Gas to Energy Opportunity on Landfill In Novi Sad – Serbia and Montenegro

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EXECUTIVE SUMMARY

Novi Sad is capital of province Vojvodina with about 350,000 citizens and municipal waste production about 100,000 t/year with growing tendency about 1% per year. Landfill in Novi Sad is open since 1985 and estimation amount of waste on landfill is about 1.500,000 t. In last few years small amount of waste was recycled and reused, but the biggest part of all waste is disposed of to landfill.

Under process of biochemical degradation of organic waste occur productions of landfill gas which contain high percentage of methane. Presence of methane makes LFG as energy and economic valuable. In this case the biggest problem is unavailability of data from previous time. Therefore it is only possible to make rough estimation about amount of landfill gas.

Collection and use of landfill gas is obligation in almost every developed country as in EU. Serbia and Montenegro is having as the strategy to go towards EU standards.

In the paper a few different scenarios about amount of LFG is discussed and for each scenario is given most useful and economic valuable solution. We believe that this paper contributes to waste management solutions in developing and in transition countries.

Keywords: Landfill, landfill gas, methane, waste amount, waste management

INTRODUCTION

Landfill can be presented as biochemical reactor with solid municipal waste and moisture as input and leach water and landfill gas as products. Few years after storage waste on landfill starting process of biochemical degradation. By process of biochemical degradation under specific condition after time beginning production of landfill gas. Process of degradation contains 4 phases. In every phase landfill gas has different composition. Finally in last phase LFG have composition as shown in table 1. This composition remains till the end of production.

Landfill sites are fourth biggest source of methane and biggest source made by the man. There is a global trend of growing of population and also growing of waste production per capita. For those reasons production of landfill gas became bigger and bigger problem.
Novi Sad landfill has the annual lying down of 100,000 t of municipal solid waste. It lies on the area of 56 ha, and has the average municipal solid waste layer of 6 m. It has been in use since 1968. Analyzing the increase in population with the amount of 1.20 kg of waste per resident, it is expected that the area from which the municipal solid waste is being taken would generate 141,000 t by 2021. Furthermore, using the experience and analyses it is calculated that the annual amount of municipal solid waste laid down in the landfill in the period between 1986 and 1995 was approximately 90,000 t per year. Novi Sad landfill is one out of the two landfills in Serbia fulfilling the main conditions for proper lying down.

Also, at the landfill ground, drilling has been done and gas wells have been placed. One of the first projects at the landfill in Novi Sad has been the project for determining the structure and the amount of landfill gases with the aim of gaining data. Data processing would present information useful for the future managing of municipal solid waste lying down. Landfill gas censoring monitors and analyses filtered water from the landfill. After landfill gas censoring and water analysis, data processing continuous towards making risk assessment, total amount of separated CH₄ and CO₂ estimates and towards analyzing possible landfill gas usage for energetic or some other feasible purposes.

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>Range 35 – 60 %</td>
</tr>
<tr>
<td></td>
<td>Average 50 %</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>Range 35 – 55 %</td>
</tr>
<tr>
<td></td>
<td>Average 45 %</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Range 0 – 20 %</td>
</tr>
<tr>
<td></td>
<td>Average 5 %</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Range 0 – 2,5 %</td>
</tr>
<tr>
<td></td>
<td>Average &lt; 1 %</td>
</tr>
<tr>
<td>Amonia</td>
<td>N.A.</td>
</tr>
<tr>
<td>NMOC</td>
<td>Range 237 – 14.294 ppmv</td>
</tr>
<tr>
<td></td>
<td>Average 2.700 ppmv</td>
</tr>
<tr>
<td>Sulfids</td>
<td>Range 1 – 1.700 ppmv</td>
</tr>
<tr>
<td></td>
<td>Average 21 ppmv</td>
</tr>
<tr>
<td>Carbon monoxid</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

( Sandelli G.J.,1992)

Table 1. Composition of Landfill gas

COMPOSITION OF LFG

Landfill gas contains many chemical compounds, with great domination of methane and carbon dioxide. Both mentioned gases are green house gases, which take a significant role in global warming of planet.

As shown in table 2. methane have global warming potential (GWP=21) and in concentration (4.5 – 15%) with oxygen can create explosive mixture. Methane also can be easily used as source of energy. Because all previously mentioned reasons now there is an intention to resolve that problem if possible with economic benefit.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Global Warming Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>1</td>
</tr>
<tr>
<td>Methane</td>
<td>21</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>310</td>
</tr>
</tbody>
</table>

Table 2. GWP of LFG constituents

Disposal of to landfill of solid waste is last of many solutions in managing of solid waste in developed countries. Few decades ago started process of discovering new solutions to
reuse waste materials to provide less costs and decrease using of new sources. Today there are a large number of solutions to recycle and reuse materials. Most known are reuse of paper, aluminum cans etc.

Besides the high percentage of recycle and reuse always remain significant amount of waste which only could be placed on landfill.

By regulation solid waste must be disposed on sanitary landfill, demanding great financial resources.

In undeveloped and developing countries, larger part of solid waste is organic waste. Organic waste under certain conditions degrades and change physical and chemical characteristic. As an outcome of that biodegradation is production of landfill gases with CH₄ and CO₂ as major compounds. Besides those gases there is smaller amount of N₂O, sulfides and other non methane organic compounds.

**DETERMINATION OF LFG QUANTITY AND ACCESSIBILITY**

Most important information in LFG management is quantity of LFG on landfill and availability of gas. Data about amount of gas can be determinate by using specialized software for that kind of calculation. One of EPA`s most recommended software for determination of amount of LFG per year is LANDGEM. Using that simply software solution and knowing necessary data, result of calculation could be given in graphic form and in text form.

In last few year on landfill in Novi Sad concentration of methane was measured minimum few times per season. Measurement was conducted on representative places. It was discovered that concentration of methane, as other gases contained in LFG, depends of many factors, especially of climate factors. Many measurements was made on different weather, temperature, humidity, wind etc. Following graphs shows measured concentration on various air temperatures:
Methane measurement result, measurement point S3-4

Methane measurement result, measurement point SL-1

Methane measurement result, measurement point SL-2

Methane measurement result, measurement point S3-10

Graph 1. 12 days methane measurement result on representative point

Graph 2. 12 days methane measurement result on point SD-1
CONCLUSION

Methane represents about 50% of LFG that could be used on many ways:

- Burning to produce heat
- For gas turbines
- For generating electricity
- As a fuel

Basic barrier of methane usage is low and variable flow of methane as after effect of variable concentration of methane in LFG. Low flow and concentration result with small amount of methane per day and high price per kWh, often much higher than fossil fuels.

Conducted measurement showing that methane concentration and availability are variable depends on weather conditions but collected data are not enough to make right conclusion. Future plans are based on continuous measuring of methane and its availability.

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