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BIOGAS FROM ORGANIC WASTES

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ABSTRACT
In the surroundings of the biogas-works – that will be established – the available biomass potential can be more or less various and differing composition in the works. We need a special instrument to determine the technological parameters that certify the maximum methane output. With help of this set-up we can make biogas technological experiments by changing of parameters that influence the process of biogas production. These experiments can be made similar to works conditions with measuring of all necessary parameters.
Keywords: organic wastes, biogas, ecological system

INTRODUCTION

It can be determined the possibilities of energy production based on biomass from changing of basic function of agricultural production, from increasing of demand for renewable energy sources and from increasing of low efficiency of current biomass utilization for energy purposes. **[Nagy, 2006.]** The biomass based energy systems base on agricultural production that accompanies human history for thousands of years, so do not be afraid that resulting in this way energy carriers just run out. **[Somogyvári, 2007.]** Fundamental task to satisfy energy demands fully with minimizing energy use, furthermore should prevail increasingly the ecological thinking during design and operation of different kind of technical equipment and facilities. **[Nemcsics, 2003.]**

In the previous practice of the EU the purpose of establishment and operation of biogas plants was typically disposal of different kind of wastes and by-products, the energy producing occurred as a yield. But now this tendency in the EU, so also in Hungary has changed basically: the purpose is economical operation of biomass based energy produced and utilized facilities. The Hungarian experimental results and the experiences of biogas producing make opportunity and motive to establish connected biogas producing and utilizing technologies which realize complex, biomass based, closed production cycle.

It is necessary such basic materials which degrade easily and has high carbon content for profit interested biogas production, the matter with low nutrient content we use as a puffer matter. The biogas production is the most economical when the basic material supply is based on the local agricultural and food industrial wastes and by-products. The economy of the biogas plants for environment protection can get better if the biogas plants are built on the process of material flow of the fermentors. The biogas production just can be competitive against the traditional energy, if we consider it with its complex advantages and we support proportional according t benefits for social. **[Petis, 2009.]** In our direct surrounding it is found plant and animal origin organic matter, all they can be basic material and the additive of biomass.

BIOMASS BASED ENERGY PRODUCTION

In parallel with running out of the fossil energy sources the renewable energy resources appreciate, however, global necessity of the environment production requires the substitution of traditional/conventional energy resources. The biogas is one of renewable energy.

In fact the biogas is the indirect conversion of some solar energy stored in natural organic matter to gaseous energy carrier by anaerob fermentation. So the biogas is the end product of the microbiological fermentation (metabolic product of the methane bacteria). It is a mixture, which consists of methane gas and carbon-dioxide. Its energy content can be determined from methane quantity. **[Kaltwasser, 1983.]; [Schulz – Eder, 2005.]** Biogas and methane quantity getting from organic matter per volume depend on quality features of organic matter and also the technological parameters of the biodegradation. Before establishment of biogas plants it is necessary to make laboratory experiments controlled the degradation of organic matter and then should be made increased scale, continuous operating mode experiments represented work circumstances and conditions. With our laboratory that includes also experimental fermenter system it can be contributed to preparatory work so it can be based the establishment of biogas plants as well as it can be reduced risk of the realization. **[Szabó – Nagy, 2008.]**

In the biogas plants we often use different kind of by-products and wastes as well as plant biomass grow for energy use to enhance the biogas yield and to improve the quality. The biologically active slurry in high concentration and quantity and the distillery residues mean potential hazard, but these can be utilised as basic material in the biogas plants according to EU practice. **[Nagy – Meggyes, 2008.]**

The biogas is a gaseous matter that is similar to natural gas, it can be utilised many ways. During selecting the energy producer unit the fundamental requirement is

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that be realized the biogas utilization with good energetic efficiency. The biogas has different combustion and compositional characteristics compared to natural gas, so it is need different condition system compared to combustion of natural gas. **[Kapros, 2009.]** The biogas producing experiments are looking for answer to the question whether can get biogas with suitable quantity and quality for utilization from basic material and additives with added characteristics. **[Meggyes – Nagy, 2009.]**

