ANALYSIS OF GREENHOUSE GASES AND ODOR LEVELS AT TPA SUMOMPO, MANADO, NORTH SULAWESI

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ABSTRACT

The research aimed to know the level of odor by hydrogen sulfide (H_2S) and ammonia (NH_3) gases, as well as to determine the level of greenhouse gases pollutant carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) at the Sumompo Waste Landfill, Manado City, North Sulawesi. This research was conducted at the TPA Sumompo, City of Manado and laboratory analyses at Agriculture Faculty from August to November 2020. The study was conducted by measuring parameters of gas greenhouse: sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), and the gas causes the smell of ammonia (NH_3) and hydrogen sulfide (H_2S) at the Manado Sumompo Trash Landfill (TPA) and then analyzed at the PT Global Quality Analytical Laboratory. The research showed that The level of odor pollution of H_2S and NH_3 gases at the Sumompo TPA showed that ammonia (NH_3) has generally passed the quality standard, while the hydrogen sulfide (H_2S) has approached the threshold of standard quality. Then, the sulfur dioxide (SO_2) gas pollution varied from 66.2 to 73.8 µg/Nm^3, and all of which were still below the SO_2 quality standard of 900 µg/Nm^3. The carbon monoxide (CO) gas ranged from 1680 to 2460 µg/Nm^3, all of which are below the quality standard of CO 30,000 µg/Nm^3, and for nitrogen dioxide (NO_2) varied from 61.4 to 76.3 µg/Nm^3, all of which were below the NO_2 quality standard of 400 µg/Nm^3. **mjp**

Keywords: TPA Sumompo, odor polluting gases, H_2S and NH_3

INTRODUCTION

Global warming is a condition of an increase in the average temperature of the earth's surface as a result of excess greenhouse gas concentrations. Increased concentration of carbon dioxide (CO_2) and other greenhouse gases emitted by burning fossil fuels, land clearing, agriculture and other human activities is believed to be the main source of global warming. This global warming is called the greenhouse effect becomes the most important environmental problems. When the Sun energy arrives at the surface of the earth, it changes from light to heat which warms the earth. However, some of the heat remains trapped in the Earth's atmosphere due to the accumulation of greenhouse gases, including water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), sulfur dioxide (SO_2) and methane (CH_4) which traps this radiation wave. These gases absorb and reflect the wave radiation emitted by the earth and consequently heat up the earth's surface. According to Sodhi (2015) contribution greenhouse gases of CO_2 is 50%, CH_4 19%, CFCs 17%, N_2O 4%, O_3 8% and H_2O 2%. Basically, the greenhouse gases come from supply energy 25.9%, industry 19.4%, forestry 17.4%, agriculture 13.5%, transport 13.1%, residential and commercial buildings 7.9% and waste management 2.8%.

The main greenhouse gas in landfill waste comes from carbon dioxide (CO_2), methane (CH_4) and dinitrogen monoxide (N_2O). Greenhouse gases are mainly caused by the landfill waste treatment that uses a system of stacking and over-burning. The combustion system produces more

greenhouse gases CO_2 , N_2O and SO_2, while the dumping system will produce a lot of odorous gases such as CH_4, H_2S and NH_3.

Global warming is a process of rising average temperatures on the atmosphere, ocean, and surface land earth. The abnormal heating of the Earth's surface is known as the 'Greenhouse Effect' (Figure 1).

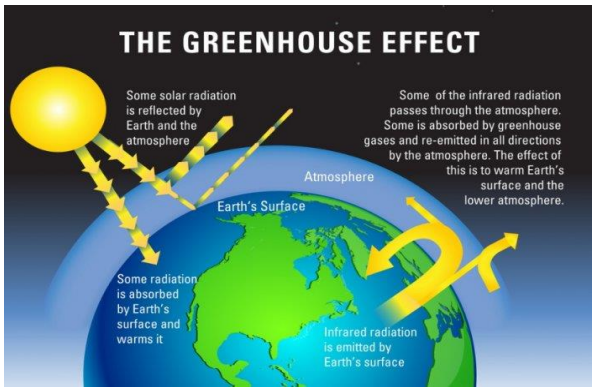


Figure 1. The Greenhouse Effect Process (Source: https://moondoggiesmusic.com/wp-content/uploads/2019/02/Pengertian-Efek-Rumah-Kaca-1.jpg)

The process of global warming begins with sunlight penetrating the air layer (atmosphere) and heating the earth's surface. The earth surface becomes hot and warms the air directly above it. The hot air rises and its position is replaced by cool air. Part of the hot air that rises to the top is retained and reflected back to the surface by the gas in the earth's atmosphere: carbon dioxide (CO_2), methane (CH_4) and nitrogen oxide (N_2O).

