

Data on Biogas production quality: Evidence from the Wastewater Treatment Plant of Durrës

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ABSTRACT

The wastewater treatment plant (WWTPD) located in Durrës, responsible for a treatment area of 205,000 inhabitants, employs the tertiary advanced wastewater treatment to generate biogas from activated



sludge for self use. The biogas collected from the anaerobic digestion tank feed the boiler and the co-generation unit which is then transformed to power its own energy grid. In order to evaluate the quality of biogas produced by anaerobic digestion of WWTPD's sludge, is measured the percentage of CH₄ and CO₂ from the biogas production during a three years period (2016 – 2018).

From the performed analyses has resulted a percentage of CH₄ up to 75% and 25% CO₂ in 2016. While the lowest percentage of CH₄ in 2018 with respectively 70% CH₄ and 30% CO₂.

Based on the value measurements, qualitative results of biogas parameters show that physicochemical and biochemical processes are performed under strict conditions and anaerobic digestion is performed according to standards.

Keywords: wastewater treatment plant, biogas, methane, anaerobic digestion, sludge

INTRODUCTION

The wastewater treatment plant (WWTPD) is located 2 km away from the city center of Durrës and treats urban wastewater of 205,000 inhabitants [1]. WWTPD employs the tertiary advanced biological treatment. The deployed technology is with active sludge with advanced

treatment for nitrogen and phosphorus reduction. Biogas obtained from anaerobic digestion of WWTPD's sludge feed the boiler and the co-generation unit and is used to satisfy the needs of the plant with electricity.

The plant has been designed to treat a total flow-rate of 60,000 m³/d. All the flow-rate is preliminary treated (screening, de-sanding) before being divided in the pre-treatment over-flow, where only 30,000 m³/d goes to the further conventional treatment, while the remaining is discharged to the wetland [2]. The sewage arrives to the inlet pumping station where it is screened through coarse screens and pumped to the pre-treatment. In the pre-treatment, Ferric Chloride is also added to remove the phosphorous in the following stages. The final section of the pre-treatment facilities is a diversion unit, which divides the flow-rate to the four lines of the aeration tank. But only two lines of aeration tanks worked because of low flow-rate in this three year of study period. The core of the treatment plant is the activated sludge process. Once the wastewater had received sufficient treatment, excess mixed liquor is discharged into settling tanks and the treated supernatant is run off to undergo further treatment before discharge. Part of the settled material, the sludge, is returned to the head of the aeration system to re-seed the new wastewater entering the tank. Excess sludge is removed from the treatment process to keep the ratio of biomass to food supplied in the wastewater in balance and is pumped to the thickening stage. Into the gravity sludge thickener tanks the sludge is mixed and agitated gently forming a solids blanket on the bottom of the tank. Solids concentration achieved by gravity thickeners were typically 2% solids from waste activated sludge. The sludge from the bottom is pumped to the anaerobic digestion tanks.



WWTP of Durrës has two anaerobic digestion tanks, but in the three years of study only one of the digester tanks has worked. The process used in digester is single-stage mesophilic continuous system. The biogas is collected from the anaerobic digestion and accumulated in the gas-holder tank to feed the boiler and the co-generation unit which is then transformed to power its own energy grid.



Figure 1 Biogas-holder and Anaerobic Digestion tanks in WWTPD

According [3] biogas produced by the wastewater treatment plant contain roughly 55÷70 percent methane and 30÷45 percent carbon dioxide and traces amounts of hydrogen gas, hydrogen sulphide, ammonia (all together about 1÷2 %) and small traces amounts of carbon monoxide, nitrogen and oxygen. The percentage of these gases depends on the sludge composition, temperature, pH and pressure [4].

<i>According to [5]</i>	60 % CH ₄	40 % CO ₂
<i>According to [6]</i>	55÷70 % CH ₄	30÷45 % CO ₂
<i>According to [7]</i>	63÷67 % CH ₄	33÷37 % CO ₂

Qualitative parameters for measuring biogas are the amount of methane CH₄ and carbon dioxide CO₂, but also other gases in the form of traces. The percentage of these gases depends on the composition of the sludge, temperature, pH and others. Since the dissolution of CO₂ depends on the pH, its fluctuations can change the percentage of gas. The amount of biogas produced for biofuel and then electricity is measured by % CH₄ [8].