BIOGAS (BIOMETHANE) PRODUCTION EXPERIMENTS, OR WASTE DISPOSAL

Used wastes during the biogas (biomethane) production are: pig manure and distillation residue of fruit (fruit marc). The reason for the choice is that the first step of prevailing of ecological thinking is predomination of the principles of sustainability, indeed the most effective environmental investment is recycling of organic wastes. Besides the biologically active thin manure in high concentration and quantity, which is a source of potential environment pollutant in animal breeding, the residues of distillation can also serve as the basic material of biogas production, which takes form on the course of the production of alcohol, and in distillery. On the course of the production of 1 hectoliter alcohol take form 27.5 lit distillery residue (waste of alcohol production), the reaction of which is sometimes strongly acidic.

This paper presents the biogas producing, wastes disposal experiments which we made under mezophyl circumstances with these wastes. We performed our experiments in a specially self-developed laboratory. The period of the experiments is 43 days (10, February 2010 – 24, March 2010). We loaded the experimental fermentors with ~40 dm^3 pig manure (slurry), the fermentors have ~50 dm^3 useful capacity and then on the 17th day (after homogeneity and stabilization process period) we applied different treatment combinations in each fermentor:

- Fermentor 1: we changed 50 V/V% of the fermentor content to fruit marc (20 dm^3 manure + 20 dm^3 fruit marc)
- Fermentor 2: we changed 25 V/V% of the fermentor content to fruit marc (30 dm^3 manure + 10 dm^3 fruit marc)
- Fermentor 3: we changed 80 V/V% of the fermentor content to fruit marc (8 dm^3 manure + 32 dm^3 fruit marc)
- Fermentor 4: we changed 10 V/V% of the fermentor content to fruit marc (36 dm^3 manure + 4 dm^3 fruit marc)
- Fermentor 5: we changed 5 V/V% of the fermentor content to fresh pig manure

During the comparative experiments (started from the 18th day to 40th day of the experiments) we continued the treatments modelled the continuous biogas producing technology in the fermentors in such a way that we changed 5 V/V% (2 dm^3) biodegraded biomass of the fermentor content to fresh biomass. The change – kept the rates which are applied on 17th day – happened follows:

- Fermentor 1: 1 dm^3 pig manure + 1 dm^3 fruit marc
- Fermentor 2: 1,5 dm^3 pig manure + 0,5 dm^3 fruit marc
- Fermentor 3: 0,4 dm^3 pig manure + 1,6 dm^3 fruit marc
- Fermentor 4: 1,8 dm^3 pig manure + 0,2 dm^3 fruit marc
- Fermentor 5: 2 dm^3 pig manure

In the fermentors during the comparative experiments we modelled continuous loading biogas producing technology under circumstances outlined bellow.

- temperature of the fermentor content 36.2 – 37.9 °C
- anaerobe environment
- during homogeneity the pH values sign basic medium
- dry content (dry solid) 3-5 %

During our experiment we controlled regularly technological circumstances they are necessary for anaerobe fermentation, we registered the quantity and the composition of generated biogas, we tested the characteristics of the input and output material for analyzing intensification effect of different treatment combinations.

TEST RESULTS

In the homogeneity (1-7 days) and the stabilization period (8-17 days) we registered the biogas production in each fermentor, and then in the comparison period (18-40 days) of the experiments besides the quantity of biogas we registered also the methane content of biogas and we analyzed the effect of different recipes on the biogas and methane production. In the *table 1* it can follow the test results of the experiments, the effect of treatments on biogas production and on methane content of biogas.

