RENEWABLE ENERGY SOURCES – BIOGAS PLANTS

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ABSTRACT

This paper deals with problematic of biogas plants.Biogas plants are an appropriate decentralized resource in light of the stability of electricity supply and feedback effects on the power system. Combined production heat and power can compete conventional sources in terms of the cost effectiveness of investment and thus to ensure a sustainable low-carbon energy.

1. INTRODUCTION

Technically exploitable potential of biomass in Slovakia is 11,237 GWh per year, which would cover nearly 40% of annual electricity consumption in Slovakia. The advantage of biomass is, that biomass don't leave "carbon footprint", because biomass during its growth through photosynthesis consumes carbon dioxide, which is released into the atmosphere in its energy use. In conditions of Slovak Republic biomass energy can be utilized as:

- forest biomass - fuel wood, energy crops,
- agricultural biomass - waste of growing and processing crops, garden biomass from orchards and vineyards, production of liquid biofuels (bioethanol), livestock manure, waste from the food industry,
- waste - waste wood processing industry, municipal waste, sludge from sewage treatment plants.

Solid biofuel include forest biomass that can be burned directly or after processing on wood chip in automatic boilers. Another way is compacting of wood chips under high pressure and temperature. The resulting products are wood briquettes or pellets, which heat value is greater than the calorific value of brown coal (14-16 MJ/kg) and moves in the values of 17-19 MJ/kg. Liquid biofuels produced from agricultural biomass is blended into fossil fuels (petrol, diesel) in suitable proportions and reducing the emission of pollutants in transport. In the following sections biogas, will be presented, which can be obtained from the processing of agricultural and biomass waste.

2. CHARACTERISTICS OF BIOGAS

Biogas is a biological process, produced by anaerobic decomposition of organic matter, i.e. without air. Main contribution of biogas is methane CH_4 and carbon dioxide CO_2. The process of anaerobic decomposition takes place in a facility called the fermenter. Anaerobic digestion has four phases in which are created:

1. Hydrolysis- simple sugars, amino acids, fatty acids
2. Acidification - organic acids, carbon dioxide, hydrogen
3. Acid-genesis - acetic acid, carbon dioxide, hydrogen
4. Methanogenesis - methane, carbon dioxide, water

In the first phase of anaerobic bacteria convert macromolecular substances (proteins, fats, carbohydrates and cellulose) using enzymes to low molecular compounds such as simple sugars, amino acids, fatty acids and water. This phase calls hydrolysis. In phase acidification acidophilus bacteria carry out further decomposition of the organic acids, carbon dioxide, hydrogen sulfide and ammonia. In the third phase called acid-genesis acetic bacteria create acetates, carbon dioxide and hydrogen. In the last phase, called methanogenesis are present bacteria, which in alkaline medium will create methane, carbon dioxide and water.

In case of continuous supply of organic matter, all these processes going uninterrupted side by side. They are not separated in time, and the place. Only at start-up, the delivery system and the multi-stage biogas plants are carried out phase separately. After starting the device it can take several weeks, when the productions of methane start. Today we know of about 10 kinds of methane bacteria that need different types of care, that other environmental temperature. In Table 1 is the calorific value of biogas based on the percentage of methane in biogas.

Table 1 Calorific value of biogas

Capacity of CH_4 in biogas	Calorific value v $MJ.m^3$	Calorific value v $kWh.m^3$
100%	35,8	9,94
80%	28,6	7,94
67%	24	6,67
55%	19,7	5,47

3. USE OF BIOGAS

The following diagram shows the relationship between the four basic ways of processing and energetic utilization of biogas.

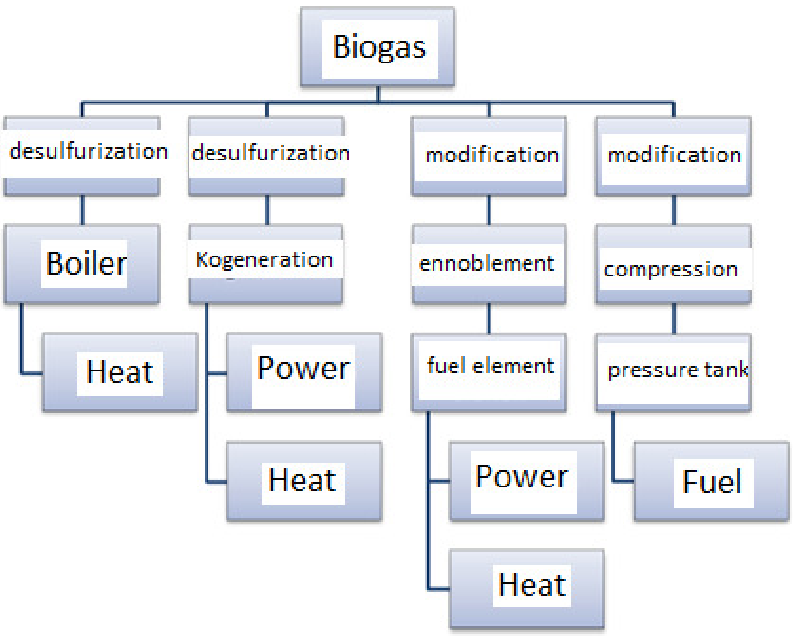

Figure 1 - Energetic utilization of biogas

The basic parameters for the production of biogas are:

Gas power - this is the amount of gas that occurs under normal conditions the biogas plant. It is reported daily volume of produced gas falling on 1 m^3 digestion tank or 1 livestock unit (LU). Average gas output is 0.96 m3/LU.day.

