

# ASSESSMENT OF METHANE BIOGAS PRODUCTION FROM A WASTEWATER TREATMENT PLANT AND ITS POTENTIAL FOR ELECTRICITY GENERATION

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## INTRODUCTION

Among the technologies for treating wastewater, the anaerobic systems have competitive advantages that make it one of the alternatives adopted by various sanitation companies. The key feature of this technology is the degradation of organic matter present in wastewater in an environment devoid of oxygen. In those circumstances, the anaerobic bacteria convert organic matter in methane gas (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>) and hydrogen sulfide (H<sub>2</sub>S). While the latter represents a major impediment to technology adoption, since it is responsible for the characteristic odor of wastewater decomposition, the former has an energetic value little explored in Brazil. The UASB (Upflow Anaerobic Sludge Blanket Reactors) are sludge blanket reactor in which the influent wastewater enters the bottom of the reactor, in a movement upward through a layer of biological sludge that lies at its bottom, and passes through a phase separator as it seeps toward the surface. Organic suspended solids are digested by bacterial action, resulting in biogas production and the growth of bacterial biomass. Biogas follows an upward trajectory with the liquid, after it goes through the sludge layer in direction to the phase separator. Several units are deployed, especially in countries with tropical and subtropical climate (VAN Haandel, 1979).

This paper presents an evaluation of methane production in an anaerobic treatment plant, with UASB reactors, and its potential use in generating electricity.

## METHODS

Was selected a wastewater treatment plant (WWTP) composed of two UASB reactors, located in Fortaleza, Brazil (3 50'2, 29 "S, 38 35'1 .99" O), with average capacity of treatment of up to 8.9 L / s, equivalent to a population of 6,145 inhabitants. Besides these reactors, this WWTP has a pumping station equipped with two pumps with power of 5 hp, two disinfection units, four sludge drying bed units, and odor treatment units composed of two scrubbers operated with calcium hypochlorite solution.

The pumping station flow was previously calibrated with ultrasound Doppler meter. The daily volumes were measured by multiplying the flow above the respective amounts of daily hours of operation of each pump. The organic load removed by the WWTP was monitored weekly by measuring the concentration of COD in raw and treated sewage according to APHA (1997).

For monitoring the production of biogas, a volumetric meter was installed at the outlet of the scrubbers, registering the cumulative hourly values during the daytime, or the cumulative total values each night. The methane concentration in the biogas produced was determined by gas chromatography.

Were acquired and are being installed an electric generator and a pump, both powered by biogas, and a gas tank for reservation of up to 7 m<sup>3</sup> of biogas. According to the equipment maker, 3.6 kwh, requires 2 m<sup>3</sup> of biogas, at least 60% methane, for each hour of operation. Both the generator and the pump were provided with removal units of hydrogen sulfide, composed of iron oxide in PVC wraps.

