American Journal of Energy Engineering
2017; 5(2): 6-10
http://www.sciencepublishinggroup.com/j/ajee
doi: 10.11648/j.ajee.20170502.11
ISSN: 2329-1648 (Print); ISSN: 2329-163X (Online)

Temperature and Stirring Effect of Biogas Production from Two Different Systems

Edmond Demollari[1, *], Etleva Jojic[1], Valdete Vorpsi[1], Erta Dodona[1], Enkeleida Sallaku[2]

[1]Department of Plant Sciences and Technologies, Faculty of Agriculture and Environment, Agriculture University of Tirana, Tirana, Albania
[2]Department of Animal Production, Faculty of Agriculture and Environment, Agricultural University of Tirana, Tirana, Albania

Email address:

demollari@yahoo.com (E. Demollari)
[*]Corresponding author

To cite this article:

Edmond Demollari, Etleva Jojic, Valdete Vorpsi, Erta Dodona, Enkeleida Sallaku. Temperature and Stirring Effect of Biogas Production from Two Different Systems. *American Journal of Energy Engineering*. Vol. 5, No. 2, 2017, pp. 6-10. doi: 10.11648/j.ajee.20170502.11

Received: April 3, 2017; **Accepted**: April 20, 2017; **Published**: May 25, 2017

Abstract: Biogas is a gas mixture, mainly consisting of methane and carbon dioxide, resulting from the biological process of anaerobic digestion of various organic materials [1]. The percentage of methane in biogas will vary depending on the process conditions and the type of organic matter fermented [2-3]. The purpose of this article is to show the differences in CH_4 production from two different anaerobic systems. The first system called Batch Environmental System (BES) function as total isolation system. The needed temperature depends on environment. The second system called Batch Constant Temperature System (BCTS) function as total isolation system but the applied temperature here is constant in whole experimentation time. Applied methods consists in checking the changes in temperature, differences in stirring speed and in determining the moisture contents together with mineral-organically material. Moisture content, mineral-organically material and pH are one of the main "sources" in order to predict theoretical biogas yield.

Keywords: Batch Constant Temperature System (BCTS), Batch Environmental System (BES), Methane Yield, Theoretical Points

1. Introduction

Optimization of the biogas process, i.e., to produce a maximal amount of methane from a given substrate mix, reactor volume and time, and during long term and stable conditions, is an issue that has been addressed more or less continuously during the development of anaerobic digestion (AD) [4]. The effect of temperature and stirring process on biogas production from cow dung manure was studied in two types of experiments, under constant temperature 37°C and average environmental temperature with the same loading rate. Mixing process is usually finished through different methods, including mechanical mixers or recirculation of the produced biogas using pumps with low rpm. Biogas is obtained by fermentation of organic materials such as animal, human, agricultural and industrial wastes [5]. Anaerobic digestion has been considered as waste-to-energy technology, and is widely used in the treatment of different organic wastes, for example: organic fraction of municipal solid waste, sewage sludge, food waste, animal manure, etc [6]. Anaerobic treatment comprises of decomposition of organic material in the absence of free oxygen and production of methane, carbon dioxide, ammonia and traces of other gases and organic acids of low molecular weight [7]. To facilitate the rate of biogas production it is necessary to ensure that operating parameters are favorable to the bacteria involved in the digestion process [8]. Stirring of the fermentable material of biogas reactor is often recommended to ensure intimate contact between the micro-organisms and particle organic material to increase rate of breakdown and degradation of organic compounds and increasingly the gas production rate, as well as breakdown the flouting material as scum to help the gas storage in gas space of biogas reactor [9]. The importance of mixing in achieving efficient substrate conversion has been reported by several researchers [10]. Kaparaju and Angelidaki (2007) reported that, mixing creates a homogeneous substrate preventing stratification and formation of a surface crust and ensures solids remain in suspension [11]. The digestion process itself starts with the bacterial hydrolysis of the biomass so as to break down carbohydrates and other insoluble organic polymers [12]. After the chemical break down, various kinds of bacteria convert the materials into different gases and organic acids in several stages [13]. Methanogenic bacteria finally convert these products into methane and carbon dioxide [14]. The biogas production rates was evaluated and compared between them in different conditions.

2. Material and Methods

The research based on realizing of two experiments that where developed in different conditions at once. The first experiment consisted of: Container 0,5m^3, 3 digesters 18 liters each, 3 electro motors with 60 rpm each, 2 (two) thermostat-resistances for keeping the temperature of water in the required condition, 3 (three) syringes in order to take samples to analyzed, FOS/TAC device, Biogas Analyzer device.

