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Determination of Zone Degradation for Sulfide (S^{2-}) and Ammonia (NH_3) in the Leachate from TPA Pakusari (Pakusari Landfill), Jember, Using Spectrophotometric Method

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Abstract: Leachate as a result from waste decomposition at landfills potentially contain toxic materials, including metals and organic matters. This leachate produces several environmental issues, including groundwater and surface water resources contamination. The landfill leachate can penetrate to the soil, blend with the soil water, flow to the soil surface, and then disembogue at the river channel. The contamination processes will vary depending on the contaminating substances and their degradation zone. Our study focused on analyzing sulfide and ammonia in the leachate. The sulfide and ammonia degradation zone have been determined by measuring the concentration of sulfide and ammonia using Spectro quant NOVA 60. The degradation zone determination ranged from the distances: 0 m, 50 m, 100 m, 150 m, and 200 m direct to the north, south, and west, and at distances of 0 m and 400 m in the east direction. The range of degradation zone based on the concentration of sulfide, ammonia, and DO (dissolved oxygen) was in a range between 150 m and 200 m from the leachate water reservoir located at TPA Pakusari (Pakusari Landfill) Jember.

Keywords: sulfide; ammonia; leachate; zone degradation.

INTRODUCTION

Garbages are materials resulting from the general public's activities that are no longer used, generally in the form of solid objects, both perishable and non-perishable [1]. Garbage is a global problem that, until now, has not found a proper solution. Collecting the waste in a final site (landfill) is one of the efforts to minimize its influence on human health. However, this effort still has weaknesses. The biological decomposition of decomposing waste resulting leachate from its process. Leachate water is generated by liquid precipitation into the landfill from rainwater infiltration and water content in the waste itself [2]. The leachate emanating from the waste degradation process from the landfill is the primary source that affects changes in the physical properties of water, especially temperature, taste, aroma, and turbidity [3]. The leachate potentially contains sulfides and ammonia, negatively affecting the environment. Sulfide and ammonia are pollutants that are very harmful to the environment. The sulfide is very toxic and has a very intense odor. When it is smelled for a long time, it will damage the human olfactory nerve. The level of free ammonia over the standard set for the waters is toxic to several types of fish [4]. Sulfide and ammonia in landfill leachate can percolate into groundwater to contaminate the water near the Pakusari Jember landfill (TPA Pakusari).

The pollutant will pollute the water flow. The zone of water flow varies along with its flow. The water flow zone is divided into four zones: the degradation zone, the active decomposition zone, the recovery zone, and the clear water zone. The dark and cloudy water characterizes the degradation zone due to the decomposition of sediment at the bottom of the groundwater, which is anaerobic to produce CO_2 and ammonia gas where the oxygen concentration is still below 0 mg/L. The degradation zone was determined based on the concentration of sulfide and ammonia in the leachate and wells water around the Pakusari landfill. The concentration of sulfide and ammonia obtained can be obtained from the water quality profile around the Pakusari landfill.

The degradation zone was studied to determine the concentration of sulfide and ammonia in the landfill leachate and the wells in which it intruded. The distance of degradation was measured from the landfill location to observe the water quality profile of the wells near the Pakusari landfill in terms of sulfide and ammonia concentrations.

METHODS

Samples

Samples were taken from the leachate reservoir of the Pakusari Landfill, Jember (TPA Pakusari), and waters from wells around the landfill. The sample was carried out in the morning at 10.00, put in the dark bottle, and placed in a box containing ice cubes before being sent to Bondowoso Regency Environmental Agency Laboratory for further analysis [5].

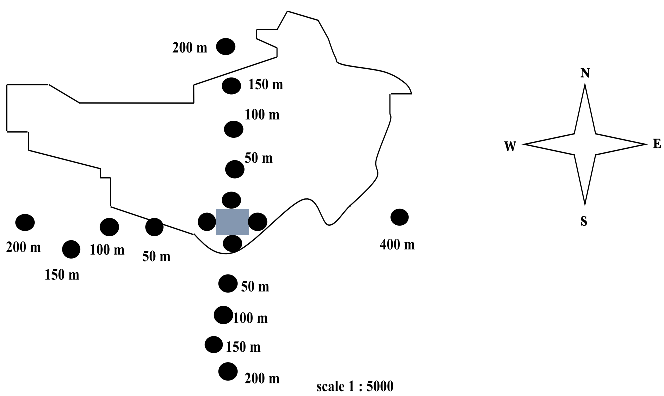

Figure 1. Sampling map

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Chemicals

Chemicals used in this experiment are: a set of specific reagents for sulfide determination in spectrophotometer NOVA 60, sulfide test (Merck) for Spectroquant Nova 60, ammonium test (Merck) for Spectroquant Nova 60.

Instruments

Instruments used in this research were spectrophotometer NOVA 60, DO meter, glass apparatus, pipet, dark bottles.

