Journal of Asian Multicultural Research for Medical and Health Science Study
ISSN: 2708-972X
Vol. 3 No. 3, 2022 (page 010-015)
DOI: https://doi.org/10.47616/jamrmhss.v3i3.303

Analysis of Air Pollution Levels Due to Methane (Ch4) Emissions at Final Disposal Site

Afsana Israt[1]

[1]Public Health Faculty, Bangladesh University of Health Sciences, Bangladesh

Received: June 5, 2022 Received in Revised: July 9, 2021 Accepted: July 16, 2022

Abstract

Methane gas, often known as CH4, is created by landfills and is considered to be one of the greenhouse gases that contribute to climate change. The anaerobic breakdown of the organic matter that is present in trash is the process that leads to the release of methane. Methane emissions are likely to increase if the Final Disposal Site's garbage is allowed to continue to accumulate in larger mounds without being processed further. The purpose of this study is to determine the amount of methane that is already being released at the DH City landfill and to forecast the amount of methane that will be released from the DH City landfill over the following ten years. As a point of reference, the IPCC Waste Model Calculation method is used in the process of calculating methane emissions from Final Disposal Sites. According to the findings, the amount of garbage generated reached 0.449 kg per person each day, with organic waste making up the majority of the waste's composition. At the DH City Final Disposal Site, the potential value of methane emissions is 2.24 Gg/year, and according to the projections for 2026, this value will increase to 4.968 Gg/year. The socialization of reduce, reuse, and recycle procedures as well as the creation of the already existent Open Dumping Landfill are two examples of mitigation and adaptation measures that might be advocated to others.

Keywords: Final Disposal Site, Garbage, Emissions, Methane

Introduction

In metropolitan places, one of the most common problems that might be encountered is that of garbage, and DH City is no exception. The extent of the trash problem rises along with the expansion of the city's population, and it becomes a significant issue both in terms of the amount of garbage and the types of waste that are produced in large cities. The creation of trash and the content of the waste, particularly the organic percentage, are directly tied to the potential for the production of greenhouse gases, which in turn will result in the production of greenhouse gases.

The warming of the climate system on a global scale is a very real phenomenon, and since 1950, a large number of researchers have witnessed dramatic changes across periods of time ranging from decades to centuries. Warming is occurring in both the atmosphere and the seas, less snow and ice are falling from the sky, sea levels are rising, and the quantities of greenhouse gases are increasing (Boer et al., 2000). Continued emissions of greenhouse gases will cause an increase in global warming as well as an acceleration of climate change over the whole climate system.

According to the most recent assessment report published by the Intergovernmental Panel on Climate Change (IPCC), the level of greenhouse gas emissions has been steadily rising from 1970 to 2010. This information comes from the Fifth Assessment Report of Working Group III. Emissions of greenhouse gases caused by human activities are increasing at a fast rate.

During the course of the previous year (2000 to 2010). The total quantity of greenhouse gases released into the atmosphere reached 49.5 billion tons (gigatons or Gt) equal to carbon dioxide (CO2) in the year 2010. This is the highest level ever recorded in the history of humanity (IPCC, 2014).

Greenhouse gases are gases that are naturally present in the atmosphere (Shen et al., 2020). Examples of greenhouse gases are carbon dioxide (CO2), methane (CH4), dinitroxide (N2O), and chlorofluorocarbons. Greenhouse gas impacts include the warming of the planet's surface (CFCs) (Kumar, 2018). Climatic change may be caused either directly or indirectly by human actions that modify the composition of the global atmosphere, as well as by the observable natural climate variability over the course of a period of time.

In light of the information presented above, it is necessary to make some additional observations concerning the calculation of waste generation obtained from the DH City Environment Agency. This calculation will serve as a reference when determining the amount of methane that is contained in the waste generated by DH City

Methods

Observational research utilizing a descriptive methodology is the kind that was conducted for this study. Only observations were performed by the researchers in order to provide a description of the distribution of methane (CH4) gas levels in the DH City Final Disposal Area. All of the residential areas around the DH City Final Disposal Site provided the participants for this study's population. The samples for this investigation were taken from two different spots, one of which was a residential neighborhood, and the other was a final disposal site. Point I is located in a residential neighborhood, while Point II is in the region that is designated for final disposal.

Following site observations and measurements of CH4 concentrations in residential neighborhoods and landfills, primary data were collected and analyzed. Secondary data may be gathered from a variety of sources, including references found online and in published works that are pertinent to the topic under investigation. Calculating the data that has been gathered as a result of the study that has been done using a tool known as a calculator Following the completion of the data processing, a descriptive analysis will be performed on the obtained findings.

Results and Discussion

DH City Final Disposal Site Garbage Data

There is a strong correlation between the number of people living in DH City and the quantity of waste that is produced at the city's final disposal site. A growing population is one of the factors that inadvertently contributes to an increase in the quantity of garbage produced. The tables 1 and 2 include information on the generation of waste.

