THE IMPACT OF WEATHER CONDITIONS ON THE PARAMETERS OF LANDFILL GAS PRODUCTION

Tamás MOLNÁR
University of Szeged,
Faculty of Agriculture, Animal Nutrition and Engineering Institute,
Hódmezővasárhely, Andrássy út 15.
A.S.A. Ltd. Hódmezővásárhely,
NRG-AGENT Ltd. Kecskemét

Abstract

People deal with the issue of the biogas originating from the decomposition of municipal waste since it is demonstrable, that on the Earth the natural and antropogen methane and carbon dioxide emission contributes to the development of the phenomenon called greenhouse effect and the general public suddenly realised the significance of the problem caused by the potential decrease of the fossil energy sources. The researches were carried out on the refuse dump in Hódmezővásárhely, where the changes of the parameters of the biogas gained from the waste were examined in relation to the weather parameters. When measuring, we record the data of the meteorological station at the refuse dump (temperature, wind-speed, rainfall) and they are processed by computer programmes. The obtained results are analysed by mathematical methods and presented in graphs.

Keywords

landfill gas, anaerob digestion

1. Introduction

With the growing number of man and with the development of technology the amount of waste is increasing. We must take care of waste management in order to protect the environment. The „A S A Hódmezővásárhely Köztisztasági Ltd." collects and stores communal waste in refuse dumps in the region. The refuse dump of Hódmezővásárhely was among the first to be built on the basis of strict environmental protection regulations and meets the requirements of the EU. The refuse dump can store 3,9 million m3 refuse that is able to provide environment friendly storage for the refuse of Hódmezővásárhely and its environs for 50 years. The problem of biogas from the decomposition of communal waste got into the focus of attention since it was proved that on the Earth the natural and antopogen methane and the carbo-dioxide emission contribute to the so-called glass-house effect. (Barótfi 2000).

2. Materal and method

2. Examination objective

The objective of my examinations is to determine the quality parameters of the produced landfill gas considering weather parameters.

2.1 Examination method

At the refuse dump a computer data collection system and a meteorological station was available for the examinations of the produced landfill gas quality.

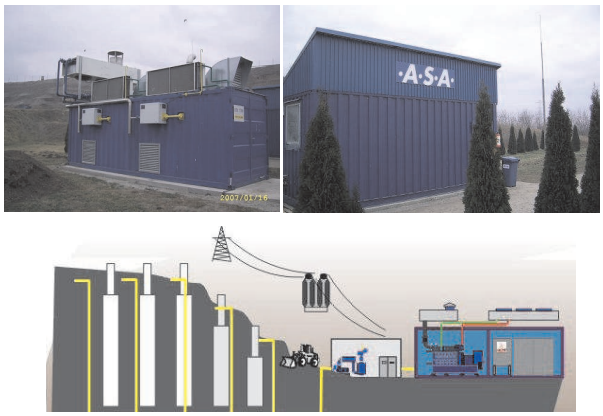

Figure 1. The location and landfill gas production system of „ASA Hódmezővásárhelyi Köztisztasági Kft" refuse dump

2.2 The location of the measuring systems at the refuse dump

The communal solid waste refuse dump of the „A S A Hódmezővásárhely Köztisztasági Ltd." works in the outskirts of Hódmezővásárhely on the area No. 01957/1. The refuse dump and the adjacent buildings are situated on a 20 ha area; the top height of deponias are 30 m. The measuring system is located in the container unit on the premises of the refuse dump. The vent pipes of the waste unite in a common pipe located in a shaft then, going through the measuring system, they join a gas-motor power plant for the energetical utilisation of the landfill gas.

