OPTIMIZATION OF THE BIOGAS PRODUCTION IN THE ROMANIAN FARMS CONDITIONS

Naghiu Livia, Al. Naghiu

Universitatea de Ştiinţe Agricole şi Medicină Veterinară Cluj-Napoca

Abstract. *In the paper there are presented the results of the BIOGEF research project that was carried on by and integrate team and was focus on the biogas production in the small medium farms conditions. Anaerobic digestion provides possibilities to produce renewable energy from organic wastes in decentralized sites, producing a methane rich biogas from manure (human and animal) and crop residues. Apart from supplying renewable energy the biogas plants have other positive effects including the strengthening of closed loop recycling management systems, reducing emissions from manure storage and producing a valuable organic fertilizer. It can also create new sources of income for farmers.*

Keywords: biogas, bioenergy, farm

INTRODUCTION

Under EU Regulation No. 1774/2002, a biogas plant means a plant in which biological degradation of products of animal origin is undertaken under anaerobic conditions for the production and collection of biogas (4).

The research was focus on the opportunity for biogas production in Romania and establishing the optimum technical solutions. Thus, biomass resources from Romanian agricultural farms were identified and characterized (3). Another object was to identify the distribution of the energy consumption in the agricultural farms and in the farm area. An energetic evaluation of biomass resources from agricultural farms has been conducted in order to determine the potential of biomass as energy resource.

For Romania, the energetic potential of agricultural residues are at a level of 230 ... 270 ktoep (depending on the level of cereal production).

The analysis of biogenic material from the existing farms in our country shows its high potential. Biogas plants can function using the manure from different animal species. Thus, different studies have shown that on can rely on the following minimum yield: 0.6 m3 biogas/day for one cow manure, 0.15 m3 biogas/day for one pig manure; 0.1 m3 biogas/day for one sheep manure, 0.01 m3biogas/day for one bird manure.

Taking into account the diversity of pedoclimatic conditions, the Romanian economic and social conditions, there is a large diversity of farms, each with distinct characteristics. Given the destination of agricultural production, farms in our country can be divided into: farms for making commercial products and subsistence farms.

The vast majority of Romanian farms are of mixed type, having in addition to crop production, a livestock production sector (977 · 103 farms with $0 \leq 5$ UZ, 183 103 farms with $5 \leq 50$ UZ and 3,2 · 103over 50 UZ).

Anaerobic digestion provides possibilities to produce renewable energy from organic wastes in decentralized sites, producing a methane rich biogas from manure (human and animal) and crop residues. Apart from supplying renewable energy the biogas plants have other positive effects including the strengthening of closed loop recycling management systems, reducing emissions from manure storage and producing a valuable organic fertilizer. It can also create new sources of income for farmers (3).

Improved utilization of animal manure has a central role in the efforts to decrease the environmental effects of farming. Unlike the other renewable energy sectors, biogas production did not mainly result from concerns over energy but rather from environmental preoccupations (elimination of pollution, treatment of waste, control of greenhouse gas emissions). Anaerobic digestion means the bacterial breakdown of organic materials in the absence of oxygen. This biochemical process produces a gas, called biogas, principally composed of methane and carbon dioxide. The fossil fuel, natural gas, is primarily methane too but usually of a higher quality than biogas and with a mix of other combustible hydrocarbons.

Anaerobic digesters produce conditions that encourage the natural breakdown of organic matter by bacteria in the absence of air. Anaerobic digestion provides an effective method for turning residues from livestock farming and food processing industries into:

- ⇒ **Biogas** (rich in methane) which can be used to generate heat and/or electricity
- ⇒ **Fibre** which can be used as a nutrient-rich soil conditioner,
- ⇒ **Liquor** which can be used as liquid fertilizer

It has been used in the agricultural sector in the form of small on-farm digesters producing biogas to heat farmhouses, dairies and other farm buildings. Experience has shown that an anaerobic digester is most likely to be financially viable if it is treated as part of an integrated farm waste management system in which the feedstocks and the products from anaerobic digesters all play a part. Larger scale centralized anaerobic digesters (centralized anaerobic digesters) have also been developed, using feedstock imported from a number of sources.

After the fermentation of raw materials used to produce biogas results a sludge that is separated into two parts: one liquid part called sludge water and one that is more consistent called coarse sludge. Both water sludge and coarse sludge, resulting from biogas fermenters, are some very good fertilizers for agricultural soils. The fermented sludge contains complex chemicals that contribute over time to restore humus, an essential part of a breeding ground. The fertilizing value of fermented sludge resulted from biogas production process has been widely recognized, and this was also confirmed in all countries that produce biogas.

Thus, a study for the physico-chemical characteristics of sludge has been realized together with the treatments applied to sludge in order to use them as fertilizers. It contains: the current status of soil fertility under increasing degradation processes, local resources of organic matter and nutrients, optimal conditions for the agricultural application of sludge and the influence sludge on soil properties and crop plants. The monitoring requirements have also been identified: criteria for land suitability in the application of sludge, maximum amount of heavy metals reported per ha and year that can be introduced on agricultural land through the sludge resulted from biogas production.

MATERIAL AND METHOD

The optimization of the technology for biogas production from biomass, started with the elaboration of the laboratory technology. It was taken into account the need for the plant to be flexible in what concerns the different substrate types that can be used together with different operating temperatures. For the design of biogas laboratory technology from biomass, after a brief review of general considerations, the technology was designed, widely exposing the premises that formed the theoretical basis and there was a brief description of "key" problems considered: the reactor and the assurance of reaction conditions taking into account the inhibitors and poisons, the temperature of the compost inside the reactor, the residence time using different types of bacteria. The technological solution is situated between clean technologies for superior capitalization of biomass, together with sludge recovery as fertilizers. For the design of biogas flow technology the several main technical parameters have been established (reaction vessel volume, type of reaction vessel: horizontal or vertical, continuous or discontinuous, the maximum operating temperature biogas collection method).

