Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 15, Issue 1, 2015
PRINT ISSN 2284-7995, E-ISSN 2285-3952

DEVELOPMENT TRENDS OF BIOGAS

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Abstract

All over the world, researches are made in order to improve the technologies, the operational and process stability and performance of biogas plants, because the world markets for biogas increased considerably in Europe and all over the world. In this paper we studied the most important parameters related to a biogas plant, starting from a local ecologic landfill, a landfill which storages industrial and household waste. In this respect, we studied operational parameters, such as organic load and hydraulic retention time, and parameters for evaluation of a biogas plant. Also, we made a case study concerning the evaluation of used waters in the landfill under the aspect of pollution sources, way of treatment and evacuation mode of used waters. The existing biomass resources everywhere in the world can give us an idea of the global potential of biogas production, which is not exploited to its full capacity, especially in our country.

Key words: *biogas, landfill, operational parameters*

INTRODUCTION

In the last period of time, the world markets for biogas increased considerably because of the increasing need of energy of the urban and even rural communities. That is why many countries developed modern biogas technologies and competitive national biogas markets throughout anaerobe digestion of intensive substantial governmental and public support. The European biogas sector counts thousands of biogas installations, and many developed countries like Germany, Austria, Denmark are among the technical forerunners, with the largest number of modern biogas plants. Important numbers of biogas installations are operating also in other parts of the world. In our country, the biogas plants became more and more used, due to the ecologic landfills, which are placed near the important cities. In other more distant countries in Asia there are also considerable numbers of very small scale, family owned biogas installations. Most biogas plants in Asia are using simple technologies, and are therefore easy to design and reproduce. On the other side of the Atlantic, USA, Canada and many Latin American countries are on the way of developing modern biogas sectors and favourable political frameworks are implemented alongside, to support this development [1].

Important research efforts combined with full scale experience are carried out around the world, aiming to improve the conversion technologies, the operational and process stability and performance. New digesters, new combinations of anaerobe digestion substrates, feeding systems, storage facilities and other equipment are continuously developed and tested.

Alongside the anaerobe digestion feedstock types, dedicated energy crops for biogas production were introduced in some countries and the research efforts are directed towards increasing productivity and diversity of energy crops and assessment of their biogas potential. Cultivation of energy crops brought about new farming practices and new crop rotation systems are about to be defined, where intercropping and combined crop cultivation are subject of intensive research as well [2]. In this European and world context, Romania begins to manage wisely waste and use this waste in order to create energy from biogas.

The existing biomass resources everywhere can give us an idea of the global potential of biogas production. This potential was estimated by different scientists, on the base of various scenarios and assumptions. The overall conclusion was always, that only a very small part of this potential is utilised today, thus there is a real possibility to increase the actual production of biogas significantly. The European Biomass Association estimates that the European production of biomass based energy can be increased from the 72 million tones in 2004 to 220 million tones in 2020. The largest potential lies in biomass originating from agriculture, where biogas is an important player. According to this association, up to 20 to 40 million hectares of land can be used for energy production in the European Union alone, without affecting the European food supply [5]. In this world context, Romania also begins to valorise its biogas potential, because it is a cheap and ecologic source of energy.

MATERIALS AND METHODS

Encouraging the use of biogas among rural communities bring great benefits both from environmental point of view, by reducing emissions and mitigating the ecological footprint, and from human health point of view, by reducing the smoke, product of burning wet wood. Within this context, it is important for the researchers to design comprehensive strategies, looking triangular efforts among producers (beneficiaries), academia (government) and business (private), that go beyond the sum of shares sector performed in the territories, and achieve effective integration into the planning and development goals, defined from rural areas, is one of the major challenges faced in promoting the development of rural and indigenous [6].

Availability of a suitable site for the construction of the bio-digester is very important, it must take into account that most areas where it wants to impact are highly rural and hard to reach, so you must choose the best, you can also find suitable properties soil, groundwater and not very high spaces available for further application of organic fertilizer produced. If possible, only work with substrates with high energy potential and avoid transportation costs of organic material are recommended. Another aspect which must be taken into consideration is marketing medium and long term products seeking to strengthen the subsistence economy of the indigenous communities involved, it is intended that once started and stabilized the production of biogas, every family will be able to exchange or sell gas and fertilizer hours, as a method of interacting with each other [6].

In this paper, we researched the most important operational parameters from a biogas plant, starting from a local ecologic landfill, a landfill which storages industrial and household waste.

Operational parameters

The construction and operation of a biogas plant is a combination of economical and technical considerations. Obtaining the maximum biogas yield, by complete digestion of the substrate, would require a long retention time of the substrate inside the digester and a correspondingly large digester size. In practice, the choice of system design (digester size and type) or of applicable retention time is always based on a compromise between getting the highest possible biogas yield and having justifiable plant economy.

