Session 2020

An Experiment of Bio-Gas Production and Data Analysis for International Goat Farm at Prairie View A&M University

Brett Johnston, Danny Logan, Warsame Ali, John Attia, Shuza Binzaid
Electrical and Computer Engineering Department
Prairie View A&M University

Abstract

Bio-Gas kit was used to produce methane in an anaerobic environment from a slurry of goat-manure, cabbage, and water. The digester vessel is the main component which consists of an airtight gallon high-density polyethylene (HDPE) plastic jar with a ¼ inch tube fitting and flexible tubing on the lid. The tubing was used to interface between the digester vessel and a flexible vinyl collection bag. The digester kit was wrapped with thermal insulation to attain temperature of 50-57ºC. An MQ-4 methane gas sensor, NTC 100K temperature sensor, and a warming coil were enclosed in the airtight jar. Sensors were interfaced with an Arduino Mega 2560 programmable microcontroller for operational control. A HC-06 Bluetooth module was added for data logging connectivity. After a several weeks of digestion, temperature and methane ppm data were measured while running the vessel was kept very well sealed during production. A microcontroller to monitor and control the gas production environment parameters can be customized for better operation in future and detect temperature, humidity, gas ppm, and controlling the heater coil.

Introduction

Methane is naturally produced as a result of microbially mediated processes under anaerobic conditions. Methane measurements are important due to methane's role as a potent greenhouse gas and as a fuel. Natural sources of methane include ruminants, anaerobic sediments, sewer, manure pits, composting heaps and landfills [1, 2, 3, and 4]. Biogas is a useable form of fuel derived from the anaerobic bacterial digestion of organic animal and plant waste materials. It is produced by placing the organic waste materials in a sealed container with enough natural fermentation heat to promote bacterial growth, and enough water to create an anaerobic "slurry" environment. This is done by a variety of metal, plastic, or concrete tanks with fixed or articulated roofs or flexible plastic membrane or bladder roofs. The gas produced can be used for heating, cooking, generation of electricity, or any other conceivable application of natural gas. With minimal alterations, the produced gas can even be used to power gasoline powered vehicles.

Many research has been done on various types of animal manure and their potential for producing biogas. These include waste from cattle, sheep, goats, chickens, pigs, horses, and fish. Different manure from different animals can require slightly different conditions to obtain optimal results. Some are better at producing biogas than others. Some combinations of animal waste and certain agricultural wastes produce higher yields of biogas when combined in the proper ratios. There is still a need for more research into which combinations of plant waste and animal waste produce the highest yields. Production of both types of animal and plant waste near each other would dictate to some degree the usefulness of certain wastes with others.

Fig.1 Commercially available Bio-Gas Kit used

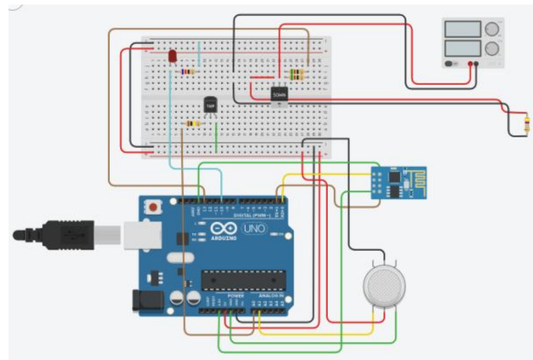

Fig. 2 Circuit as drawn on www.tinkercad.com

Summary and Conclusions

At the end of week 5, detected was methane gas presence as indicated by the MQ-4 raw data and the displayed ppm measurement (indiscriminate) reported through our program. It was found that temperature increase approaching 55ºC when methane ppm also increased. Future studies are needed to confirm this in more controlled environment. Also, additional sensor data would provide more accurate production gas composition analysis. More accurate gas monitoring includes tracking data for carbon dioxide, humidity, additional temperature data points, and ammonia as well as adding the appropriate equations and code to our program. To be specific, the thermophilic and mesophilic gas production curves can better define by the process. At the end of week 8, there was no methane gas production in the collection bag due to perceived contamination issues, but it did have a measurable amount of methane in the control digester vessel. As stated before, greater care will be needed while operating and maintaining the digester vessel. This emphasizes the importance of this study and is exactly why remote monitoring and adjustment of process parameters can be so valuable to this renewable energy source.

References

[1] S. Sutaryo, A.J. Ward, H.B. Møller **Thermophilic anaerobic co-digestion of separated solids from acidified dairy cow manure**
Bioresour. Technol., 114 (2012), pp. 195-200

[2] A. Agostini, F. Battini, M. Padella, J. Giuntoli, D. Baxter, L. Marelli, S. Amaducci **Economics of GHG emissions mitigation via biogas production from Sorghum, maize and dairy farm manure digestion in the Po valley**
Biomass Bioenergy, 89 (2016), pp. 58-66

[3] M. Huber-Humer, J. Gebert, H. Hilger **Biotic systems to mitigate landfill methane emissions**
Waste Manag. Res., 26 (2008), pp. 33-46 https://extension.psu.edu/carbon-methane-emissions-and-the-dairy-cow, Accessed 22nd Dec 2017

[4] Y. Liu, B. Ni, K.R. Sharma, Z. Yuan **Methane emission from sewers**
Sci. Total Environ., 524–525 (2015), pp. 40-51

Brett Johnston, Danny Logan
Mentioned above are electrical engineering students at Prairie View A&M University, Texas.

Warsame Ali, John Attia, Shuza Binzaid
The above named individuals are researchers in the SMART Center at Prairie View A&M University.