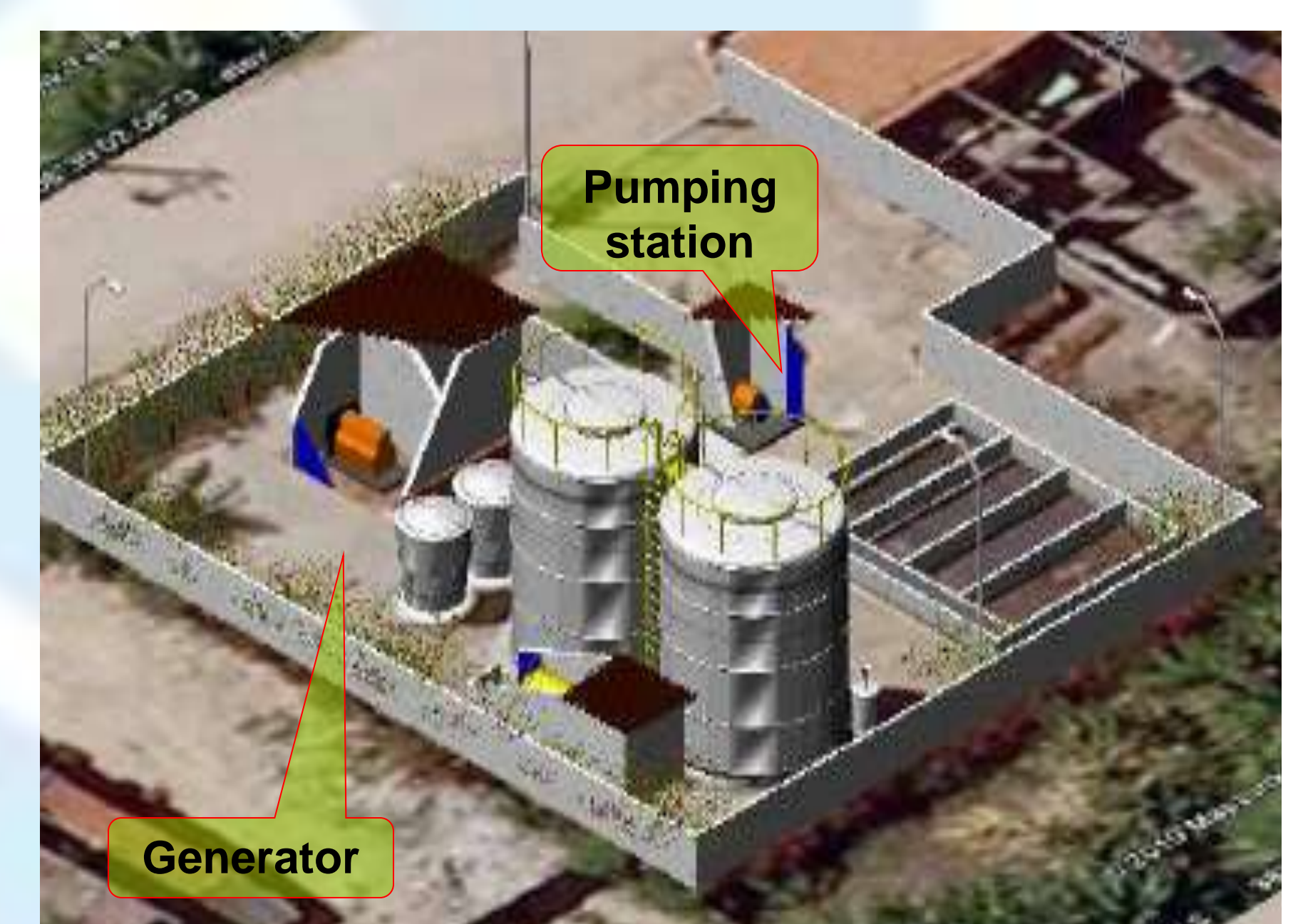


Figure 1. Figures showing the two UASB reactors, as well as generator, pump station and storage of biogas.

## RESULTS AND DISCUSSION

During the monitoring period of the experiment, from July to October 2010, the station received an average sewage flow of 3.5 L / s, equivalent to 40% of the design value (8.9 L / s). The influent COD concentrations were with values always above 1,000 mg / L, while the removal efficiency ranged from 39 to 73% (Table 1). Whereas the WWTP average flow and the COD average removal of 574 mg / L, the station is able to remove about 173 kg of COD per day.

Table 1. Influent and effluent COD concentration

Date (DD/MM/YYYY)	Influent COD (mg/L)	Effluent COD (mg/L)	Removal Efficiency (%)
24/08/2010	1,079	287	73
21/09/2010	1,184	518	56
28/09/2010	1,025	622	39
15/10/2010	1,086	608	44
19/10/2010	1,063	537	49
Average	1,088	514	52