The organic load

In this respect, the organic load is an important operational parameter, which indicates how much organic dry matter can be fed into the digester, per volume and time unit, according to the equation below:

$BR = m * c / V_R$ [1], where:

BR - organic load [kg/d*m3]

m - mass of substrate fed per time unit [kg/d]

c - concentration of organic matter [%]

VR - digester volume [m3]

Hydraulic retention time

An important parameter for dimensioning the biogas digester is the hydraulic retention time [3]. The hydraulic retention time is the average time interval when the substrate is kept inside the digester tank. Hydraulic retention time is correlated to the digester volume and the volume of substrate fed per time unit, according to the following equation:

$HRT = V_R / V$, [1] where:

HRT- hydraulic retention time [days]

VR- digester volume [m3]

V - volume of substrate fed per time unit [m3/d]

According to the above equation, increasing the organic load reduces the hydraulic retention time. The retention time must be sufficiently long to ensure that the amount of micro-organisms removed with the effluent (digestate) is not higher than the amount of reproduced micro-organisms.

The duplication rate of anaerobic bacteria is usually 10 days or more. A short hydraulic retention time provides a good substrate flow rate, but a lower gas yield. It is therefore important to anaerobe digestion the hydraulic retention time to the specific decomposition rate of the used substrates. Knowing the targeted hydraulic retention time, the daily feedstock input and the decomposition rate of the substrate, it is possible to calculate the necessary digester volume.

Fig. 1. Storage cell in an ecologic landfill near a city
Source: www.greenprophet.com

Parameter list

A number of parameters (Table 1) can be used for evaluation of biogas plants and for comparing different systems.

There are two main categories of parameters:

- Operating data, which can be determined by measurement
- Parameters, which can be calculated from the measured data.

In order to evaluate the performance capabilities of a biogas plant a multi-criteria analysis should be performed. Evaluations based on a single parameter can never do justice to the process. In order to determine if a biogas plant can provide a return on investment, in an acceptable time frame, economic parameters must always be included [4].

Table 1. Parameters for evaluation of biogas plant

Parameter	Unit	Symbol	Determination
Temperature	T	°C	Measurement during operation
Operational pressure	P	mbar	Measurement during operation
Capacity, throughput	V	m3/d; t/d	Measurement
Reactor volume	VR	M^3	Determined by construction
Gas quantity	V per day/ year	m3/d; m3/a	Measurement during operation and conversion to Nm3
Retention time (hydraulic, minimum guaranteed)	HRT MG RT	d	Calculation from operating data
Organic anaerobe digestion		kg oTS / (m3 * d)	Calculation from operating data
Methane concentration in biogas	CH 4	%	Measurement during operation
Specific biogas yield		%	Calculation from operating data
Specific biogas production		m3 / m3	Calculation from operating data
Plant efficiency	H	%	Net energy drawn from gross energy
Specific treatment costs		€/m3 Input; €/GV	Calculation

Source: [1]

RESULTS AND DISCUSSIONS

These parameters for evaluation of a biogas plant were verified in the local ecologic landfill in which we made our observations and measurements.. In this landfill, the waste received for storage must obey the environmental authorization. Thus, the following waste are permitted to be stored: city and trade waste, institutions waste, etc. The following waste are forbidden to be stored: liquid waste, explosive waste, corrosive, flammable, oxidant waste, dangerous hospital waste, or other dangerous clinic waste.

The waste are received only if, during the whole period of storage, they have non harming influence on man and the surrounding environment. The waste is distributed in thin layers of maximum 1 m and then it is compacted. The compact density for household waste must be minimum 0,8 t\m³. In the following figure, it is shown the way of waste unloading in a landfill.

Fig.1. Waste unloading in an ecologic landfill
Source: www.ecologic-nc.com

We made a case study in a local landfill, researching some parameters which indicate the environmental quality.

The first category of parameters were those of water emissions.

Emissions sources

The emissions came from the heating system with gas petrol liquidified and obey the limits imposed by current legislation. The most important emissions found are:

- powders;
- carbon monoxide (CO);
- sulphur oxides (SO_x);
- Nitrogen oxides (NO_x).

The problems connected to biogas emission are solved based on the prognosis of landfill gas production. The degassing system is constructed in such a way to be sealed from the environment and the drainage system of the rain waters.

CONCLUSIONS

In the last years, due to the situation of searching of new sources of renewable energy, the biogas plants are more and more used in Europe and in our country, because it is a source of energy which can be used both for rural and city communities. Also, the biogas production is in connection with the landfills, which manage the waste of large communities. In this paper, we studied some operational parameters, such as: Organic load and Hydraulic retention time, and some parameters which are used for evaluation of biogas plants, such as: temperature, pressure, reactor volume, gas quantity, methane concentration in biogas. In this respect, we made a case study in a local ecologic landfill, where we identified the pollution sources, the way of treatment and the evacuation way of used waters from this landfill.

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