Table 1. DH City Final Disposal Site Waste Generation Annually

Year	Weight (kg)
2015	194.451.559
2016	193.405.111
2017	203.419.001
2018	246.970.841
2019	247.182.733
2020	246.271.225

2021	237.851.884

Table 2. Waste Generation Per Characteristics based on IPCC Standard

Year	Organic	Paper	Wood
2015	149.533.248,9	16.567.273	1.225.044,82
2016	144.686.363,5	17.038.990	1.373.176,29
2017	147.926.297,5	19.467.198	1.403.591,11
2018	187.006.320,8	20.671.459	1.679.401,72
2019	189.638.592,8	21.232.997	1.705.560,86
2020	186.476.571,6	20.612.902	1.674.644,33
2021	182.479.965,4	20.431.477	1.617.392,81

Data Processing

Table 3. Methane Emissions from DH City Landfill Waste Generation assuming population

Year	Waste Generation (kg)	DDOCm (Gg)	Lo (Gg)	DDOCmaT (Gg)	DDOCmdecompT (Gg)	CH_4 (Gg)
2015	191.956.391	9,745	6,231	9,412	0	0
2016	192.679.549	9,982	6,543	19,973	0,563	0,375
2017	202.412.088	10,134	6,674	25,361	1,089	0,726
2018	243.543.512	11,342	6,925	35,669	1,613	1,075
2019	245.345.984	11,536	7,147	44,428	2,232	1,488
2020	247.532.875	12,03	7,368	53,187	2,815	1,876
2021	238.423.021	12,525	7,596	61,946	3,36	2,24

Table 4. Prediction of methane content of DH City Landfill assuming population

Year	Waste Generation (kg)	DDOCm (Gg)	Lo (Gg)	DDOCmaT (Gg)	DDOCmdecopT (Gg)	CH_4 (Gg)
2022	273.477.185,60	11,397	7,579	71,696	3,847	2,565
2023	244.763.552,80	11,689	7,691	79,2	4,305	2,87
2024	216.049.920,00	11,981	7,796	86,21	4,746	3,164
2025	187.336.287,20	12,273	7,90567	93,5493	5,169	3,446
2026	158.622.654,40	12,565	8,01417	100,806	5,586	3,724
2027	129.909.021,60	12,857	8,12267	108,063	5,987	3,991
2028	101.195.388,80	13,149	8,23117	115,32	6,373	4,249

Every year there is a rise in the amount of methane (CH4) that is released into the atmosphere. A calculation of methane (CH4) emissions in the generation of paper waste is carried out in order to determine the methane emissions from the generation according to the characteristics of the waste in the DH City Final Disposal Site. The purpose of this calculation is to determine the methane emissions from the generation. The results of the computation of the methane (CH4) emissions caused by paper waste. To determine the value of methane (CH4) emissions in organic waste utilizing data from 2015-2021 as a review, then it is possible to carry it out for the subsequent years by adhering to the phases of work in 2015-2021.

A calculation of methane (CH4) emissions in the generation of wood waste is carried out in order to determine the methane emissions from the generation according to the characteristics of the waste in the DH City Final Disposal Site. This calculation is carried out in order to determine the methane emissions from the generation. Table 4.12 presents the results of the calculation used to determine the amount of methane (CH4) emissions in wood waste. This was done in order to acquire the value of methane (CH4) emissions in organic waste using data from 2010–2011 as a review.

Effect of Waste Maturity and Thickness on Methane Gas Emissions (CH4)

According to the findings of an examination of the data, it is common knowledge that the age of the trash has a major impact on the amount of methane gas emissions. For the purpose of this investigation, waste samples were collected according to three categories: organic, paper, and wood. The activity of microorganisms that are responsible for degrading garbage is what causes waste to mature to the point where it can be disposed of. Waste that has not been destroyed by microbes is referred to as raw garbage, whereas waste that has been decomposed by microorganisms is referred to as mature waste.

Methane gas is a byproduct of the anaerobic fermentation (decay) of organic matter that is carried out by methane bacteria, also known as methanogens (Zehnder & Stumm, 1988). At the very end of the process of waste degradation, the action of methanogenic bacteria is what happens. At the beginning of the decay process, an aerobic process takes place. This type of decay is caused by microorganisms that need oxygen (O2), and it results in the production of carbon dioxide (CO2), water (H2O), and nitrate. The aerobic decomposition process typically lasts for about two to three weeks, or until the oxygen supply in the waste is significantly diminished, whichever comes first. Then, after all of the oxygen gas has been used, the next stage is the acidic anaerobic decomposition. This process may take anywhere from one to two years and results in a drop in the temperature of the trash. Anaerobic bacteria are responsible for the production of carbon dioxide and organic acids (Gu & Galicia, 2012). In addition, the process of decomposition moves into its last phase, known as anaerobic methane. During this phase, bacterial activity results in the production of methane gas as well as carbon dioxide gas.

The depth of the garbage pile has a considerable bearing on the amount of methane gas that is emitted. In this investigation, the depth of the garbage was assessed using three different parameters: 0 meters, 1.5 meters, and 3 meters. Because anaerobic circumstances are necessary for the action of methanogenic bacteria, the thicker the waste, the stronger the state without oxygen will be supported (anaerobic). The primary contributor of oxygen to waste is the air that we breathe (atmosphere). Because of this, the uppermost layer of trash is often quite oxygenated, which leads to aerobic breakdown of the waste. Because anaerobic decomposition of waste happens in the absence of oxygen, methane gas is produced as a byproduct of the process. The thickness of the layer of trash is directly correlated to the oxygen level.