Followed method in apply, in the Figure 1 called Batch Constant Temperature System (BCTS). It functioned under total isolation system, when in it are fixed the needed devices as thermostat-resistance, electromotor with60 rpm and biogas plastic pipe lines. Functioning of the system started in the moment when pretreatment of manure is done (removal of stones in different sizes, weed grasses etc.). The system isolated totally. Working statement of electromotor was 2 times/24 hours. Each time counted 15 min. Interval time between working statement was 2 hours. Measurement with biogas analyzer device done every 5 days. Process duration was 35 days. The heat created from thermostat-resistance transmitted at digesters through water.

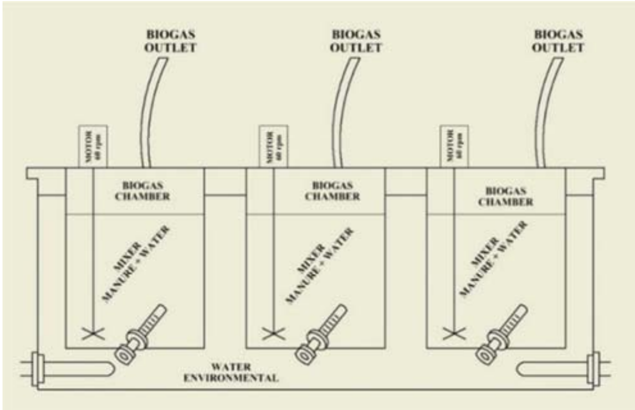

Figure 1. *Batch Constant Temperature System (BCTS).*

The second experiment consisted of: Greenhouse, digester 2m^3, plastic pipes for gas transportation, device of removing sulfur, volumetric device, pump, biogas bag, biogas utilizes device, manual stirring system. The measurement of temperatures inside and outside the greenhouse measured everyday between 11:00 am – 12:00 am. Process duration was 35 days. The biogas quality measured every 5 days.

Followed method, in apply in the Figure 2 called Batch Environmental System (BES). This system functioned under anaerobic system. The system had a manual stirring system. It operated with 90 rot/min in working statement 1 time/24 hours, for 15 minutes.

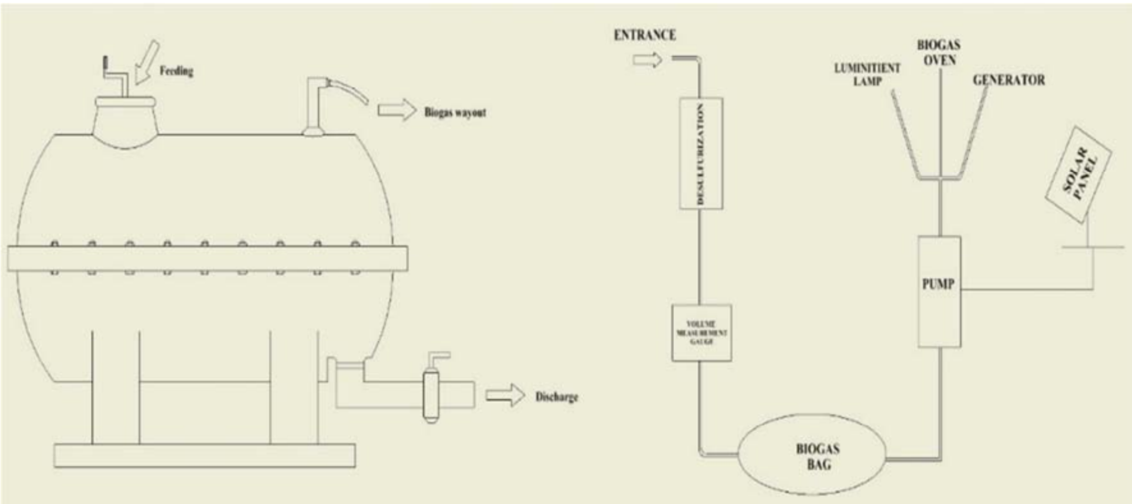

Figure 2. *Batch Environmental System (BES).*

Method for determine the moisture content and dry matter was the same for both systems. Percentage of moisture content was measured as the weight lost during drying and is expressed as a percentage of the (as received) wet sample:

$$\% Moisture = \left[\frac{(Weightwetsample + vessel) - (Weightdrysample + vessel)}{(Weightwetsample + vessel) - (Weightemptyvessel)}\right] \times 100 \quad (1)$$