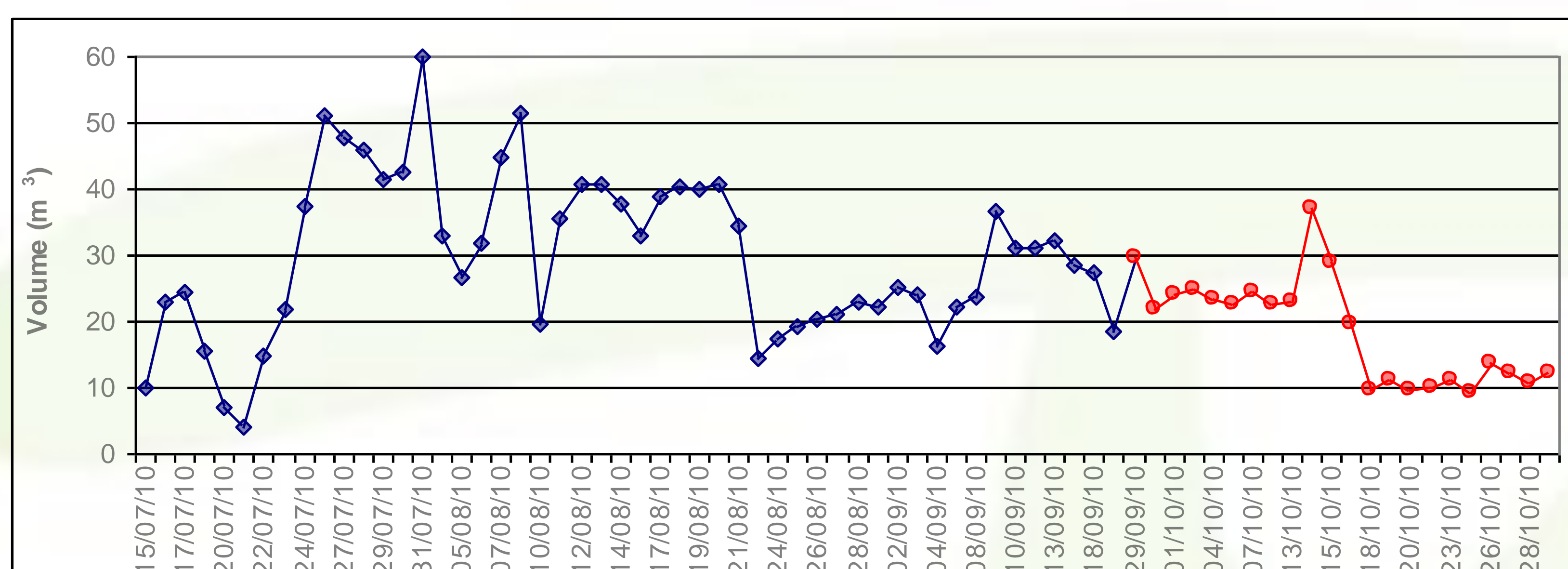


Figure 2. Daily volume of biogas produced by the reactor 1 (blue) and reactor 2 (red).

The monitoring of the biogas volumetric production, between the months from July to October 2010, it varied from 40 to 60 m<sup>3</sup>/day for the first reactor and 9-37 m<sup>3</sup>/day for the second one, with the respective averages 30 and 18 m<sup>3</sup>/day (Figure 2). The lower production coincided with the dates immediately after the discharge of accumulated sludge in the reactor, which is related to the methanogenic activity that occurs in the reactor. The lack of standardized procedures on how, when and for how long to perform these discharges, possibly explain the uneven production and the efficiency variations mentioned above.

Chromatographic analysis of biogas composition showed an average of 75% CH<sub>4</sub>, 8% CO<sub>2</sub> and 17% N<sub>2</sub>. These values are consistent with those found by Coelho et al. (2006).

Evaluating the methane production as a function of organic load removed (173 kg COD / day) and adopting an average value of biogas production of 48 m<sup>3</sup>/day (reactor 1 and 2) and 75% of methane concentration in the biogas, it can estimate an average of 0.28 m<sup>3</sup> CH<sub>4</sub> per kg COD removed. This amount is equal to 81% from that indicated by Chernicharo (1997), which is 0.35 m<sup>3</sup>.

Considering the biogas average production and consumption by the station specified by the generator and pump maker (2 m<sup>3</sup> /hour), the WWTP may be self-sufficient in electricity supply to power the pumping station. This hypothesis will be tested as soon as possible with the installation of such equipment.

## CONCLUSIONS

The evaluated WWTP showed good production of biogas (48 m<sup>3</sup>/day average) with significant methane concentrations (75%). Although it showed great variations in production over the three months of monitoring, the average values of methane production per COD removed (0.28 kgCH<sub>4</sub>/kgCOD) were close to the theoretical values proposed in the literature (0.35 kgCH<sub>4</sub>/kgCOD). The volume of biogas produced was shown to be sufficient to supply all the generator demand to power the WWTP pumping station. It is possible that the pumping station be energy self-sufficient.