MATERIALS AND METHODS

The biogas is collected from the anaerobic digestion tank. Samples were taken at the digester tank outlet, according to IS/ISO 14853 [9]. Methods for determining percentages are instrumental and volumetric. In this paper

is used the volumetric method for the determination of CO₂, where CH₄ is then found as the difference with CO₂ (assuming that the amount of other trace gases is very small, negligible). For this purpose, was used the ORSAT apparatus, with the method of absorbing gas in an alkaline solution.

$$\%CO_2 = \frac{(V_1 - V_2) \times 100}{V_1}$$

$$\% CH_4 = \% 100 - \% CO_2$$

% CO₂ – percentage of CO₂ in the biogas sample

% CH₄ – percentage of CH₄ in the biogas sample

V₁ – initial volume of biogas

V₂ – the volume of biogas after passing into the KOH solution

In order to have the highest quality biogas production, have been controlled its parameters keeping under control the anaerobic digestion process and pH in the anaerobic digestion reactor.

RESULTS AND DISCUSSIONS

Biogas produced by the Wastewater Treatment Plant in Durrës contains methane gas CH_4 , carbon dioxide CO_2 and other trace amounts of gases. From the analyzes performed during the three years period (2016 – 2017– 2018), the pH was in normal and stable values. The pH values of the sludge in the digester tank were within normal close to 7.0 with the range 7.47 – 7.58. This has affected the good quality of biogas with a satisfactory percentage of CH_4 . Table 1 presents the average production values calculated by study year as well as the percentage of CH_4 and CO_2 for each year.

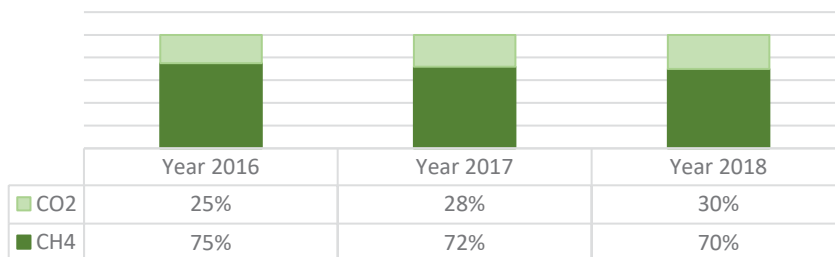


Table 1. Biogas quality of WWTPD

In 2016, where the amount of biogas was higher, its quality is in the ratio 75% CH_4 and 25% CO_2 . Referring [10] this year had the best parameters in terms of sludge in the digester tank. A small decrease in the amount of CH_4 is seen in the other two years, but the results are very good. Table 2

presents the average production values of biogas calculated by study year as well as the equivalent amounts in $\text{m}^3 \text{CH}_4$ for each year.

<i>Year</i>	Average daily biogas production (m^3/day)	Average daily per year of methane ($\text{m}^3\text{CH}_4/\text{day}$)
<i>2016</i>	1392.95	1044.7125
<i>2017</i>	944.88	680.3136
<i>2018</i>	653.34	457.3400

Table 2: Biogas production in 2016, 2017 and 2018 [10]

Qualitative results of biogas parameters show that physicochemical and biochemical processes were achieved under strict conditions and anaerobic digestion was carried out according to standards. The process is made in the absence of oxygen, nitrates or sulphates. During the anaerobic digestion the mixing of the sludge in the tank is carried out. This is a necessary and very important process because the sludge is spreaded evenly throughout the digester tank while maintaining the temperature and the spread of methanogenic bacteria homogeneously. The filling of the reactor is done in small quantities, so that the microorganisms have a constant concentration of organic matter, eliminating the risk of overload and increasing the concentration of volatile acids.

CONCLUSIONS

- During a study period of three years the Wastewater Treatment Plant in Durres has produced a quality biogas with a percentage of CH₄ 70÷75 % and 25÷30 % of CO₂.
- The optimal quality of biogas depends on the composition of the sludge, temperature, pH and others.
- Qualitative results of biogas parameters in WWTPD show that physicochemical and biochemical processes were achieved under strict conditions and anaerobic digestion was carried out according to standards.
- Quality parameters of biogas are optimal due to the solids concentration achieved by gravity thickeners with percentage up to 2%.

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