The greenhouse effect is caused by the increasing concentration of carbon dioxide (CO_2) and other gases in the atmosphere. The 100% energy that enters earth is 25% reflected by clouds or other particles in the atmosphere, 25% absorbed by clouds , 45% absorbed by the earth's surface, and 10% reflected back by the earth's surface. The absorbed energy is reflected back in the form of infrared radiation by clouds and the earth's surface. However, most of the infrared emitted by the earth is retained by clouds and CO_2 and other gases, to be returned to the earth's surface. Apart from CO_2, which can cause a greenhouse effect are sulfur dioxide (SO_2), nitrogen monoxide (NO) and nitrogen dioxide (NO_2) as well as several organic compounds such as methane gas and chlorofluorocarbons (CFCs).

Based on this description, it is necessary to conduct research on the presence of greenhouse gases and the level of odor in the Sumompo TPA in Manado City. The research aimed to know the level of odor by hydrogen sulfide (H_2S) and ammonia (NH_3) gases, as well as to determine the level of greenhouse gases pollutant carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) at the Sumompo Waste Landfill, Manado City, North Sulawesi. Benefits of this research, can be used to evaluate the level of gaseous pollution of hydrogen sulfide, ammonia, carbon monoxide, sulfur dioxide and their contribution to the current level of greenhouse gas pollutants in the Sumompo TPA, Manado City, North Sulawesi.

METHOD

Place and time of research

This research was conducted at the TPA Sumompo, City of Manado and laboratory analyses at Agriculture Faculty from August to November 2020 (Figure 2).

Measured Gas Parameters

Measured parameter gases in the Sumompo landfill consist of carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), amonia (NH3) and hidrogen sulfide (H_2S).

Measurement Method

Measurement of gas parameters using a method based on the Indonesian National Standard (SNI) is presented in Table 1.

Supporting parameters were also measured at the location, i.e. meteorological data at the time of the measurement, which are presented in Table 2.

Research Implementation

The study was conducted by measuring parameters of gas greenhouse: sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), and the gas causes the smell of ammonia (NH_3) and hydrogen sulfide (H_2S) at the Manado Sumompo Trash Landfill (TPA) and then analyzed at the PT Global Quality Analytical Laboratory.