2.2.1 The elements of deponia gas extracting system (Figure 2)

Gas well ⇒ Gas collecting pipes ⇒ Gas controller unit ⇒ Compressor unit ⇒ Cogenerational power station

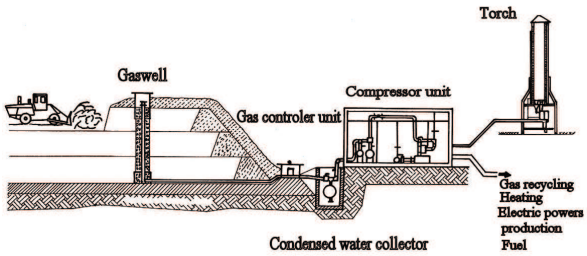

Figure 2. Process figure of gas production

2.2.2 The measuring points of gas-wells

When preparing the measuring system three measuring points were established. Measuring point 1 is the two measuring cones, one for measuring the applied depression and the other is for measuring the quality compound of the landfill gas and the opening angle of the sluice valve.

- p = depression [Pa]
- α_{ki} = sluice valve opening angle [o]

Measuring point 2 is situated at the vacuum pump. Pressure values can be measured in front of and behind the pump, and thus the amount of the produced landfill gas can be calculated.(Figure3).

$$\Delta \mathbf{p} = \frac{\rho}{\mathbf{2}} \cdot v_K^{\,2} \Rightarrow \mathbf{v_k} = \sqrt{\frac{2\Delta p}{\rho}}$$

$$V_k = A \cdot v_k$$

- V_k = The potential amount of landfill gas [m^3/s]
- V_t = The produced amount of landfill gas [m^3/s]
- A = Pipe diameter[m^2]
- $V_t > V_k$

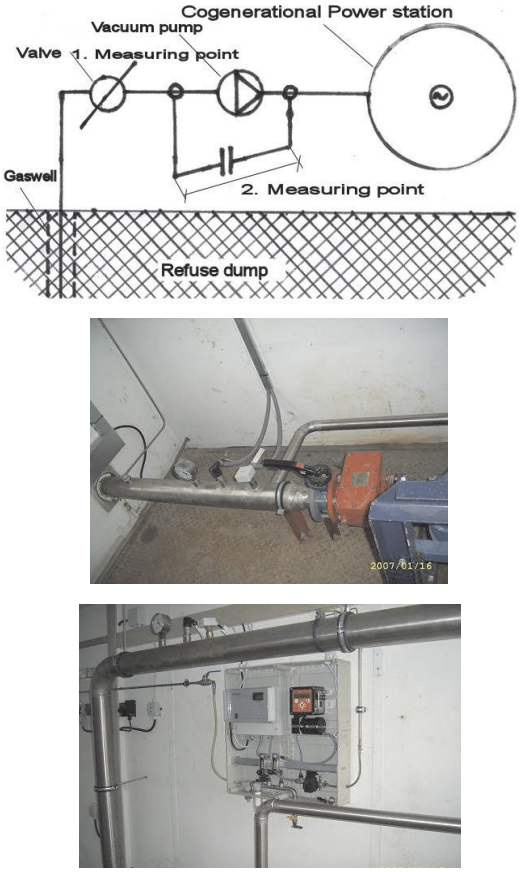

Figure 3. The location of the measuring systems at the refuse dump

2.2.3 The quality parameters of landfill gas

- CH_4 Methane [%]
- CO_2 Carbon-dioxide [%]
- O_2 Oxygen [%]

2.3 Data provided by the meteorological station

Measuring point 3 is located at the meteorological station of the refuse dump. It provides the weather parameters

- T_{ki} = external temperature [Co], φ = air humidity [%]
- v_{sz} = windspeed [m/s], h = rainfall intensity [mm/h]
- P_h= local atmospheric pressure (QFE), P_t = sea level pressure (QNH).

