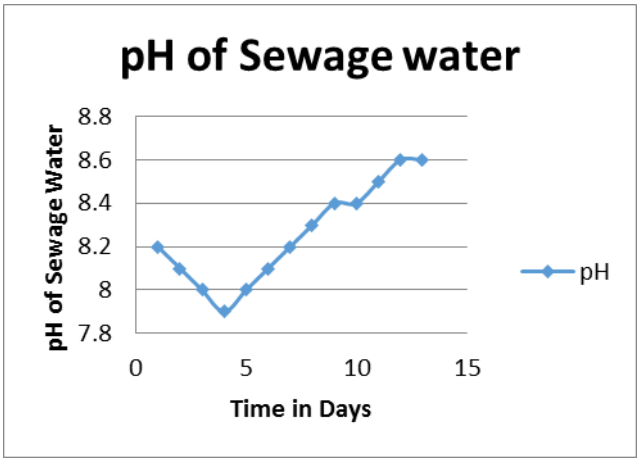
The following graph is time in days verses percentage of gas in which the percentage of enrichment of methane gas and depletion of carbon dioxide is plotted with respect to time. As the growing of microalgae is takes placed purification of biogas is going on. by using the gas chromatography technology 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.

REFERENCES

Books

1. Prof. Anil Vispute 2014-15, Laboratory Manual, Shree Industrial Training Centre, Practical Training of Analytical Instruments.

Journals

1. Abatzoglou, N. and Boivin, S., 2009, A review of biogas purification processes Bio fuels Bio Prod Bio Refining, 3, pp. 42–71.

2. Abdel-Raouf, N., Ibraheem, I.B.M., Hammouda, O., 2003. Eutrophication of River Nile as indicator of pollution. In: Al-Azhar Bull. of Sci., Proceeding of 5th Int. Sci. Conf. 25–27 March 2003, pp. 293–306.

3. Abel, P.D., 1989. Water pollution biology. Ellis Horwood Series in Wastewater Technology. Ellis Horwood Ltd., John Wiley & Sons, Chichester.

4. Brian H. Kiepper, Ph.D. Assistant Professor & Extension Specialist Department of Poultry Science. College of Agricultural & Environmental Sciences Adjunct Faculty Member, College of Engineering, University of Georgia, Bioremediation of Sewage Wastewater Using Selective, Algae for Manure Production

5. Baeza-Squiban, A., Bouaicha, N., Santa-Maria, A., Marano, F., 1990. Demonstration of the excretion by Dunaliella bioculata of esterases implicated in the metabolism of Deltamethrin, a pyrethroid insecticide. Bull Environ. Contam. 45, 39–45.

6. Barclay, W.R., Mc-Intosh, R.P., 1986. Algal Biomass echnologies. Beih. Nova Hedwigia, 83. Bastian, R.K., Reed, S.C., 1979. Aquaculture systems for wastewater treatment. Seminar Proc. And Engin. Assessment. U.S. EPA, Washington D.C., 20460 p. 485.

7. Benemann, J.R. 1989. The future of microalgal biotechnology. In: Cresswell, R.C., Rees, T. A.V., Shah, N. (Eds.), Algal and Cyanobacterial Biotechnology. Longman, England, pp. 317–337. Bhat, S.V., Melo, J.S., Chaugule, B.B., Souza, S.F.D., 2008.

8. Borowitzka, L.J., 1991. Algal biomass and its commercial utilization. In: Proceedings of a Seminar held at Murdoch Univ. Western Australia, 29th November, 53–60.

9. Bosman, J., Hendricks, F., 1980. The development of an algal pond system for the removal of nitrogen from an inorganic industrial; effluent. In: Proc. Int. Symp. On Aquaculture in Wastewater NIWP, CSIR, Pretoria, pp. 26–35.

10. Cai-XiaoHua, Traina, S.J., Logan, T.J., Gustafson, T., Sayre, R.T., Cai, X.H., 1995. Applications of eukaryotic algae for the removal of heavy metals from water. Mol. Mar. Biol. Biotechnol. 4 (4), 338–344.