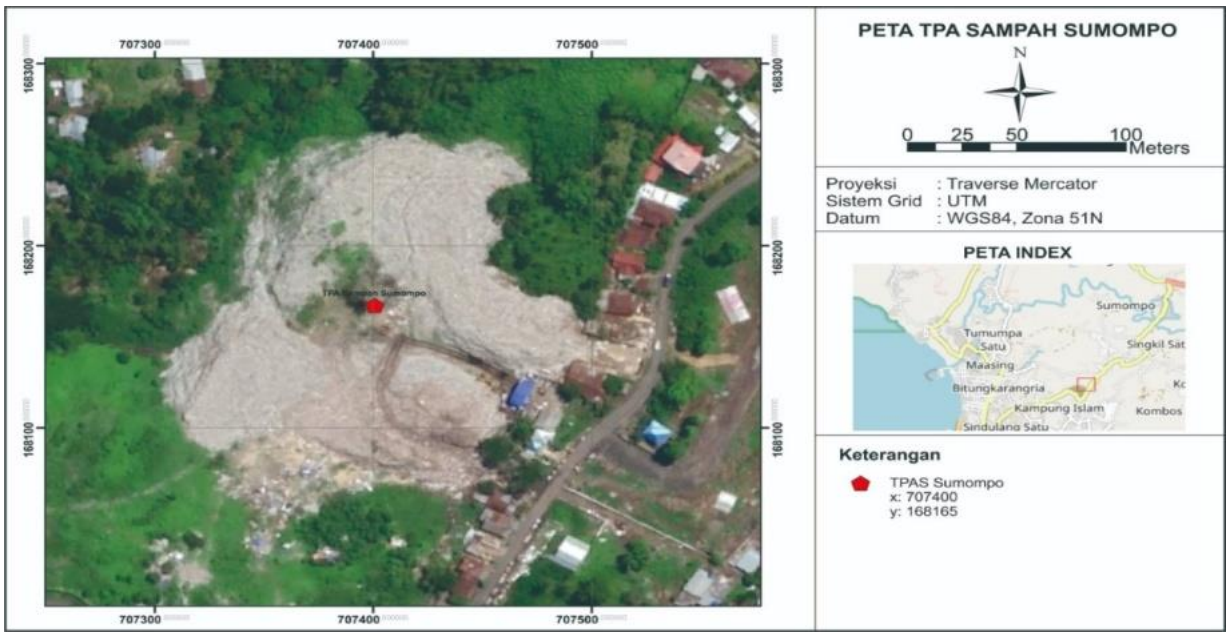


Figure 2. Location Map of Sumompo Garbage TPA

Table 1. Parameters Measured and Measurement Methods

No	Test Description	Sampling Time	Regulatory Limit	Unit	Method
A.	***Ambient Air***				
1.	Sulfur Dioxide, SO_2	1 Hour	900/1H	µg/Nm^3	SNI 19-7119.7-2005
2.	Carbon Monoxide, CO	1 Hour	30000/1H	µg/Nm^3	SNI 19-7119.10-2011
3.	Nitrogen Dioxide, NO_2	1 Hour	400/1H	µg/Nm^3	SNI 19-7119.2-2005
B.	***Odor***				
1.	Amonia, NH_3	1 Hour	2.0	ppm	SNI 06-6989.30-2005
2.	Hidrogen Sulfida, H_2S	1 Hour	0.02		

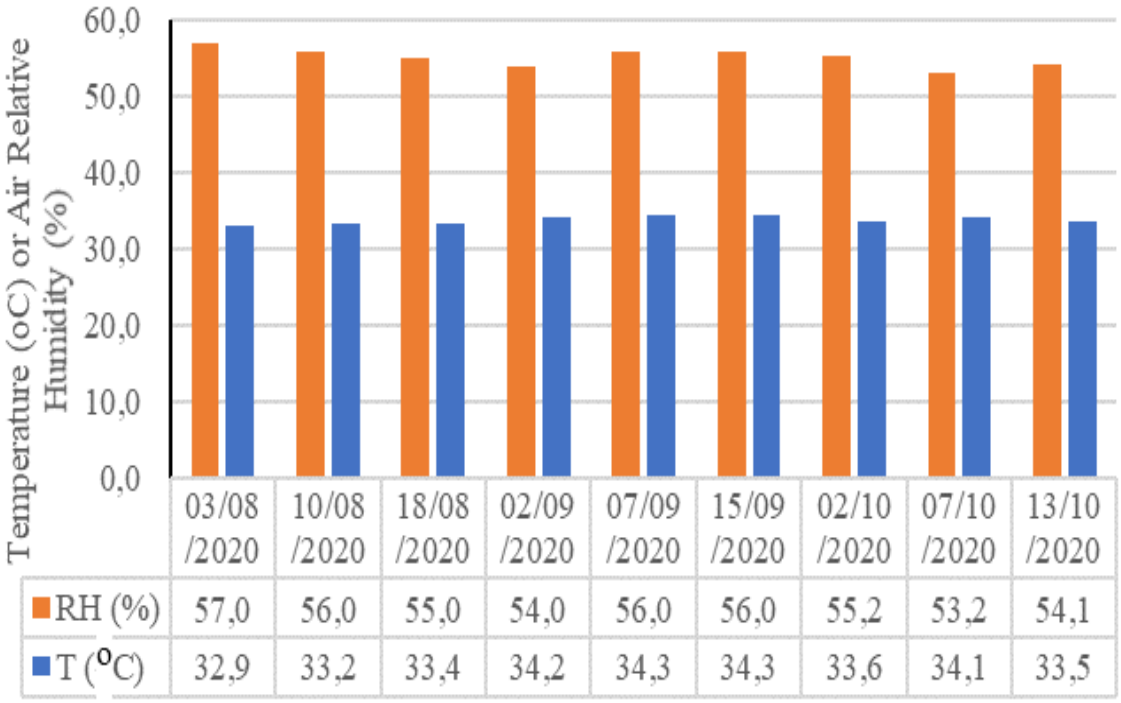
Table 2. Supporting Parameters: Meteorology Data.