Determination of Sulfide Content

A total of 5 mL of the sample was added with the sulfide test reagent according to the usage rules stated in the analysis procedure. The test was carried out in triple.

Determination of Ammonia Content

A total of 5 mL of the sample was added with the ammonium test reagent according to the usage rules stated in the analysis procedure. The test was carried out in triple.

Measurement of Dissolved Oxygen (DO)

A total of 25 mL of the water sample was stirred and then measured with a DO meter by dipping the electrode into a 50 mL beaker glass. The test was carried out in triple.

RESULTS AND DISCUSSION

Sulfide is the result of the decomposition of organic substances and a decrease in sulfur content. Anaerobic decomposition of various sulfur-containing substances and reducing sulfur mixtures to sulfides produce an unpleasant odor.

The determination of sulfide concentration was started with the leachate samples in the reservoir taken at 4 points, 4 directions, are: P 1 (South); P2 (North); P3 (West); P4 (East).

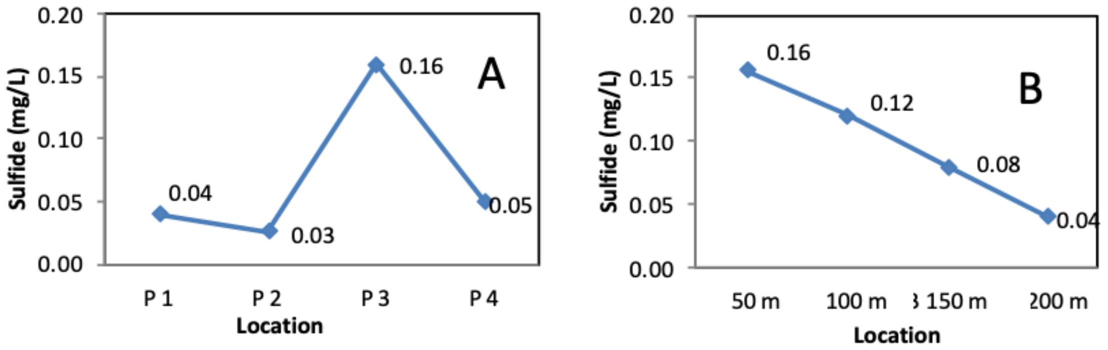

Figure 2. Sulfide concentration (A) in different direction (B) to the west direction in different distance

Due to the high sulfide concentration at P3 (West), the determination of sulfide concentration was continued to the residents' wells around the Pakusari landfill towards the West with a distance of 50 m, 100 m, 150 m, and 200 m.

Based on the sulfide concentration results at Figure 2, the well's water quality was not good. The high concentration of sulfide generated a foul odor in the water. In the long term, sulfides with low concentrations potentially cause permanent effects such as respiratory tract disorders, headaches, and chronic cough. A treatment to remove sulfide from the water is crucial. One method to remove sulfides in water is aeration, the process of gas transfer, especially in transferring oxygen from the gas phase to the liquid phase.

Ammonia also called nitrogen ammonia, is produced from the bacterial decomposition of organic substances [6]. Sampling to determine the concentration of ammonia started from the leachate reservoir.

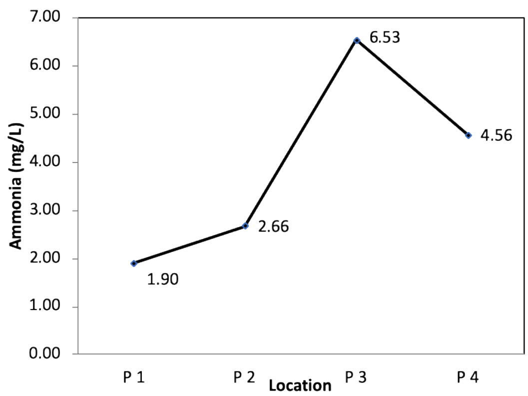

Figure 3 Ammonia concentration at leachate reservoir

From Figure 3, the highest ammonia concentration was in the west direction of the landfill. This result might be because the water flow leads to the west, following the gradient of the land surface at the Pakusari landfill.