3. Results

3. The quality-parameter changes of landfill gas produced at the refuse dump with regard to the average temperatures

The examinations were carried out at 4 gas-wells, where the daily temperature values measured by the meteorological station were compared with the quality parameters of landfill gas, as they are shown graphically. The results are summarised by the diagram-series of Figure 4. The quality parameters of landfill gas produced at the gas-wells are within the range of CH_4 = 40-70%. The graphs indicate that the methane content values of the landfill gas changes considerably near average temperature values. The main reason for this can be the fact that it is not only the average temperature that affects landfill gas production but also the organic-matter-content of the gas-well. The amount of precipitation in the examination period has a significant influence as well. Considering the diagrams it is obvious that in case of gas-wells 1 and 2 the qualitative and quantitative variation is more remarkable. It was probably caused by the unfavourable compound of the organic-matter at the gas-wells and also the mechanic failures (obstruction, condensate). In case of gas-wells 3 and 4 the qualitative parameters of the landfill gas are within a certain dispersion guaranteeing the safe operation of the gas-well and the elements of the technology

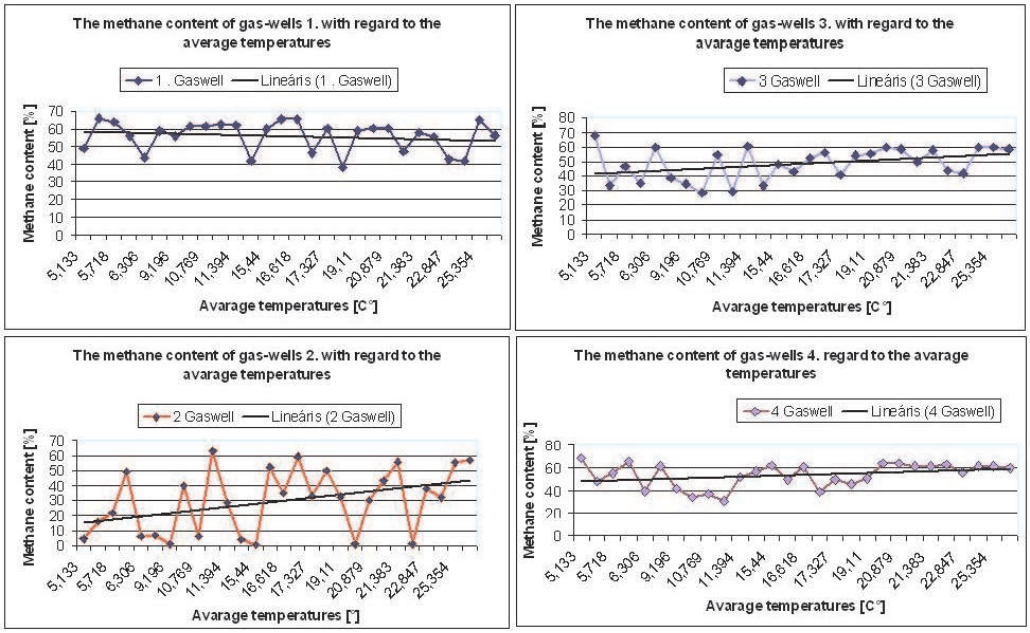

Figure 4. The methane content of gas-wells 1-4 with regard to the average temperatures

My examinations and measurements showed that the correlation between the quality of the landfill gas and the outside average temperature is not considerable. The main reason for this can be that the outside temperature does not influence directly the quality parameters of the landfill gas owing to the thickness and the insulation-effect of the waste.

However, there are weather conditions (outside temperature and precipitation amount) that affect landfill gas production positively. For instance, if sufficient amount precipitation falls and the outside temperature is low. These together enhance landfill gas production and improve its quality.

3.1 The quality-parameter changes of landfill gas produced at the refuse dump with regard to wind speed

The examinations were carried out between 2007. 01. 31. – 2007. 10. 10.; the wind speed values measured by the meteorological station were compared with the quality parameters of landfill gas, as they are shown graphically. The data were classified according to wind-speed then the methane content values were added and presented in a graph. In Figure 5 we can see he methane content variation of the landfill gas with regard to wind-speed.