No.	Description	Unit
1.	Temperature	0 C
2.	Relative Humidity	%
3.	Minimum Wind Speed	m / s
4.	Wind Speed Maximum	m / s
5.	Wind Direction	

RESULTS AND DISCUSSION

1. Odor Pollution Level at TPA Sumompo

The measured meteorological data for Sumompo landfill site show that temperatures vary from 32.9 ºC in August to 34.3 ºC in September 2020 (Figure 3). The maximum wind speed varies from 0.8 m/s in August to 1.7 m/s in September 2020, with wind direction predominantly from South to North and West to East in September 2020.



	03/08 /2020	10/08 /2020	18/08 /2020	02/09 /2020	07/09 /2020	15/09 /2020	02/10 /2020	07/10 /2020	13/10 /2020
RH (%)	57,0	56,0	55,0	54,0	56,0	56,0	55,2	53,2	54,1
T (^{o}C)	32,9	33,2	33,4	34,2	34,3	34,3	33,6	34,1	33,5

Figure 3. Temperature and humidity variations at Sumompo landfill site.

Air temperature affect odor pungenity of hydrogen sulfide (H_2S) and ammonia (NH_3) due to chemical reactions of organic waste decomposition and increase the odor amount in the air. The wind speed and wind direction research results which are dominated from South to North and West to East on the moon, it can be said that the areas that get a lot of odor pollution, especially in the area around GBI Sumompo and the area around GPDI Bethesda Buha.

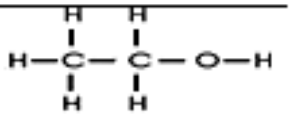
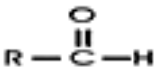
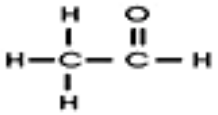
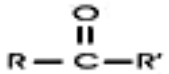
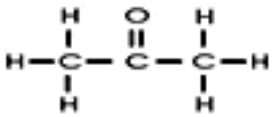
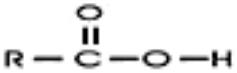
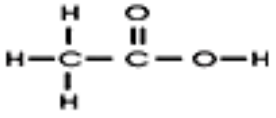
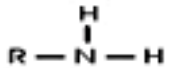
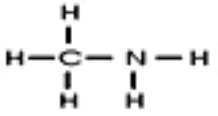
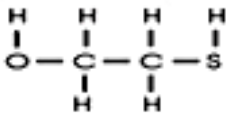
Odors are volatile chemical compounds carried in the air which enter the epithelium olfactory of human nasal cavity, and trigger sensory smells. Odor is detected by the sensory smells in nose, it must fulfill certain molecular properties. Odor molecules generally have one or two functional groups in their structure (Table 3). Pungent odor is a form of air pollution. Decree of the Environment Minister no.:KEP-50/MENLH/11/1996 concerning Odor Level Quality Standards, it is stated that odor is an unwanted odor in a certain level and time that can interfere with human health and environmental comfort. The odor standard is the maximum allowable odor limit in the air that can interfere with human health and environmental comfort.

The odor level is a form of air pollution. In Government Regulation Number 41 of 1999 concerning Air Pollution Control, it is stated that air pollution is the substances, energy and/or other components in the ambient air caused by human activities, so that the quality of ambient air drops to a certain level and unable to fulfill its function, therefor interfere human health and environmental comfort.

