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Evaluation of the Potential of Biogas and Methane a Party of the Cow Dung

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***Abstract**: The present research seeks the valorization of the local biomass for the production of the biogas from the farm of Mr. Kerenta DIALLO, in the district of the Commune of Urban Aviation of Faranah in the People's Republic of China (Beijing). Solid Totals (TS) and Solid Volatiles (VS) were directly chromatographed from a 120 g sample of cow dung. The digestion lasted 24 days, it was obtained from graduated tubes 2862 ml of biogas. The average composition of the product is 52.21 % CH4 and 32.82 % CO2. The average digestion temperature was 35°C, with a pH variant between 6.5 to 7.6.*

Keywords: Valorization; Biomass; Cow dung, Biogas; Production; Composition.

1.0 INTRODUCTION

The global growth of primary energy needs in recent years (1990 - 2015) is 1.7% per year, including strong growth in the Middle East (4.9%) per year and in some developing countries, such as than India and China respectively 4.0% and 4.8% per year. Renewable Energies in electricity generation accounted for 303 GW crests in 2016 for photovoltaic systems, and 487 GW electrics for wind turbines. Hydropower produced 16.0% of the world's electricity in 2015, other renewable energies 7.1%. In 2014 the share of bioenergy in general was 113 GW of which 1GW only in Africa on a total electrical capacity of 186 GW [1].
Methanation is a natural process of biological degradation of organic matter in a medium without oxygen (anaerobic digestion), due to the action of multiple microorganisms (bacteria). It takes place in four stages (Hydrolysis, Acidogenesis, Acetogenesis and Methanogenesis), with different bacteria adapted to each of these stages in a digester that transform complex organic substrates into simple molecules (monomers: acids, alcohols, etc.), then into biogas [2].

Biogas is a fuel composed mainly of CH_4 and CO_2, which come from the degradation of organic plant or animal matter (anaerobic fermentation). Methane is a hydrocarbon of the alkane family, it is the only conventional hydrocarbon that can be obtained through a natural biological process [3]. The average composition of the biogas is as follows: CH_4 (50 - 75 %), CO_2 (25 - 40%) and volatile gases with very low percentage (H_2S, N_2, NH_4). In general, its composition varies with the nature of the substrate and the conditions of digestion (temperature, pH, process, etc.) [4].

In Africa this technique of anaerobic digestion is very little used, however, Burundi and Tanzania hold the most important facilities, estimated at about 500 units. In Guinea, numerous studies have been conducted on the production of biogas from cow dung for heat production and lighting [5, 6]. Also, the Higher Agronomic and Veterinary Institute of Faranah in collaboration with the University of Agriculture of China undertook research on the production of biogas from various biomasses, including cow dung the dung of hens, pig slurry and calopogonuim mucunoides etc., and with the construction and experimentation of two digesters of respective volumes 15 and 23 m^3.

However, no significant popularization has been made on this subject. Similarly, in most biogas research, chemical compositions (CH_4, CO_2, etc.) have not been determined. The present research thus focuses on the evaluation of the biogas potential of cow dung and the determination of the levels of methane and carbon dioxide in the gas produced.

2.0 MATERIALS AND METHODS

2.1 Materials

As part of this research, we were interested in cow dung from the farm of Mr. Kerenta DIALLO, in the District urban community of Faranah 3 km from the Higher Agronomic and Veterinary Institute of Faranah, a sample was taken for the purposes of analysis in China. The equipment used is from the Laboratory of Electrical Engineering and Low Carbon Emission Technology of China (UAC), namely: digesters, muffle furnace, pH meters, graduated test pieces, an HP chromatograph (2100, Beijing, China) and technical data sheets indicating the calculation formulas for methane (CH4) and carbon dioxide (CO2).