Fig. 1. The experimental anaerobic vertical digester

During the laboratory experiments it was used substrates based on the cattle and horse manure.

RESULTS AND DISCUSSION

The research results are presented synthetically in the bellow tables.

Table 1

Analyze of the chemical substrate - cattle manure

Specification	U / M	Values measured	Testing method	Uncertainty of measurement (k=2)
Humidity	%	72,17	*SR ISO 11465 – 1998*	10,0 %
Losses at calcination	%	88,3	*SR EN 12879 / 2002*	10,0 %
TC (total carbon)	g / kg	470	Company standard	10,0 %
Total nitrogen (N_T)	%	1,83	*STAS 7184/2– 85* SR ISO 7150-1:2001	10,0 %
Aluminium (Al)	mg / kg	578	*SR ISO 11466:1999 SR EN ISO 11885 : 2009*	10,0 %
Calcium (Ca)	mg / kg	11102		10,0 %
Cadmium (Cd)	mg / kg	< 1,0		10,0 %
Total chromium (Cr_T)	mg / kg	< 1,0		10,0 %
Copper (Cu)	mg / kg	30,2		10,0 %
Total iron (Fe_T)	mg / kg	827		10,0 %
Total phosphor (P_T)	mg / kg	12130		10,0 %
Magnesium (Mg)	mg / kg	6503		10,0 %
Manganese (Mn)	mg / kg	194		10,0 %
Molybdenum (Mo)	mg / kg	< 1		10,0 %
Nickel (Ni)	mg / kg	3,75		10,0 %
Potassium (K)	mg / kg	4026		10,0 %
Sodium (Na)	mg / kg	1583		10,0 %
Zinc (Zn)	mg / kg	94,85		10,0 %
Plumb (Pb)	mg / kg	0,66		10,0 %

Table 2

Chemical analysis of the substrate - horse manure

Characteristic	UM	Value
Methane content (vol.)	%	56
Chlorine	mg/MJ	<2,7
Fluorine	mg/MJ	<1,4
Chlorine and fluorine	mg/MJ	<2,7
Total sulphur	mg/MJ	<20
Solid particles (maximum dimension)	mg/Nmc	<10(<10micron)
Oil (not in a liquid form)	mg/Nmc	<400
Silicon	mg/Nmc	<0,10
Relative humidity	%	<90
Gas temperature	˚C	10 – 50
Gas pressure	kPa	2 – 10

Table 3

Characteristics of the BIOGEF biogas

Specification	U / M	Values measured	Testing method	Uncertainty of measurement (k=2)
Humidity	%	74,5	*SR ISO 11465 – 1998*	10,0 %
Losses at calcination	%	91,12	*SR EN 12879 / 2002*	10,0 %
TC (total carbon)	g / kg	450	Company standard	10,0 %
Total nitrogen (N_T)	%	1,9	*STAS 7184/2– 85* SR ISO 7150-1:2001	10,0 %
Aluminium (Al)	mg / kg	827	*SR ISO 11466:1999* *SR EN ISO 11885 : 2009*	10,0 %
Calcium (Ca)	mg / kg	10289		10,0 %
Cadmium (Cd)	mg / kg	< 1,0		10,0 %
Total chromium (Cr_T)	mg / kg	< 1,0		10,0 %
Copper (Cu)	mg / kg	17,03		10,0 %
Total iron (Fe_T)	mg / kg	1377		10,0 %
Total phosphor (P_T)	mg / kg	11415		10,0 %
Magnesium (Mg)	mg / kg	3228		10,0 %
Manganese (Mn)	mg / kg	59,2		10,0 %
Molybdenum (Mo)	mg / kg	< 1,0		10,0 %
Nickel (Ni)	mg / kg	5,33		10,0 %
Potassium (K)	mg / kg	8810		10,0 %
Sodium (Na)	mg / kg	3238		10,0 %
Zinc (Zn)	mg / kg	< 1,0		10,0 %
Plumb (Pb)	mg / kg	47,5		10,0 %

CONCLUSIONS

The experimental results are showing the high potential of biogas production in the case of the Romanian agricultural farms.

Successful implementation of BIOGEF technology depends on several key elements that ensure high efficiency and a quality product: ►reactor and ► reaction conditions.

Depending on the composition of substrates that are introduced in the digesters of the biogas production plant, a wide range of sludge facilities can be obtained with different content of fertilizing macro and microelements.

Currently less then one percent of the potential benefits from anaerobic digestion are being used. Reasons for this include the obstacles such as the legislative framework and the lack of economic incentives for potential investors. Countries like Denmark, Germany, Austria and Sweden promote effective mechanisms to produce biogas from organic wastes by political measurements.

REFERENCES

1. Bhatia, R., Pereira, Eds. (1988). Socio-economic Aspects of Renewable Energy Technologies. Praeger, New York.
2. Goldenberg, J. Thomas Johnson (1995). Energy as an instrument for socio-economic development, UNDP, New York, pag 10-11
3. Kopetz H, (1998). Bioenergy in Europe, European Conference on Renewable Raw Materials, p118-126
4. Naghiu, Al. (2008). Baza energetică pentru agricultură şi silvicultură, Editura Risoprint, Cluj-Napoca, ISBN 978-973-751-689-3