The air quality at the Sumompo TPA is found that the ammonia (NH_3) concentration has generally passed the quality standard, while the hydrogen sulfide (H_2S) has approached the threshold of quality standard (Table 4).

The odor problem from the solid waste management activities of TPA Sumompo arises because the waste which generally contains organic material and has been aged for several days to weeks or months is entering the degradation process by microorganisms. In this process, the organic material is broken down by microorganisms, especially bacteria, into a more stable material. During biodegradation process, some energy (heat), water vapor, carbon dioxide (CO_2), CH_4 (methane), hydrogen sulfide (H_2S), ammonia (NH_3) and various other odorous compounds are released.

Table 3. Functional Groups and Groups of Odor-Causing Compounds.

Functional group	Compound group	Formula	Example
Hydroxyl -OH	Alcohols		 Ethanol
Carbonyl as first or last carbon -CHO	Aldehydes		 Acetaldehyde
Carbonyl as internal carbon -CO-	Ketones		 Acetone
Carboxyl -COOH	Carboxylic acids		 Acetic acid
Amino $-NH_2$	Amines		 Methyl amine
Sulfhydryl -SH	Thiols		 Mercaptoethanol

The foul odor that spreads to the area around the TPA and its surroundings has caused anxiety in the surrounding community. Seeing the current conditions at the Sumompo TPA Trash, the TPA is no longer suitable for being a garbage disposal in the City of Manado. This is because the landfill area is no longer adequate because it cannot be expanded any longer to support the waste from the city of Manado, which is very large every day. So it is necessary to think about the city government of Manado to find a replacement location for the Sumompo TPA.

2. Greenhouse Gas Level (SO_2, CO, NO_2)

2a. Sulfur Dioxide (SO_2)

The SO_2 measurement results of Sumompo TPA are presented in Figure 4. Gaseous SO_2 data varied from 66.2 µg/Nm^3 to 73.8 µg/Nm^3, all of which were still under the SO_2 quality standard of 900 µg/Nm^3. The wind speed around the Sumompo TPA can trigger SO_2 respiratory system disorders. The 400-500 ppm level will be very dangerous for human, 8-12 ppm level cause eye irritation, 3-5 ppm level cause unpleasant odor. The concentration of SO_2 gas in the air will be detected by the human senses (smell) when its concentration range of 0.3-1.0 ppm (source http://airveronmental.blogpot.com/2015/02/parameter-pencemar-udara-kriteria).

Table 4. Odor levels of NH_3 and H_2S at the Sumompo Manado TPA

Measurement Date	Amonia (NH_3) ppm	Hidrogen Sulfida (H_2S) ppm
03/08/2020	3,0024 *	0,0195
10/08/2020	2,0095 *	0,0183
18/08/2020	2,1000 *	0,0187
02/09/2020	1,9600	0,0176
07/09/2020	2,0100 *	0,0183
15/09/2020	1,9800	0,0194
02/10/2020	2,0300 *	0,0210 *
07/10/2020	1,9600	0,0186
13/10/2020	2,0200 *	0,0193
Baku Mutu	2,0000	0,0200