There is a considerable influence on emissions of methane gas caused by the interplay between the age of the waste and the thickness of the trash. It is possible to demonstrate, at least in theory, that a thick layer of garbage is where the maturation of the waste takes place. It is thus possible to draw the conclusion that the waste's maturity level and thickness will have an effect on the emissions of methane gas.

Effect of Maturity and Acidity (pH) of Waste on Methane Gas Emissions (CH4)

The amount of gaseous metastases that are released into the atmosphere is impacted by the age of the trash. In the same way as it was described in the previous discussion, the action of bacteria during the second phase, which is the anaerobic breakdown of acids, results in the production of leftover substances in the form of carbon dioxide and organic acids. Because organic acids are present, the pH of the waste will drop, and it will become more acidic as a result. The immature (raw) waste has a higher pH than the mature (processed) waste does. The pH of the trash will drop as it matures, and the mature waste will have a lower pH than the raw garbage. As a consequence, the quantity of methane gas emissions is influenced by acidic waste.

The view of Setyanto & Bakar (2005), who asserts that the production of CH_4 gas is influenced by the contents of the waste, including pH, corroborates the assertion that the pH of waste has an effect on the emissions of methane gas. Setyanto & Bakar (2005) says that the pH of waste has an effect on the production of CH_4 gas. Since waste is a dynamic system, the interaction between the environmental conditions of waste and the creation of CH_4 will be extremely unique and will rely on the qualities of the environment in which it is created (Bloemhof-Ruwaard et al., 1995). The creation of CH_4 is directly related to the level of acidity present in both the soil and the trash. This is because acidity has an effect on the activity level of methanogenic bacteria. In general, a pH of 7 provides the best conditions for the methanogenesis process. Methanogenic bacteria are limited in the sorts of substrates and nutrients that they can utilize as an energy source. They can only use a few different kinds of substrates. Additionally, the presence of certain chemicals such as NO_3 and SO_4 might inhibit the formation of CH_4 in a given environment (Bowman, 1990). In this scenario, the presence of organic matter will cause an increase in the rate of fermentative production, which in turn will cause a rise in the production of CH_4. According to Partohardjono (2002), the organic acids that are created during the process of garbage degradation serve as a substrate for the methanogenic bacteria.

There is a substantial correlation between the age of the trash and its acidity, and this correlation plays a role in the releases of methane gas. In the same way that the influence of maturity and thickness on methane gas emissions was explained, the explanation for the fact that waste breakdown activities would create leftover chemicals in the form of organic acids can be found here.

Conclusion

The potential for methane gas (CH_4) emissions from the existing waste sector in DH City is very large. These emissions are estimated to have reached approximately 2.79 gigagrams in 2016, having been generated from 237,851,884 kilowatt-hours of waste generation, almost all of which operate in open dumping. The majority of this gas is created as a byproduct of the process through which paper, wood, and organic waste are broken down. The results of data processing obtained from the prediction of population and waste generation can be used to make a prediction of methane gas (CH_4) emissions at the DH City Final Disposal Site for the next 10 years. These results show that the potential for methane (CH_4) is 6.51 Gg, p until the year 2026. This is a direct proportion to the estimate of the quantity of garbage that will be created in the year 2026, which is 271,609,147.2 kg. The condition of the DH City Final Disposal Site, which is normally moist owing to the climate, as well as the content of organic waste, which is about 60–70 percent, contribute to the significant potential for the production of methane gas (CH_4).

References

Bloemhof-Ruwaard, J. M., Van Beek, P., Hordijk, L., & Van Wassenhove, L. N. (1995). Interactions between operational research and environmental management. *European journal of operational research*, *85*(2), 229-243.

Boer, G. J., Flato, G., & Ramsden, D. (2000). A transient climate change simulation with greenhouse gas and aerosol forcing: projected climate to the twenty-first century. *Climate dynamics*, *16*(6), 427-450.

Bowman, S. (1990). *Radiocarbon dating* (Vol. 1). Univ of California Press.

Gu, T., & Galicia, B. (2012). Can acid producing bacteria be responsible for very fast MIC pitting?. In *CORROSION 2012*. OnePetro.

Kumar, A. (2018). Global warming, climate change and greenhouse gas mitigation. In *Biofuels: Greenhouse gas mitigation and global warming* (pp. 1-16). Springer, New Delhi.

Setyanto, P., & Bakar, R. A. (2005). Methane emission from paddy fields as influenced by different water regimes in Central Java.

Shen, M., Huang, W., Chen, M., Song, B., Zeng, G., & Zhang, Y. (2020). (Micro) plastic crisis: un-ignorable contribution to global greenhouse gas emissions and climate change. *Journal of Cleaner Production*, *254*, 120138.

Zehnder, A. J. B., & Stumm, W. (1988). Geochemistry and biogeochemistry of anaerobic habitats. In *Biology of anaerobic microorganisms* (pp. 1-38).