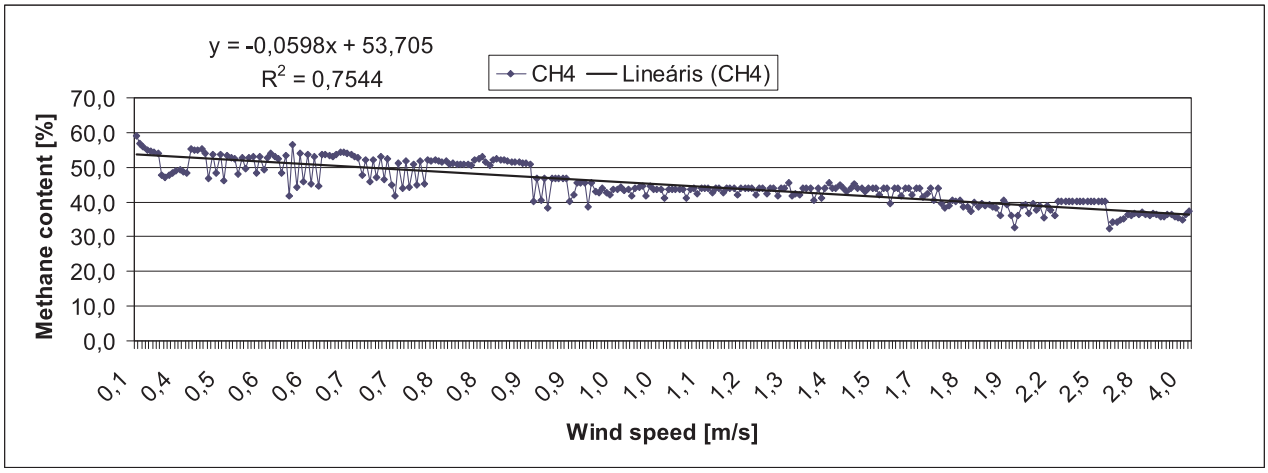

Figure 5. The methane content of landfill gas with regard to wind speed

3.2 The quality-parameter changes of landfill gas produced at the refuse dump regarding precipitation intensity

The examinations were carried out between 2007. 01. 31. – 2007. 10. 10; the precipitation intensity values provided by the meteorological station were compared with the quality parameters of landfill gas, as they are shown graphically. The data were classified according to precipitation intensity then the methane content values were added and presented in a graph. In Figure 6 we can see the methane content variation of the landfill gas with regard to precipitation intensity.