Note: * Already above the quality standard

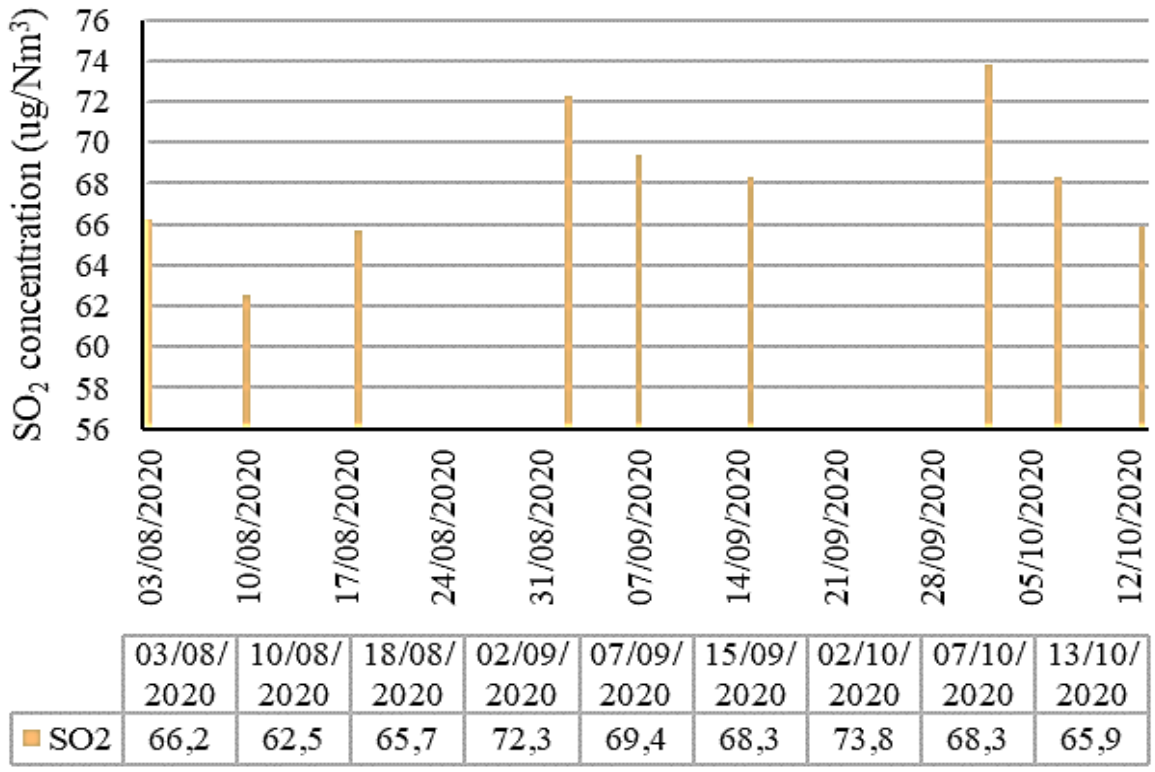
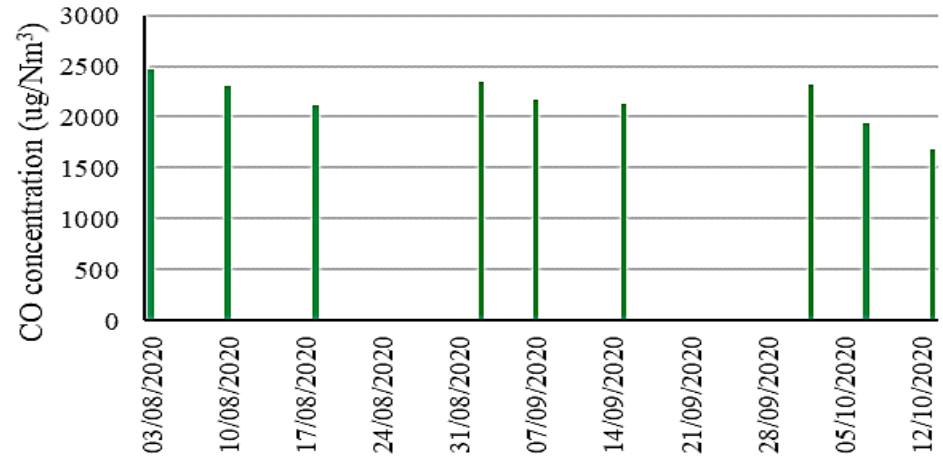


Figure 4. Parameter of SO_2 at Sumompo TPA.



	03/08/2020	10/08/2020	18/08/2020	02/09/2020	07/09/2020	15/09/2020	02/10/2020	07/10/2020	13/10/2020
CO	2460	2310	2110	2340	2165	2130	2315	1942	1680