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Table 1 Biogas production of different kind of treatment combination

Days	Fermentor 1 50:50		Fermentor 2 75:25		Fermentor 3 20:80		Fermentor 4 90:10		Fermentor 5 K	
	biogas produc-tion *[dm³]*	methane content *[%]*	biogas produc-tion *[dm³]*	methane content *[%]*	biogas produc-tion *[dm³]*	methane content *[%]*	biogas produc-tion *[dm³]*	methane content *[%]*	biogas produc-tion *[dm³]*	methane content *[%]*
1.	0		0		0		0		0	
2.	0		8		8.0		9.0		9.0	
3.	12		26.0		10.0		13.0		9.0	
4.	18		32.0		12.0		22.0		23.0	
5.	24.3		39.7		18.0		32.7		42.0	
6.	24.3		39.7		18.3		32.7		36.0	
7.	24.3		50.0		18.3		37.2		31.0	
8.	36.0		51.0		20.0		46.0		27.0	
9.	36.0		36.0		29.0		45.0		25.0	
10.	36.0		43.0		39.0		45.0		25.0	
11.	25.0		41.0		24.0		44.9		24.0	
12.	36.0		43.0		24.0		44.7		25.0	
13.	36.0		44.0		37.0		45.0		23.0	
14.	36.0		44.2		39.0		44.7		27.0	
15.	27.0		50.0		36.0		32.0		24.0	
16.	31.0		32.0		29.0		26.0		25.0	
17.	18.0		18.0		27.0		24.0		23.0	
18.	80.7	73.1	71.0	76.4	The system has become acidic, so produced gas had high carbon-dioxide content in the comparison period of the experiment		92.0	54.1	27.0	54.6
19.	82.0	73.6	69.7	75.3			57.0	53.6	21.0	54.4
20.	82.0	73.5	69.0	76.1			57.7	53.4	21.0	54.7
21.	83.0	74.2	69.0	76.5			57.7	53.9	21.7	54.8
22.	80.6	74.9	43.0	74.3			58.0	65.2	18.0	55.7
23.	76.4	74.1	54.0	71.2			57.0	62.2	16.0	57.9
24.	71.0	68.2	66.0	69.7			66.0	57.3	22.0	56.3
25.	65.0	67.8	67.0	72.2			64.0	53.2	24.0	52.2
26.	63.2	68.3	42.7	74.2			57.0	54.1	22.7	54.8
27.	63.4	68.9	53.0	76.4			60.0	53.6	22.6	57.4
28.	63.0	72.6	63.0	77.1			59.0	51.3	22.8	59.3
29.	56.0	64.3	61.0	66.8			52.0	54.7	21.0	56.3
30.	61.0	66.9	67.0	71.6			59.0	56.3	24.0	56.1
31.	61.0	66.7	62.0	69.6			59.0	57.8	23.0	56.3
32.	59.0	68.1	53.0	74.1			63.0	58.1	31.0	57.1
33.	58.0	67.6	63.0	70.2			67.0	57.2	40.0	54.1
34.	56.2	68.4	61.1	70.1			64.3	56.9	40.1	54.2
35.	56.4	66.9	59.0	71.1			63.4	58.7	52.0	54.0
36.	55.9	67.2	62.0	69.6			61.0	60.2	27.0	53.2
37.	53.0	64.3	66.0	69.8			61.1	56.4	25.0	50.7
38.	58.0	62.5	59.0	69.8			61.7	53.4	28.0	48.2
39.	60.0	66.5	61.0	68.9			66.0	53.5	25.0	50.6
40.	77.0	65.9	65.0	69.4			63.0	53.4	27.0	51.1
41.	54.0	67.4	68.0	68.7			54.0	53.6	21.0	51.3
42.	51.0	68.2	48.0	69.8			47.2	52.1	26.0	48.4
43.	50.0	67.3	46.0	67.6			47.0	52.4	27.0	48.6
average (18^{th} - 40^{th} days)	66.17	68.89	61.15	72.19	-	-	61.99	56.02	26.17	54.52

Comments:

K_kontroll (this fermentor contains only pig manure)

50:50_this fermentor contains 50 % pig manure, 50 % fruit marc

75:25_ this fermentor contains 75 % pig manure, 25 % fruit marc

20:80_ this fermentor contains 20 % pig manure, 80 % fruit marc

90:10_ this fermentor contains 90 % pig manure, 10 % fruit marc

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Data of *table 1* it can be determined that because of mixed in different rates – created different conditions for formation of biogas (biomethane) – organic wastes which were involved in the test the biogas production capacity of each fermentor changed greatly compared to production of the control fermentor which contains only pig manure.