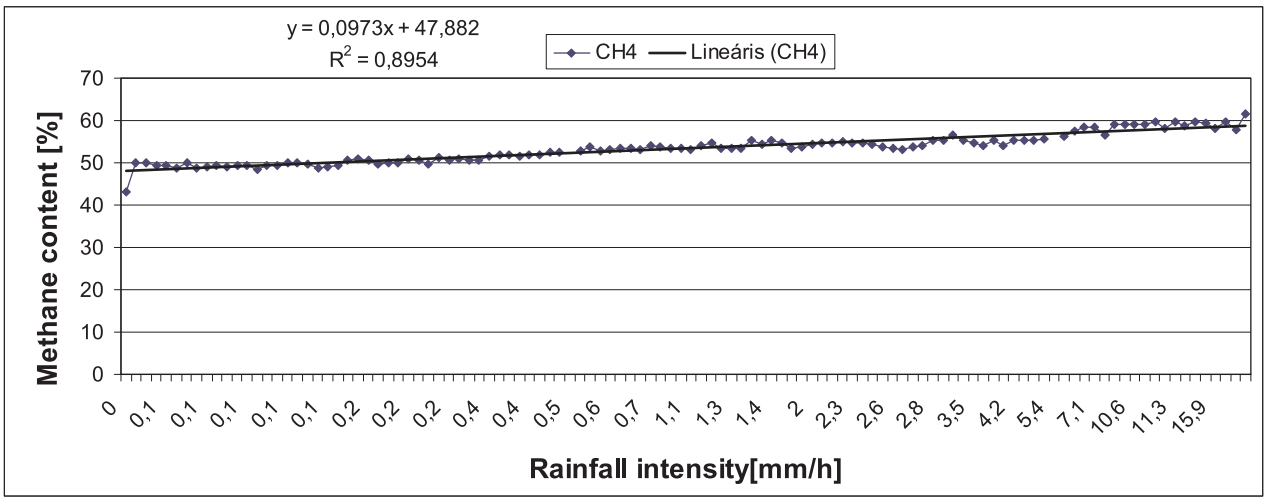

Figure 6. The methane content of landfill gas with regard to precipitation intensity

3.2 The quantity of landfill gas produced at the refuse dump at the examination period

The landfill gas produced at the refuse dump is utilised at a co-generation power plant. The annual quantity of the landfill gas used in the power plant and the produced electricity is shown in Table 1. The quantity of landfill gas used in the examination period is a total of 227441,12 m^3, the produced and utilised electricity of the co-generation power plant is 377,96 MWh, the annual energetic efficiency is 35,18 %, the fuel-use is 3866,499 GJ, the number of gas-engine operating hours is 5840,17 h, and the number of peak hours is 3350,49 h.

4. Conclusions

With an increasing wind speed the methane content values measured at the gas-wells decrease as the velocity of the air at the sides of the waste-dump increases. It results in vacuum in the centre of the waste dump (heap) and it counteracts the size of suction applied inside the waste-dump; thus the system will over-

concentrated and the oxygen-content will rise. While the quantitative values increase the qualitative parameters of the landfill gas will deteriorate. From the weather parameters the air pressure values also affect the qualitative parameters of the landfill gas. Therefore we can conclude that the air pressure at the refuse dump will change the methane content of the landfill gas: in case the air pressure rises the methane content of the landfill gas will also rise. All knowledge connected with biogas is beneficial for technological process. The efficient examination of quantity and quality parameters of the refuse dump where the gas is originated is very significant and this can give new useful results for the practice. The examinations were carried out at four gas-wells where we put the data of the daily temperature provided by the meteorological station and the changes of the parameters of biogas in proper order and these data were illustrated on a chart and it shows well that the qualitative differences of the gained biogas are notable. On the refuse dumps these differences can influence the energetics exploitation to a great extent.

Table 1. The quantity of landfill gas produced at the refuse dump in the examination period

Month	Fuel use [MJ]	Energy MWh	Hours (h)	**Landfill gas [Nm^3]**	Average consumption [m^3 / h]
January	308557,00	30,16	442,25	**18150,41**	41,04
February	420995,00	41,15	508,25	**24764,41**	48,72
March	347083,00	33,93	425,75	**20416,65**	47,95
April	123926,00	12,11	199,04	**7289,76**	36,62
May	95497,00	9,34	153,00	**5617,47**	36,72
June	246676,00	24,11	395,36	**14510,35**	36,70
July	387113,00	37,84	619,18	**22771,35**	36,78
August	393978,00	38,51	630,17	**23175,18**	36,78
September	278931,00	27,27	446,15	**16407,71**	36,78
October	388382,00	37,97	621,23	**22846,00**	36,78
November	484933,00	47,40	775,70	**28525,47**	36,77
December	390428,00	38,17	624,09	**22966,35**	36,80
Total	**3866499,00**	**377,96**	**5840,17**	**227441,12**	

5. References

1. Barótfi I.: Környezettechnika kézikönyv. Mezőgazda Kiadó, Budapest, 2000

2. A.S.A. Hódmezővásárhely Köztisztasági Kft.: A hódmezővásárhelyi hulladéklerakó telep környezeti hatástanulmánya. Hódmezővásárhely, 2000

3. Tabasaran O. Gas production from landfill. In: Bridgewater AV, Lidgren K, editors. Household waste management in Europe, economics and techniques. New York: Van Nostrand Reinhold Co.; 1981. p. 159–75.