Percentage of dry matter was measured as the remaining weight of sample after drying and is expressed as percentage of the (as received) wet sample:

$$\% DryMatter = \left[\frac{(Weightdrysample + vessel) - (Weightemptyvessel)}{(Weightwetsample + vessel) - (Weightemptyvessel)}\right] \times 100 \quad (2)$$

3. Results and Discussions

Analyses showed in Tables 1 and 2 are for both experiments. In the anaerobic digestion of energy crops and organic waste into energetically usable biogas the dry matter content (DM) of the substrates has a major influence on the course of the process [15]. Because of the close substrate-specific connection between dry matter content and organic dry matter content with the process parameters "volume load", "gas production rate" and organic degradation rate the determination of the DM content and the organic dry matter content allows improved process control and active influence on the degradation process in the bioreactor [12]. Pretreatment process and taking the samples for analyzed (before starting the experiment) are common. Production of CH_4 was almost in maximum of its production 58,1%.

Table 1. *Sample of Dry Matter and Lost Moisture.*

Weight of initial sample(gr)	Weight of sample after drying(gr)	Initial dry sample (%)	Average of initial dry sample(%)	Lost of moisture (%)	Average of lost moisture(%)
139.15	25.05	18.00		82.00	
131.45	23.5	17.88	17.97	82.12	82.03
127	22.9	18.03		81.97	

Table 2. *Mineral Material and Organic Material.*

Nr.	Weight of empty vessel (gr.)	Weight of initial sample (gr.)	Weight after burn vessel (gr.)	Weight after burn (neto) (gr.)	Mineral material	Organic material
1	36.60	7.03	37.34	0.74	10.51%	89.49%
2	40.89	7.42	41.71	0.83	11.15%	88.85%
3	22.29	4.79	22.80	0.51	10.59%	89.41%
Average					10.75%	89.25%

In Figure 3 and Figure5, CH_4 yield had a increased progression compared with time that needed in order to yield. The maximum value, BCTS system has reached in 56,1% CH_4. Difference between obtained value from experiment, compared with theoretical value 60% - 65% CH_4, means that these 'lost' percentages were in thermal isolation and in updated of the system in order to add different elements that could improved quality and amount of the yield. Seeing pH values during the developed experiment, saw that these were inacceptable values for mesophilic process.

BCTS system, saw from the chart, have had a good growth. In the last two datas near to the peek, values lays between 55,8% CH_4 and 58,1% CH_4. BES system, in the last two data near to the peek, have achieved values: 55,8% CH_4 and 58,1% CH_4.

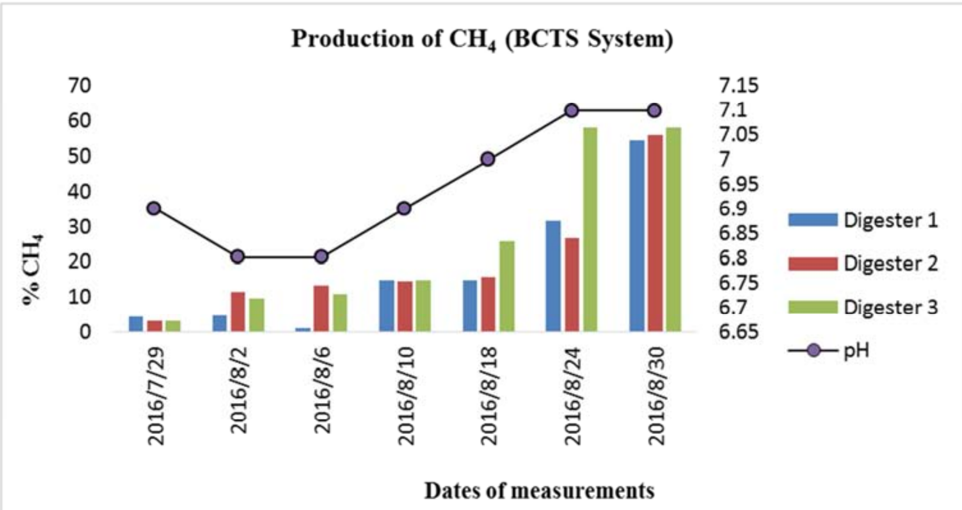

Figure 3. *Methane production by BCTS System.*

Figure 4 showed values of oxygen from 9,97% to 0,23 %. In the same time, CH_4 values growth from 3,49% to 56,1%. These changes during the developed experiment, gave an impact that the progression was always in increase. Almost, the same situation were seen and at Figure 6. As in Figure 4 and in Figure 6, it came out two common points. These points called theoretical points of the systems. Theoretical points of BCTS system is in the value 2% for O_2 and 10% for CH_4 but in BES system is in the value 6% for O_2 and 32% for CH_4. This change in values showed the changes of speed CH_4 yields in two different systems, where the base factor is temperature. Temperature choice and control were critical to the development of anaerobic digestion process, having a strong influence over the quality and quantity of biogas production [18].

