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A Modified Biogas Generator in Cow farm and Rural Area of Developing Countries

Mohammad Malekiha [1], Mohammad Namakizadeh Isfahani[2], Mansour Namakizadeh Isfahani[3]

Abstract

Biogas as a source of renewable energy can be produced from variety of organic materials such as agricultural residue, animal manure, municipal wastewater, etc. Anaerobic digestion of organic material is decomposing of organic content in the absence of oxygen. In this procedure organic material is decomposed by bacteria to variety of end product in which the main gasses are Methane and Carbon dioxide. The application of anaerobic digestion for biogas generation in Iran is referred to Sheikh Baha al-Din Muhammad Ameli's bathroom in 16 century, which used generated biogas from bath wastewater for boiling water. In this study the basic design and fundamental information of Baha al-Din's bathroom is used for generation of biogas. In modified procedure 24.8 m^3/day biogas generate per 2000 Kg of cow manure. This simple design could be used as a source of energy in rural area of developing country.

Keywords: *Biogas, Anaerobic digestion, agricultural residue, cow manure, Methane, renewable energy.*

1. INTRODUCTION

Anaerobic digestion is decomposition of organic compounds in the absence of oxygen which produces Methane, Carbon dioxide, Ammonia and Organic acids with low molecular weight [1], [2]. Today anaerobic treatment is not only used to control various sources of pollution such as wastewater, industrial wastes, municipal solid wastes [3]-[5] but also used for generation renewable energy such as hydrogen & biogas [1],[6]. By increasing production of waste (solid –liquid) in the world and also simplicity of anaerobic biogas process has led to traditional & Industrial production of biogas. 74 million ton biogas produced spontaneously from manure of cow from annually as well as 40 million ton from municipal wastes which by distribution through the atmosphere causes environmental pollution. These wastes could simply be used as a raw material of biogas digester [7].

In most developing countries which do not have access to the fossil fuel such as oil & natural gas, wood & animal manure are the main source of energy. Application of these sources causes environmental, social & medical problems. Cutting of the trees not only damages the landscapes but also causes interference in natural cycles, destruction of forests, soil erosion & degrading the soil & water resources as well as direct burning of animal manure could cause health problems & illnesses [8]. The use of animal manure in production of biogas as an energy source has certified itself to be an important strategy in solving the problem of energy usage in rural Area of developing countries. By using substrates like manure of cow, hen, agriculture residue & other organic residue, generated biogas could applied as the source of energy of a single house, a farm or a village [9].

The first experience of generation & application of biogas refers to Baha al-Din Muhammad Ameli in 1547 A.D. He conducted the generated biogas from well of a bath to the bath flame for heating water. Jan Baptista Van Helmant in 1625 determined that flammable gases could elude from decaying organic matter. An aerobic

[1] *Corresponding author: Foolad Technic International Engineering Company., Isfahan, Iran.* *Mohammadmalekiha@yahoo.com.*

[2,3] *Water treatment Department, Namakizadeh Institute, Isfahan, Iran. Info@ebara-esfahan.ir*

digestion was first described by Benjamin Franklin in 1767, but Alessandro Volta in 1776 was the first mam who analyzed the methane. He found a correlation between amount of decaying organic matter & amount of flammable produced gas. Sir Humphrey Davy in 1808 was the first man who applied anaerobic decomposition in agriculture. He determined that methane is produced in decomposition of cow manure in absence of oxygen. The development of microbiology as a science lead to research by Buswell in 1930 to identify anaerobic bacteria & conditions that promote methane production in that time scientist thought that organic compounds hydrolyzed partly or completely but today obviously it has been certified that they are affected by various enzymes producing Alcohol & Fatly acid than generate methane [7] ,[10].

Recently large volume of cow manure generated in farms annually which are disposed in to landfills or are applied to agriculture lands without treatment. Anaerobic digestion of these wastes provides an opportunity for energy problem in developing countries. In this paper, cow manure was studied for the use of anaerobic digestion with objectives of treating cow wastes & generating biogas. The produced biogas contains mainly methane & Carbon dioxide which can be used as a source of green energy. The aim of this paper was to investigate the effectiveness & performance characteristics of anaerobic digestion of cow manure for continuous biogas production.

2. MATERIALS & METHODS

2.1. SUBSTRATE PREPARATION

Fresh cow manure was collected from a cow farm in east of Isfahan. The cow manure was diluted with water at the ratio of 1:1. The Fibers were removed by sieve mesh 2 mm size. The prepared substrate was stored in a reservoir and transferred to the underground concrete reactor by the gravity. The composition of raw cow manure is given in table 1.

Table 1. Chemical analysis of fresh cow manure

organic Compounds	Dried materials	N	S	EC (dS/m)
85.29 %	19.85 %	2.07 %	0.2 %	19.8

2.2 REACTOR

Biogas reactor 2m*2m*6.5m was constructed in a cylinder shape from reinforced concrete and water proof coating equated with heat exchanger underground. Construction steps of biogas reactor consist of excavation, foundation, reinforcement, concert works and covering the walls with a mixture of cement and waterproof material. A manometer and thermometer installed for monitoring pressure and temperature and emergency safety valve.

