Greenhouse Gas Emissions from a Landfill

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ABSTRACT – An average of 855 tons of solid waste is being disposed in Sanliurfa everyday without being subjected to a recycling process. Currently, the Sanliurfa Municipality stores the solid waste 7km in the southeast of Sanliurfa, in the Ikizce village in the west of the Sanliurfa-Akcakale road controlled by Sanliurfa Municipality. In this study, the daily analyses of the greenhouse gases CH₄, CO₂, and N₂O will be made of the simulation of present situation in a laboratory scale. There are three different type of cover material used in this simulation. Also; the meteorological data will be followed during the course of the analyses. In light of these analyses, the gas amounts will be recorded with the closed chamber method daily. Average greenhouse gas emissions of CH₄, CO₂, and N₂O without cover were measured as $1.4 \pm 0.1 \ \mu g/m^2/hr$, $325.8 \pm 249.7 \ \mu g/m^2/hr$, and $2.3 \pm 2.0 \ \mu g/m^2/hr$, respectively.

Keywords: greenhouse gas emissions, CH4 emission, CO2 emission, N2O.

I. INTRODUCTION

A major part of municipal solid waste disposed of in landfills consists of organic carbon, which is partly microbiologically degradable resulting in greenhouse gas emissions such as methane (CH₄) and carbon dioxide (CO₂). CO₂ from landfills is greenhouse effect-neutral due to its biogenic origin, and the amount negligible compared to other CO₂ producing sectors such as industry and transport. On the other hand, CH₄ is a more powerful greenhouse gas.

CH₄ is the main component of landfill gas (LFG) produced from anaerobic degradation of Municipal Solid Waste (MSW) and represents one of the most important anthropogenic greenhouse gas emission sources [1-2]. 3-7% of global total CH₄ emissions generated by landfills [3-4]. Since CH₄ has stronger molar absorption coefficient for infrared radiation and longer atmospheric residence time, over a time period of 100 years, the global warming potential for CH₄ is 25 [5]. The global atmospheric concentration of CH₄ has increased from a pre-industrial value of about 715 up to 1732 ppb (parts per billion) in the early 1990s, and was 1774 ppb in 2005 [6]. The atmospheric increases are mainly caused by anthropogenic activities, accounting for more than 60% of the total CH₄ budget [6].

Worldwide, CH_4 emission from the waste sector is about 18% of the global anthropogenic CH_4 emission, with landfills being the main source estimated to release between 35 and 69 Tg CH_4 per year to the atmosphere [7]. In the United States, as well as in Europe, waste disposal represents the second largest source of anthropogenic CH_4 emission, comprising approx. 22% of the total anthropogenic CH_4 emission [8-9]. However, these projections are based on estimated and modelled rates of CH_4 production applied to national statistics for disposed waste and not on actual landfill field emission measurements, since whole landfill methods to measure real data for national greenhouse gas emission inventories for Turkey, and even for site-specific measurements are still missing.

N₂O is a well-known greenhouse gas accounting for approximately 5% of the total greenhouse effect [10] Agricultural soils contribute approximately 50% of the World's anthropogenic N₂O emissions [5] and currently this source of N₂O represents 2.4% of the European release of anthropogenic-derived greenhouse gasses [11]. Nitrous oxide (N₂O), a greenhouse gas with a 296-fold global warming potential compared to that of CO_2 over a 100-year time span [5, 12]. The N₂O emission has grown by 50% since 1970 and 11% since 1990, mainly due to the increasing use of fertilizers in agricultural fields [12]. N₂O is produced mainly by microbial processes in soils, as by-products of nitrification and an intermediate product of denitrification [13-14]. Higher N₂O emission is largely stimulated by the fertilizer application, i.e., the application of mineral fertilizers, poultry manure, sewage sludge, and the drying-wetting cycles caused by irrigation or precipitation [15-18].

 N_2O emissions have been detected in landfills and attributed in the main to processes in the cover [7, 19-20] and in some cases directly to methanotrophic activity [20]. Thus, properties of the cover material used to support CH₄ oxidation may be important for N₂O emissions [21].