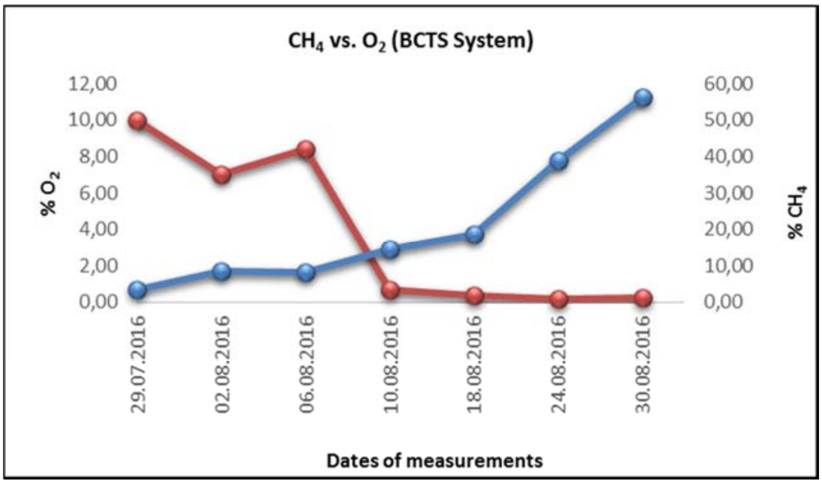

Figure 4. *Methane production versus oxygen production in BCTS System.*

The biogas production rate and the methane content were being measured at different stirring speeds and intervals periods [16]. The importance of mixing in achieving efficient substrate conversion has been reported by several researchers (McMahon et al., 2001; Stroot et al., 2001; Kim et al., 2002; and Vedrenne et al., 2007) [16].Stirring is a process that do not let in order to precipitate the organic matter from liquid. It is so necessary for the process of methane yield. The proper mixing improved and helped the distribution of substrates and microorganism. Kowalczyk, (2012) found that the energy demand of mixing could be reduced by12–29% if intermittent mixing was used instead of continuous mixing [17]. In the BCTS system the speed was 60 rpm and the stirring time was 2 times with 15 min/time. According to Figure 4, the increased methane yield was nearly constant. On the other hand, we saw Figure 6. The increased methane yield of BES system, based mostly on speed of mixer, 90 rpm with 15 min/time. Here, the peek-time of biogas yield was a bit shorter (in days) than BCTS system. It can be noted that the biogas production increased with increase the stirring time and the stirring speed.