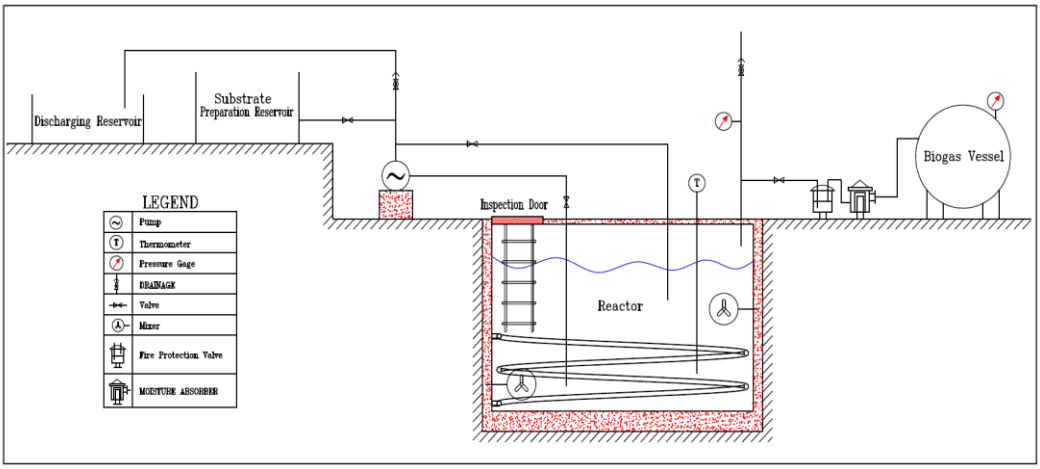

Figure 1. Biogas reactor drawings

2.3 TEMPERATURE EFFECT

The rate of biogas production process is affected by temperature. Going up the temperature increases biogas production [11]. The best temperature for bacteria in mesophyll digester is 35°C [12]. Lianhua et all in 2010 did the same experiment, their result showed that in aerobic digester the best efficiency is gained through 35-37 °C [3].

2.4 ANALYTICAL METHOD

The 100 ml samples was taken every 3days and analyzed for acidity with pH meter. Other parameters such as pressure, temperature and biogas flow were monitored by some measurement tools [1], [4] the results are given in figure 2.

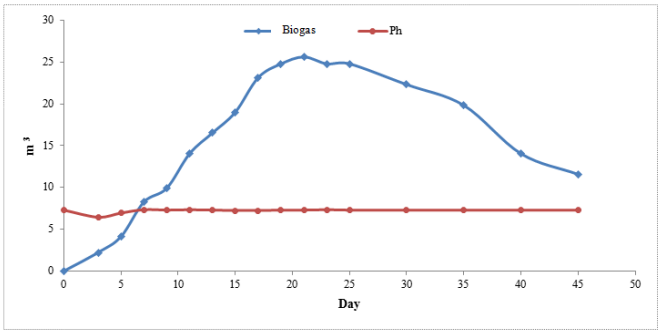

Figure 2. Volume of Biogas m^3 and pH changes

3. PERFORMANCE TEST

Performance test was done through the 45 days period. The reactor filled with 2 tons of substrate and temperature fixed at 35 °C. The substrate was checked for C/N ratio with standard method [6], [11]. The C/N ratio determined 29/1. After 4 days of test pH was fixed by phosphate buffer. The performance test was showed that the biogas production is directly proportion to the growth of bacteria and the rate of biogas generation is slow in early and last days of test. Figure 3. shows the performance test of biogas reactor.

Figure 3. Performance test of biogas reactor.

4. CONCLUSION

The result of this study showed the production of 24.8 m^3/day biogas production from cow manure in in 82m^3 reactor at 35 °C, in pH 7.3. For continues biogas generation according to the study, 570 litters of fresh substrate should be added to the reactor after 35 days of process. Furthermore there are lots of advantages connected to constructing such biogas plant in cow farms for instance, it can open rural economies by the use of green energy, relieves the cost by the use of fossil fuel and protecting the environment and finally the simplicity and ease of using this technology in rural area of developing countries makes it one the best environmental friend source of energy.

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BIOGRAPHY

Mohammad Malekiha *works as a researcher University of Isfahan, Faculty of Chemistry and R&D Specialist of Foolad Technic International Engineering Company.*

B.Sc., of Applied Chemistry, 2004, Faculty of Chemistry, Faculty of Sciences, University of Isfahan, Isfahan, Iran.

M.Sc., Analytical Chemistry, 2007, Faculty of Chemistry, Faculty of Sciences, University of Isfahan, Isfahan, Iran.

He may be contacted at:

mohammadmalekiha@yahoo.com or mohammadmalekiha@gmail.com.