Figure 5. Parameters of Carbon Monoxide (CO) at the Sumompo TPA

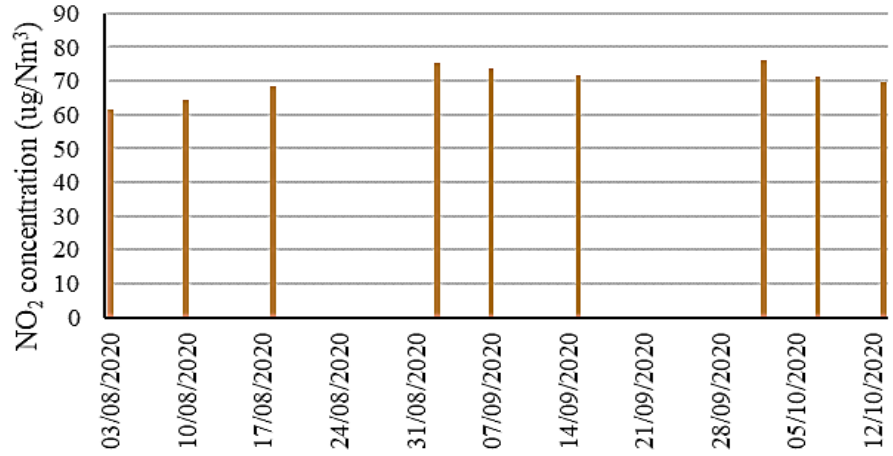
2b. Carbon Monoxide (CO)

Carbon monoxide (CO) at the Sumompo TPA are presented in Figure 5. The CO gas vary from 1680 µg/Nm^3 to 2460 µg/Nm^3, and all values are still under the CO quality standard of 30,000 µg/Nm^3. Carbon monoxide (CO) is a gas produced from a variety of processes, including: burning coal, wood, and using fuel in motorized vehicles. The dangerous level of CO pollution is exposed to or inhaled carbon monoxide gas which can cause the blood's ability to bind oxygen to decrease. This is because CO gas is more easily bound to hemoglobin and then forms carboxyhaemoglobin (COHb). The more COHb that is formed, the less oxygen will be circulated throughout the body. As a result, the body will experience a lack of oxygen (hypoxia).

2c. Nitrogen Dioxide (NO_2)

The Nitrogen Dioxide (NO_2) results at the Sumompo TPA are presented in Figure 6.

The NO_2 concentration in the air varied from 61.4 µg/Nm^3 to 76.3 µg/Nm^3, all of which were still below the NO_2 quality standard of 400 µg/Nm^3. Nitrogen oxide gas (NOx) has two forms, namely nitrogen monoxide gas (NO) and nitrogen dioxide gas (NO_2). The NO_2 gas is classified as an air pollutant. High concentrations of NO gas can cause disorders of the nervous system resulting in convulsions. If this poisoning continues it will cause paralysis. NO_2 is four times more toxic than NO (https://mad.wikipedia.org).



	03/08/2020	10/08/2020	18/08/2020	02/09/2020	07/09/2020	15/09/2020	02/10/2020	07/10/2020	13/10/2020
NO2	61,4	64,5	68,4	75,1	73,5	71,7	76,3	71,4	69,7

Figure 6. Parameters of Nitrogen Dioxide (NO_2) at the Sumompo TPA.

CONCLUSION AND SUGGESTION

Conclusion

The level of odor pollution of H_2S and NH_3 gases at the Sumompo TPA showed that ammonia (NH_3) has generally passed the quality standard, while the hydrogen sulfide (H_2S) has approached the threshold of standard quality.

The sulfur dioxide (SO_2) gas pollution varied from 66.2 to 73.8 µg/Nm^3, and all of which were still below the SO_2 quality standard of 900 µg/Nm^3. The carbon monoxide (CO) gas ranged from 1680 to 2460 µg/Nm^3, all of which are below the quality standard of CO 30,000 µg/Nm^3, and for nitrogen dioxide (NO_2) varied from 61.4 to 76.3 µg/Nm^3, all of which were below the NO_2 quality standard of 400 µg/Nm^3.

Suggestion

Currently, it is suspected that around the Sumompo TPA site has also occured groundwater pollution. It is recommended to conduct research on groundwater around the residential areas around the Sumompo TPA.

Stench polluting odor at the area around the TPA Sumompo has created considerable nuisance for surrounding communities. The current conditions of Sumompo TPA, showed that TPA is no longer suitable for garbage dumping site of Manado City. It is suggested that the Manado City government to relocation for this dumping.

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