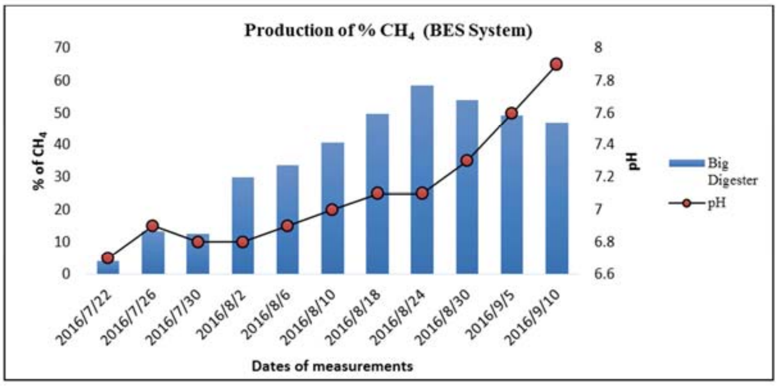

Figure 5. *Methane production by BES System.*

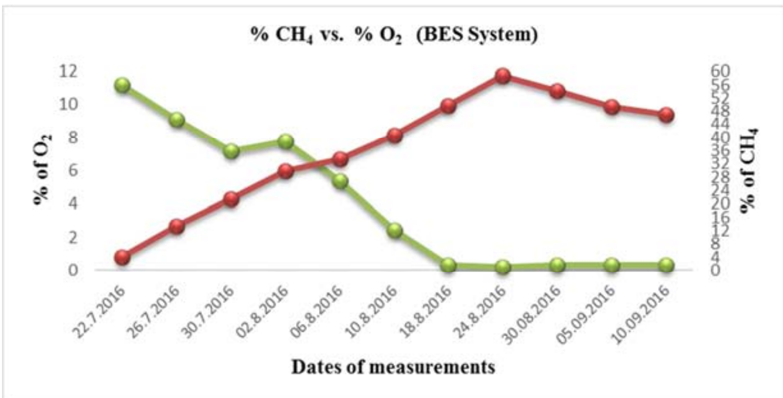

Figure 6. *Methane production versus oxygen production in BES System.*

4. Conclusions

The obtained and compared results in this study, demonstrated consideration how the trend has increased productivity, BCTS system gives more security and guarantee the continuous production of biogas. Another fact which favors BCTS system, is the attitude of constant temperature, not having dependent fluctuations or climate change. Changes in temperature, outside the greenhouse to inside the greenhouse in BES system, made it less continually evaluate biogas production from wastes manure. Theoretical points that were shown, told us changes in CH_4 values between two different systems BCTS and BES. These showed the changes of speed CH_4 yields, where the base factor is temperature. Temperature choice and control were critical to the development of anaerobic digestion process, having a strong influence over the quality and quantity of biogas production. Taking in consider the time of obtained values of biomethane production, from two different systems, BCTS system was much more faster and better than BES system.

References

[1] Paul Dobre, Farcaş Nicolae, Florentina Matei- Romanian Biotechnological Letters, Vol. 19, No. 3, 2014.

[2] Vintila, T., Neo, S., Vintila, C. (2012) - Biogas Production Potential from Waste in Timis County, Scientific Papers: Animal Science and Biotechnologies, 45 (1), 366, 373

[3] Dobre, P., Farcaş, N., Găgeanu Iuliana(2009) - The influence of temperature on the organic substratum in the production of biogas. – Lucrări Ştiinţifice INMATEH, nr. 27, Bucureşti.

[4] https://liu.se/forskning/brc/nyhetsavdelning-for-brc/1.484919/1.484922?l=en

[5] Cheremisinoff, N. P. and Ellerbush (1980). Biomass: Application, technology and production. Marcel Dekker Inc, U.S.A., 131-145.

[6] Li R., Chen S. and Li X. 2009. Anaerobic co-digestion of kitchen waste and cattle manure for methane production. Energy Sources. 31: 1848-1856.

[7] Lopes W. S., Leite V. D. and Prasad S. 2004. Influence of inoculum on performance of anaerobic reactors for treating municipal solid waste. Bioresource Technology. 94: 261-266.

[8] Fernardo, C. E. C. and Dangoggo, S. M. (1986). Investigation of some parameters which affect the performance of biogas plants. Nigerian Journal of solar Energy, 5,142-148.

[9] Effect of mechanical stirring on biogas production efficiency in large scale digesters El-Bakhshwan, M. K.; S. M. A. Abd El-Ghafar; M. F Zayed and A. E. El-Shazly.

[10] McMahon et al., 2001; Stroot et al., 2001; Kim et al., 2002; and Vedrenne et al., 2007.

[11] Kaparaju, P. and I. Angelidaki, (2007). Effect of temperature and active biogas process on passive separation of digested manure. Bioresour.Technol. DOI: 10.1016/j. biortech 2007.02.003.

[12] B. A. Adelekanand A. I. Bamgboye. Effect of mixing ratio of slurry on biogas productivity of major farm animal waste types. Journal of Applied Biosciences 22: 1333–1343(ISSN 1997–5902).

[13] Ciborowski P, 2004. Anaerobic Digestion in the Dairy Industry. Minnesota Pollution Control Agency Air Innovations Conference (http://www.epa.gov/ttn/airinnovations/2004conference/less_polluting/peter_ciborowski.ppt).

[14] Fergusen T. and Mah R, 2006. Methanogenic Bacteria in Anaerobic Digestion of Biomass, p49.

[15] www.ferrosorp.de/english/anwendungen/biogas/determination-of-moisture-in-biogas-plants.html

[16] J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 6 (1): 47 – 63, 2015.

[17] Kowalczyk, A. (2012). Untersuchung der Übertragbarkeit und Reproduzierbarkeit von Versuchenzur Biogasbildung in kontinuierlichen Prozessensowieerste Studienzuderen Optimierung [Dissertation]. Bochum; 2012.

[18] DOBRE, P., FARCAŞ, N., MATEI, F., (2014) –Main factors affectingbiogas production-an overview. Romanian Biotechnological Letters, Vol. 19, No3, 2014, University of Bucharest.