11. Carpenter, M., Robertson, J., Skierkowski, P., 1989. Biodegradation of an oily bilge waste using algae. In: Biotreatment. The use of microorganisms in the treatment of hazardous materials and hazardous wastes. O., The Hazardous Materials Control Research Institute, pp. 141–150. 270 N. Abdel-Raouf et al.

12. Cerniglia, C.E., Gibson, D.T., Van Baalen, C., 1980. Oxidation of napthalene by Cyanobacteria and microalgae. J. Gen. Microbiol. 116, 495–500.

13. Chaiprasert, P., 2011. Biogas production from agricultural wastes in Thailand. J. Sustainable Energ. Environ. Spec. Issue, 63–65. Chakraborty, N., Banerjee, A., Pal, R., 2011. Accumulation of lead by free and immobilized cyanobacteria with special reference to accumulation factor and recovery. Bioresour. Technol. 102, 4191– 4195.

14. Chaumont, D., Thepenier, C., Gudin, C. and Junjias, C., 1988. Scaling up a tubular photoreactor for continuous culture of Porphyridium cruentum from laboratory to pilot plant (1981– 1987). In: Stadler, T., Mollion, J., Verdus, M.Cc., Karamanos, Y., Morvan, H., Cchristiaen, D. (Eds.), Algal Biotechnology, Elsevier Applied Science, London, pp. 199–208.

15. Dr. Hutcheson University of Maryland 1 December, 2011 Biogas Efficiency: Producing and Utilizing Renewable Energies

16. Devinny, JS.and Deshusses, M A., 2007,Biofiltration for air pollution control. Lewis Publishers.

17. Darley, W.M., 1982. Algal Biology; A physiological Approach. Basic Microbiology, vol. 9. Blackwell Scientific Publications, Oxford. Darnall, D.W., Greene, B., Henzl, M.T., Hosea, J.M., Mcpherson, R.A., Sneddon, J., Alexander, M.D., 1986. Selective recovery of gold and other metal ions from an algal biomass. Environ. Sci. Technol. 20, 206–208.

18. Dasilva, E.J., Dommer Gues, Y.R., Nyns, E.J., Ratledge, C., 1987. Microbial Technology in Developing World. Ofxord Science Publication, 261. Davis, E.A., Dedrick, J., French, C.S., Milner, H.W., Myers, J., Smith, J.H.C., Spoehr, H.A., 1953. Laboratory experiments on Chlorella culture at the Carnegie Institution of Washington.

19. Department of Plant Biology. In: Burlew, J.S. (Ed.), Algal Culture. From Laboratory to Pilot Plant. Ccarnegie Institution of Washington, Washington, D.C., pp. 105–153. De la Nou¨ e, J., Basseres, 1989. Biotreatment of anaerobically digested swine manure with microalgae. Biological Wastes 29, 17–31.

20. De la Nou¨ e, J., De Pauw, N., 1988. The potential of microalgal biotechnology. A review of production and uses of microalgae. Biotechnol. Adv. 6, 725–770. De la Nou¨ e, J., Proulx, D., 1988. Tertiary treatment of urban wastewater by chitosan-immobilized Phormidium sp. In: Stadler, T., Mollion, J., Verdus, M.C., Kamaranos, Y., Morvan, H., Christaien, D. (Eds.), Algal Biotechnology. Elsevier Applied Science, New Yourk, pp. 159–168.

21. De Pauw, N., Verlet, H., De Leenheer, L., 1980. Heated and unheated outdoor cultures of marine algae with animal manure. In: Shelef, G., Soeder, C.J. (Eds.), Algae Biomass. Elsevier/North Holland Biomedical Press, Amsterdam, pp. 315–341.

22. Deng, L., Su, Y., Su, H., Wang, X., Zhu, X., 2006. Sorption and desorption of lead (g) from wastewater by green algae Cladophora fascicularis. J. Hazard. Mater., Dio:10.1016. Dinges, R., 1976.