Gas yield - this is the total amount of gas collected from the substrate during the contact time. It can also be related to one LU per unit volume of the digester or per 1 m^3 of fresh slurry. But here it must take into account the difference in water content. Therefore, it is preferable to indicate the quantity obtained per 1 kg organic dry matter. The average gas yield is 0.33 m3/kg.

The degree of decomposition - indicates the percentage of organic solids which were spread over a period of contact. Complete decomposition at the level of mineralization is theoretically possible, but only if in the substrate is not lignin, which the methane bacteria are not able to decompose. However, in practice this is not desirable, because this decomposition would require a long contact time, and that means higher financing costs. Another reason why the substrate does not decompose completely is that the substrate must remain in the organic material for the production of humus, since the digested substrate is used as a fertilizer. Average value decomposition is 43.5%.

Contact time - input material in the digester - fermenter is related to the temperature of the fermentation process. It has a great influence on the degree of decomposition. Short time of contact brings high power gas, but on the other side a low gas yield and degree of decomposition. For long time of contact the power gas decreases, but the gas yield and the degree of decomposition increases. The contact time is calculated by partitioning the tank volume daily dosage the amount of a substrate. When using manure as substrate it should be taking into count with these listed residence times:
• Process temperature 20-25 ° C - contact time of 60 to 80 days,
• Process temperature 30-35 ° C - contact time of 30 to 35 days,
• Process temperature 45-55 ° C - contact time of 15 to 25 days.
On the gas yield has a great impact type of organic solids.

The net proceeds of gas - this is the amount of gas which left from the gross yield after use and after deduction of the energy needed to support the process. In today's modern biogas plants is the net proceeds from 65 to 70 % of gross revenue, for 100 % gas utilizations throughout the year. Energy consumption to support the process would be low – it is necessary to achieve the greatest percentage of dry matter in the substrate.

Composition and quality of biogas - biogas quality is mainly determined by the ratio of combustible methane - CH_4 to unhelpful carbon dioxide - CO_2. Carbon dioxide dilutes biogas and causes increased costs for gas storage. Methane content in biogas depends primarily during the fermentation process, track nutrients in the substrate and the temperature of substrate.
For the evaluation of the performance of biogas plants the most important indicator is the content of methane. By the considering we need to take into account not only of the quantity of gas, but also on the content of methane in it. The biogas is also a hydrogen sulfide (H_2S) and trace elements of ammonia (NH_3) , molecular nitrogen , hydrogen and oxygen . Their proportion is about 6-8 %. Fresh biogas contains saturated water vapor, which can cause problems during combustion in engines and boilers. Therefore, it is very important to drying gas, whereby, together with condensed water is removed too much of the ammonia, which is located in the gas.

4. OPERATION OF THE BIOGAS PLANT

Biogas plants consist of an entrance (homogenization) tank digester, digestion tank - fermenter , which includes gas-tank , output tank which is designed for the storage of digested materials from end-use by cogeneration unit , equipment for utilization of waste heat and other auxiliary equipments for processing and transport of biogas and its Energetic utilization. Biogas plant scheme is shown in Fig. 3. The most important part of any Biogas plant is a fermented. Fermenters are designed horizontally or vertically. Horizontal fermenters have priority in the possibility of installing powerful, functionally safe and energy efficient mechanical stirrers. Their disadvantage is requirement of large space, oversize of tank surface in proportion to its volume and the impossibility of vaccination of fresh substrate by bacterial flora of the digested material.

The block diagram in Fig. 2 describes the energy balance of biogas plants. The input stock is biomass (corn silage, grass silage, biodegradable waste). Energetic inputs are also electrical energy to drive the mixers and conveyors and transportation fuel for transport fermenter part of biomass - digestate.