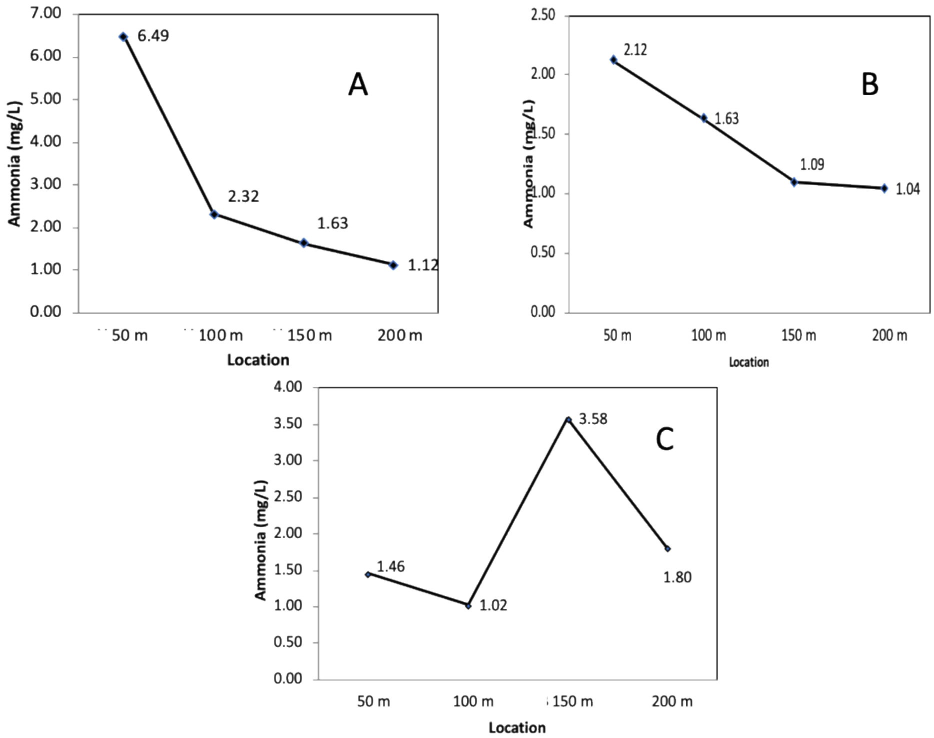

Figure 4. Ammonia concentration from wells at different ranges, and different direction from landfill: (A) North (B) South (C) west

The data from this experiment in Figure 4, showed that the water quality around the Pakusari landfill was not acceptable because of its pollutants content, especially ammonia, which is very dangerous for the body and the life around us. The high ammonia concentrations on the water's surface will cause the death of fish. Ammonia potentially harms human health and the environment, interfering with breathing and irritating the nose and throat mucous membranes.

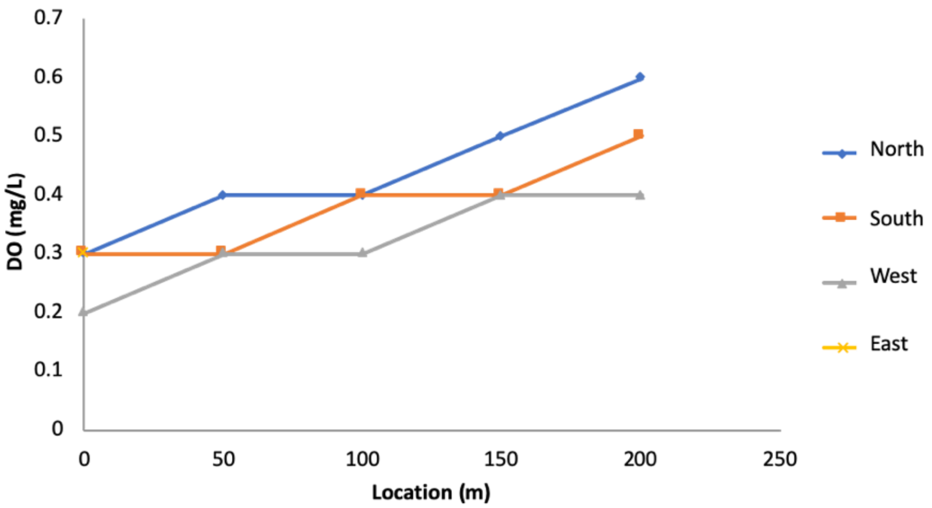

Figure 5. Dissolved oxygen concentration

The presence of oxygen in water is usually measured in the amount of dissolved oxygen (dissolved oxygen), namely the number of milligrams of oxygen gas dissolved in one liter of water. The DO (Dissolved Oxygen) concentration in the water was at a concentration of 0 ppm and below the DO concentration limit in the waters. If dissolved oxygen or DO is low, then there will be no life in these waters.

The distance of the degradation zone can be set between 150 m and 200 m in the north, south, and west directions. As for the east direction, the closest distance is 400 m, where the distance is not a degradation zone.

The healthy water quality profile around the Pakusari TPA is presented in a distribution map of sulfide and ammonia concentrations.

The distribution profile of sulfide and ammonia shows that the highest concentrations of sulfide and ammonia are located in leachate reservoirs and wells close to the Pakusari Jember landfill. In general, the concentration of sulfide and ammonia, which is located far from the leachate storage at the Pakusari TPA, has met the requirements for determining the quality of drinking water set by the KEPMENKES in 2002.

CONCLUSION

Based on the experiment results, we can conclude that the degradation zone based on the concentration of sulfide, ammonia, and DO (dissolved oxygen) was between 150 m and 200 m from the leachate reservoir of the Pakusari landfill. The quality profile of the Pakusari landfill well's water in terms of sulfide and ammonia concentrations is at a distance of 50 m to 100 m, in which the concentration of sulfide and ammonia concentrations exceeded the acceptable limits by the Minister of Health in 2002.

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