2.2 Methods

The methodology is based on the harvest of fresh manure, 2 kg of this manure was collected, kept in 2 bottles of 1 kg each and transported to China (Beijing) where the analyzes were made. A sample of 120 g was tested for 24 days in a digester, after introducing a solvent (the inoculum). During the digestion, the laboratory analyzes made it possible to follow the evolution of the following parameters: the pH by the electronic method, the daily temperature using a mercury thermometer, the Solid Totals and the Solid Volatiles by the standard method, the production of biogas through a graduated plastic test tube. The levels of methane and carbon dioxide were calculated by the relations 1 and 2 [3].

$$\% \, CH_4 = (VT/VS) \times 59.70 \quad (1)$$

$$\% \, CO_2 = (VT/VS) \times 40.3 \quad (2)$$

Where: VT is the Total Volume of the sample and VS is the Solid Volatile of the sample.

The VS and VT values are given directly by the HP (2100; BEIJING, CHINA) chromatograph equipped with a thermal conductivity detector (TCD) and a thermometer with a porapak packed column (60/80 mesh). The operating conditions during the analyzes are: column temperature (120°C.), detector temperature (80°C), injector temperature (150°C) and the carrier gas flow rate (30 ml/m).

3.0 RESULTS AND DISCUSSIONS

3.1 Results

The results obtained are given in Table 1.

Table 1: Biogas produced and its composition in CH_4 and CO_2

Days	Biogas (ml)	CH_4			CO_2		
		V_T	V_S	V_{CH4} (%)	V_T	V_S	V_{CO2} (%)
1	143	34860	63878	32,57	1737	2012	34,79
2	153	44168	77765	33,9	1774	2127	33,62
3	136	47665	77877	36,53	1113	1649	27,14
4	132	52763	64383	48,92	2309	2986	31,16
5	118	46001	58217	47,17	2184	2188	40,22
6	142	48538	61004	47,19	2905	3235	36,19
7	196	54040	68895	46,82	2487	2947	34,01
8	190	55590	67696	49,02	1590	2139	29,96
9	170	52898	65102	48,5	1310	2488	32,87
10	125	54691	43106	75,74	2146	2933	29,48
11	124	53825	70285	45,67	1930	2970	26,19
12	102	50180	69704	42,97	2369	2774	34,41
13	105	52406	63021	49,64	1658	2745	24,34
14	147	52347	66813	46,77	2344	2570	36,75
15	106	56886	62559	54,28	1793	2266	31,83
16	83	58387	62559	55,71	1972	2266	35,07
17	75	61421	58754	62,25	2211	2300	38,72
18	100	65785	64566	61,29	2191	2859	30,89
19	102	65285	64566	60,82	2191	2859	30,89
20	93	64959	61247	62,34	2393	2987	32,28
21	95	63959	61247	62,34	2334	2987	32,28
22	82	63796	62488	60,94	2294	2783	34,89
23	79	63796	62488	60,94	2294	2783	34,89
24	64	63796	62488	60,94	2234	2783	34,89
Total	2862	-	-	-	-	-	-
Average	-	-	-	**52,21**	**-**	**-**	**32,82**

3.2 Discussions

The curves in the figure below, taken from the results of Table 1, allow good analysis and discussion.