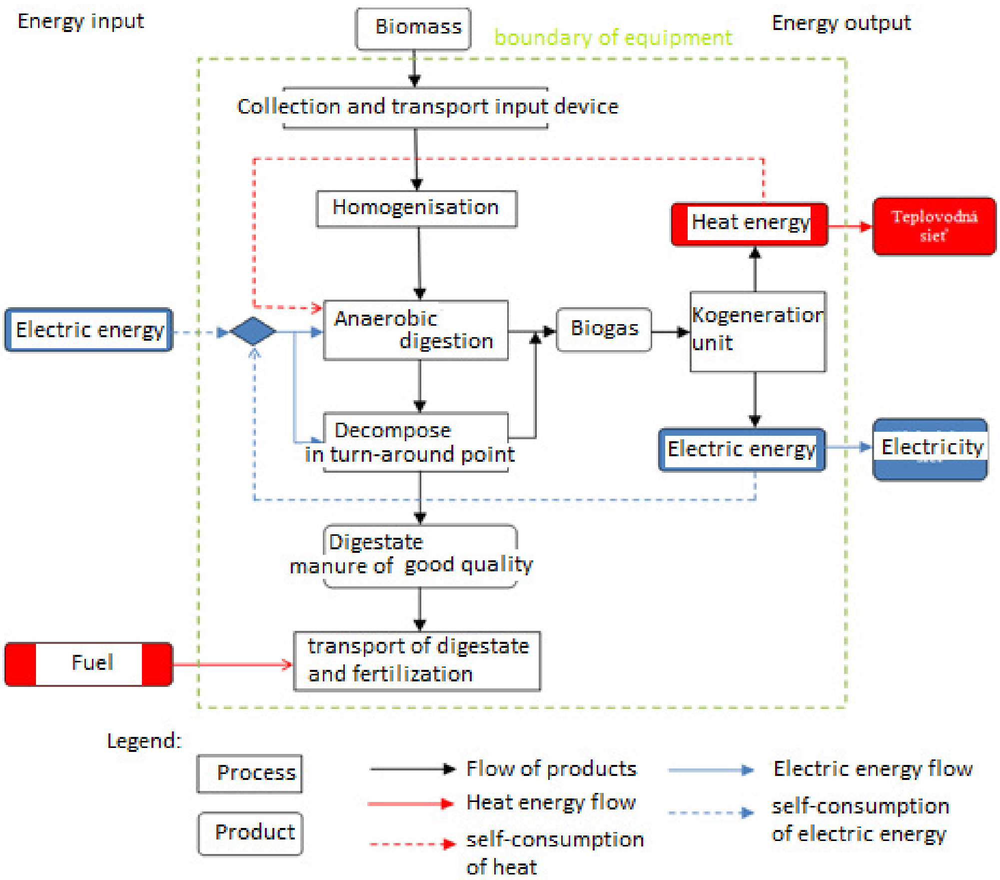

Figure 2 – Block diagram of energy balance of biogas plant

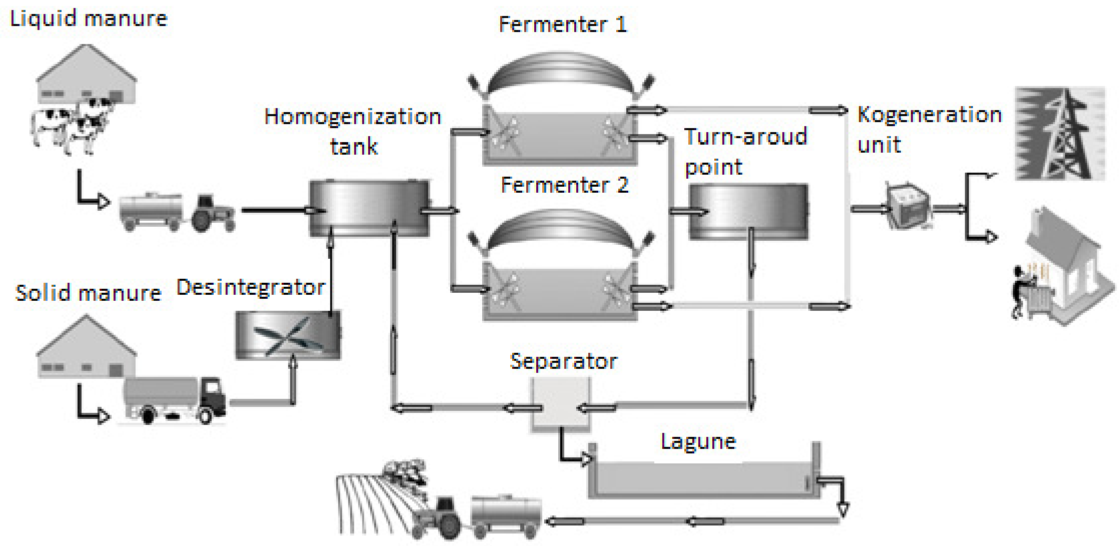

Figure 3 – Scheme of biogas plant

5. CONCLUSIONS

Biogas plants are an appropriate way to diversify energy sources and thus contribute to reducing dependence on imported fossil fuels. They also contribute to the improvement of the regional economy and increase employment. However, with the development of biogas plants must also take the development of electricity supply system, because biogas plants represent decentralized resource which operates certain retroactive effects on the system, which was primarily designed for centralized electricity generation.

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