According to the data of comparison period the biogas production of control fermentor (Fermentor 5) is behind the treated fermentors. The biogas production of treated fermentors is 2.3-2.5-fold of control fermentor. The fermentor (Fermentor 4) which contains 10 percent waste of alcohol (fruit marc) considering the produced biogas though shows significant differences compared to the production of control fermentor, but the methane content of generated biogas is similar compared to the methane content of biogas in the control fermentor.

Among the fermentors which contain 25 percent and 50 percent waste of alcohol (fruit marc), the fermentor with 50 percent waste of alcohol (Fermentor 1) proved to be more productive, however, considering the methane content of produced biogas the fermentor with 25 percent waste of alcohol (Fermentor 2) able to produce ~5 percent higher methane content values. Noted that methane content of produced biogases can consider harmonized (compensated) in both fermentor, the methane contents which was measured in comparison period was 10-20 percent higher in every case like the methane content of produced biogas in control fermentor.

It can be also observed that the fermentor which contains 80 percent waste of alcohol (Fermentor 3) can not operate stable, indeed the system has become acidic, it was indicated by approx. 5.21 units pH of the fermentor content which was measured in comparison period. In every case it is necessary to keep the pH of the fermentor content in basic range, being that the methane bacteria like basic environment. In this fermentor was produced gas had high carbon-dioxide content in comparison period of experiment.

CONCLUSIONS

Producing and utilization of renewable energy sources is motivated by not only energy policy, environment protection, competitiveness but rural development aspects. Energy utilization of biomass originated from agriculture can create odds, opportunity for catch up for Hungarian region, Hungarian agriculture. But present situation and future situation of biomass production for energy is contested, the economy is influenced strongly by trends of global market.

Biogas producing experiments bellows

- It can be experienced significant differences considering treated fermentors compared to the control fermentor (Fermentor 5).
- Waste of alcohol (fruit marc) has acidic pH so it can be applied only in limited quantities and conditions in biogas systems.
- In the case of biomass which contains 50 % percent higher rate of waste of alcohol (organic wastes with acidic pH) the biogas system becomes acidic, becomes unfit for producing biogas (biomethane).
- The biomass which contains 25 and 50 percent waste of alcohol (fruit marc) means a potential biogas producing method considering both quantity of produced biogas, both methane content of biogas.
- It can be created favourable conditions with applied recipes for producing a potential renewable energy source – biogas (biomethane) – , and also the waste disposal realizes simultaneously biogas production.

To save status of our environment and to satisfy energy demands effectively and economical it can be solved solely with harmonized application of traditional and renewable energy sources. So in our days the priority tasks to take advantage of perspectives which lie in the utilization of biogas produced from organic wastes – like an universal energy carrier – for energy. **[Meggyes – Nagy, 2009.]**

In Hungary there is past of the biogas producer sets adapted on the agriculture. Nevertheless, economic assessment of the biogas producing, and the utilization is still not clear. In every case we have to take into consideration the energy demands of facilities and it must be added available material during the year which consist of by-products in suitable quantity and quality. Adapted to the characteristics of available material must take into consideration the process with improved technology. Until today in the agriculture and in the industry the main product had always a decisive role for formation of the production value. Only in the recent years the utilization of by-products and waste received good attention. During the rate of investment costs of biogas production and rate of return period have to take into considering both the income of sold biofertilizer and the advantages of environment protection, too.

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