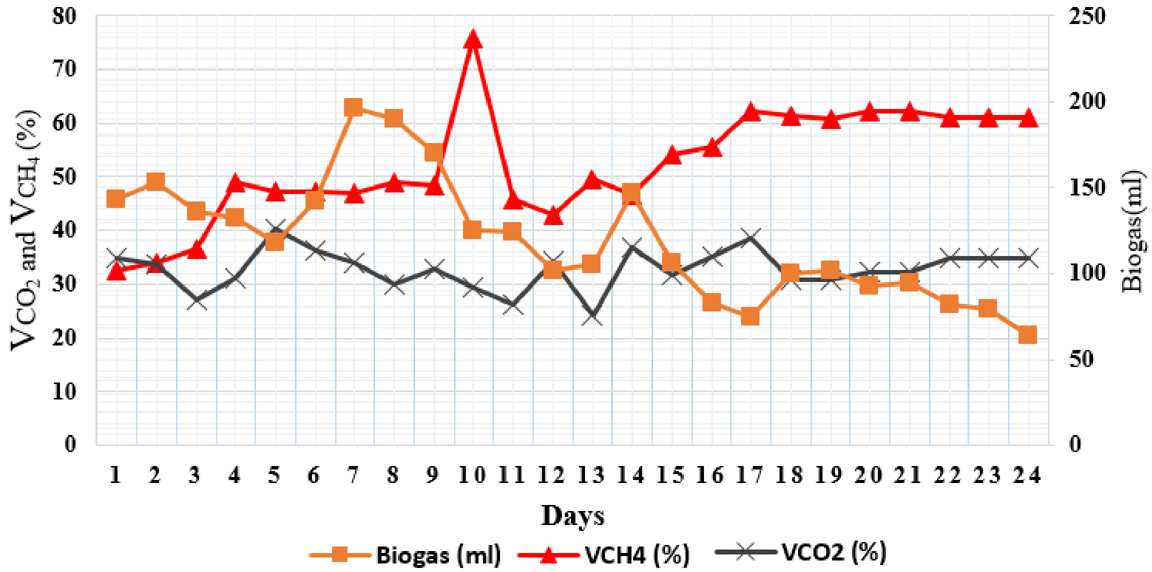

Figure: Kinetics of daily biogas production and Daily composition of CH_4 and CO_2 of the biogas produced

The daily biogas production kinetics curve (figure) shows that, from the 1st to the 2nd day of digestion, there was a slight increase in production (153 ml) and from the 2nd to the 5th day there was a relative decrease in production (118 ml). From the 5th to the 6th day there is an increasing increase in production (196 ml) and from the 7th to 13th day there is a decrease in production (105 ml). A slight increase in production is recorded on the 14th day (147 ml). Finally, from the 14th to the 24th day, a gradual decrease in the production of biogas is recorded. These different fluctuations in the kinetics of biogas production are generally due to variations in certain methanization parameters (temperature, pH, etc.).

During the 24 days of digestion the biogas production was 2862 ml, with an average temperature of 35°C (mesophilic digestion mode) in the experimental digester. The pH ranged from 6.5 to 7.6 (basic medium), which is favorable for methanation micro-organisms [7]. This digestion process is characterized by three phases (exponential, plateau and exhaustion) [8]. The exponential phase lasted 10 days from the closure of the digester, a strong biogas production was recorded (1505 ml). This phase corresponds to the methanogenic phase. The plateau phase lasted 12 days, from the 11th to the 21st day, with a production of 1132 ml. The phase of exhaustion lasted 2 days, from the 22nd to the 24th day, with a very weak production of biogas, one attends the effect of exhaustion of the substrate.

The curves for the composition of CH_4 and CO_2. Of the biogas produced (figure), show that the biogas produced between the 1st and the 2nd day is richer in CO_2 than in CH_4 (poor quality biogas). From the 2nd day until the end of digestion (the 24th day), the level of CH_4 remains higher than that of CO_2. During the 24 days of digestion, the average levels of CH_4 in the produced biogas is 52.21% and that of CO_2 is 32.82%. The maximum value of the CH_4 level was recorded on the 10th day, i.e. (75.74%) and the lowest CO_2 level was recorded on the 13th day, i.e. (24.34%). These results show that the biogas produced is a good quality fuel [9, 10].

4.0 CONCLUSION

This research made it possible to estimate the biogas potential of cow dung and the chemical composition of CH**4** and CO2 in the laboratory gas. The results obtained show a crucial importance of the energy recovery of these animal dung. The extension of this anaerobic digestion technique from animal waste would reduce the release of methane into the atmosphere and also improve energy problems (lighting and heat) in the breeding areas of Guinea. This research must be followed by the characterization of effluents (digestates) for its use in composting (soil fertilization).

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