An average of 855 tons of solid waste is being disposed in Sanliurfa everyday without being subjected to a recycling process. Currently, the Sanliurfa Municipality stores the solid waste 7km in the southeast of Sanliurfa, in the Ikizce village in the west of the Sanliurfa-Akcakale road controlled by Sanliurfa Municipality. In this study, we have measured the CH₄, CO₂, and N₂O emissions in a laboratory scale with a material from municipal solid waste (MSW) made of the simulation of present situation of the Sanliurfa landfill various situations, no cover material, 1-cm-thicken cover material, and 1.5-cm-thicken cover material, has also been studied during April 2011–July 2011.

II. MATERIAL AND METHODS

Sanliurfa Municipality stores the solid waste 7km in the southeast of Sanliurfa, by the Ikizce village in the west of the Sanliurfa-Akcakale road controlled by Sanliurfa Municipality. An average of 855 tons of solid waste is being disposed in Sanliurfa everyday without being subjected to a recycling process. Landfill and cover material from Sanliurfa Landfill site is taken for laboratory scale study. There are three types of cover materials are used to assess real landfill situation. There are three different cover type studied in this study, which are no cover, 1-cm thicken, and 1.5cm-thicken cover material. There are three replicates has been studied. 4 kg of landfill material was put in each big pot and then cover material was put in each pot. After that, 4 kg of landfill materials were poured them in and for each part compress with hand and leave their top open of each pot. The pots were leaved on the top of Department of Environmental Engineering of Harran University.

A. Emission Measurements

In order to determine the amount of gas emissions in the landfill, the closed chamber method is used. We used a cylindrical closed chamber which has diameter of 20 cm and height of 17 cm and has about 0.5 diameter hole top of each chamber. LFG emitted from cover soils accumulated in the headspace of the collection chamber. A minimum of 10-mL headspace gas samples was withdrawn into 10-mL polyethylene syringes at predetermined interval of 30 min. LFG concentrations were immediately analyzed using a green-house gas chromatograph with an ECD, FID and metanizer detector (SRI Instruments) LFG fluxes were calculated with the following equation [17, 22-25]:

$$\mathbf{f} = (\mathbf{V}/\mathbf{A}) \ (\mathbf{C}/\mathbf{t}) \tag{1}$$

Here, f is gas emission, $\mu g/m^2/d$; V is closed chamber's volume, m³; A is closed chamber's section, m²; C is the gas concentration measured in closed chamber, mg/m³; t is the duration of taking a pattern, day.

Samples were undertaken every day between April 2011 and July 2011. Average air temperatures of sampling times were 28.4°C. Gas samples were collected 10:00 and 14:00 for each day.

III. RESULTS

3.1 Effect of cover material

The effect of cover material between garbage levels across the sampling period is shown in Table 1.

	Gas Emission, µg/m²/hr		
Gas	No cover1 ^a	1-cm-cover	1.5-cm-cover
CH ₄	1.4 ± 0.1	1.5 ± 0.1	1.5 ± 0.1
CO_2	$325.8 \pm$	$386.3 \pm$	$305.5 \pm$
	249.7	330.6	220.9
N_2O	2.3 ± 2.0	3.2 ± 2.7	2.7 ± 2.1

a The evaluation is average ± standart deviation.



Figure 1- Monthly CH₄ emissions



Figure 2- Monthly CO₂ emissions



Figure 3- Monthly N₂O emissions



Figure 4- Monthly mean temperatures

Monthy trends of measured mean gas emissions are shown in Fig. 1-3. Also monthy air temperatures are shown in Fig. 4. Monthy average CH₄ emissions were almost constant during sampling period. CO₂ and N₂O emissions were increased in May 2011 almost constant during sampling period after that decreased and become constant. Since raining occurred in May 2011, N₂O emissions were increased. Overall, CH₄ and N₂O emissions were nearly constant except raining occurs. CO₂ emissions were decreased by the time.

IV. CONCLUSIONS

Using different type of covering has no effect on greenhouse gas emissions. This study was the simulation of greenhouse gas emissions of a landfill that finishes accepts new garbage. This study is helped missing LFG inventory of Turkey.

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