# Evaluation of Leachate Quality at Municipal Solid Waste Landfill Site: Case Study in Sliwung, Situbondo Regency, East Java, Indonesia

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## Abstract

**Objective:** This study aims to evaluate the quality of landfill leachate that has been treated in a wastewater treatment plant.

**Mathods:** Leachate samples were taken for 12 months (January-December) in 2018. The leachate quality parameters studied were: $BOD_5$, COD, TSS, total N, and heavy metals (Hg and Cd).

**Results:** The results showed that the $BOD_5$ quality met environmental quality standards in May, June, July, September, October and December, COD exceeded environmental quality standards, TSS met environmental quality standards in February, March, August, and December, N total met quality standards environment for 11 months, only December did not meet environmental quality standards, heavy metals (Cd and Hg) were below environmental quality standards.

**Conclusion:** The Sliwunglandfill to conduct an approach study that can reduce the $BOD_5$, COD, and TSS values so that they do not exceed the specified quality standards.

***Keywords*:** *leachate, coagulation, landfill, municipal solid waste*

## Introduction

Waste is a on of the world problem and not only in Indonesia, in several developed countries waste is a complex problem that causes environmental pollution. Symptoms of population growth correlate with waste production[1]. In Indonesia, plastic waste is a kind of waste that is often found in several areas, especially in big cities. The most of plastic waste is produced by urban areas. The excess waste capacity and the lack of optimal waste management causes the waste to be carried by the river to the ocean.

The government in conducting management and processing efforts, forms a shelter known as a final disposal site (landfill). The garbage that has accumulated and is not immediately handled will produce looking waste which is called leachate. Leachate is liquid waste that contains harmful organic and inorganic materials[2,3]. The leachate with high concentrations also has the potential to contain heavy metals Fe, Cr, Hg, Pb, and Cl[4]. In Indonesia, the leachate management has been regulated in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.59/Menlhk/Setjen/Kum.1/ 7/2016 concerning the quality standard of leachate. In this regulation, the government can assess and evaluate the management of leachate in each landfill which is spread throughout Indonesia.

The process of leachate formation occurs when large amounts of buried waste are wetted by rainfall, causing sediment to occur in the soil[2,5].The leachate leaks will cause dangerous impacts ranging from environmental pollution and health problems[6,7]. The pathogenic bacteria produced exceeds the ferocity of *Escheria coli*. The contamination of soil and water will cause a decrease in the biodiversity of biota components and a decrease in environmental quality.

Landfill ofSliwung is the final waste management sites in Situbondo Regency, East Java, Indonesia. The purpose of this study is to evaluate the feasibility of a waste management site based on the quality standards set by the government. This assessment can be a recommendation and study in increasing efforts to improve the quality of waste management to maintain environmental sustainability and safety

## Methods

***Research Sites.***This research was conducted in January - December 2018. The LandfillSliwung is located in Situbondo Regency, East Java, Indonesia with a coordinate point of 7°45'14.16"S South Latitude and 114° 1'8.51"E East Longitude. Situbondo Regency has an areaof1,638.5 $KM^2$ .

***Kind of Study.*** This studywas included in quantitative descriptive. The data obtained will be analyzed descriptively using literature references. Scientific studies will be a method of comprehensive discussion analysis by referring to several sources of research.

***Research procedure.*** Leachate samples were taken 12 times each month from January to December 2018. At the time of sampling, the research also recorded whether it was rainy or dry. Sampling is located at a single location. This is because the sampling based on the source of pollution is included in the point sources discharges[8]. The collected samples were then analyzed in an accredited laboratory, namely was PT. JasaTirta I. The parameters observed in this study refer to the provisions of the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.59/ Menlhk/Setjen/Kum.1/7/2016. The methods used in the analysis of leachate can be seen in table 1 below.

**Tabel 1.Parameters observed and the method of analysis**

| Nomor | Parameter | Method | Characteristic |
|---|---|---|---|
| 1 | BOD5 | APHA. Ed. 20.5210 B, 1998 | Chemical |
| 2 | COD | QI/LKA/19 (Spectrophotometri) | Chemical |
| 3 | TSS | QI/LKA/23 (Spectrophotometri) | Chemical |
| 4 | N Total | APHA. Ed. 21.4500-N-Organik B, 2005; QI/ LKA/65 (Spectrophotometer UV); APHA. Ed. 21.4500-NO2 B, 2005; APHA. Ed. 21.4500-NH3 F, 2005 | Chemical |
| 5 | Cd | APHA. Ed. 21.3111 B, 2005 | Chemical |
| 6 | Hg | QI/LKA/56 (HVG) | Chemical |
| 7 | | | |
| 8 | Temperature | QI/LKA/12 | Physic |
| 9 | pH | QI/LKA/08 | Physic |
| 10 | Smell | - | Physic |
| 11 | Total Coliform | QI/LKA/53 (Double Tub) | Biological |

The existence of the quantity of leachate is influenced by the season in a region. So that environmental conditions affect the concentration level of the leachate produced. The seasons in Indonesia consist of the dry and rainy seasons. So table 2 shows the recording of the sampling process based on season conditions and the date of collection.

**Table 2. Sampling, Analysis Date, and season**

| No. | Sampling date | Analysis Date | Season |
|---|---|---|---|
| 1 | 26 January 2018 | 26 January-09 February 2018 | Rainy season |
| 2 | 20 February 2018 | 20 February – 6 March 2018 | Rainy season |
| 3 | 22 March 2018 | 22 March - 6 April 2018 | Rainy season |
| 4 | 6 April 2018 | 6 – 20 April 2018 | Drainy season |
| 5 | 9 May 2018 | 9 – 24 May 2018 | Drainy season |
| 6 | 28 Juny 2018 | 28 Juny – 12 July 2018 | Drainy season |
| 7 | 24 July 2018 | 24 July – 7 August 2018 | Drainy season |
| 8 | 31 July 2018 | 31 July – 14 August 2018 | Drainy season |
| 9 | 20 August 2018 | 20 August – 4 September 2018 | Drainy season |
| 10 | 12 October 2018 | 12 – 26 October 2018 | Rainy season |
| 11 | 09 November 2018 | 09 – 26 November 2018 | Rainy season |
| 12 | 6 December 2018 | 6 - 20 December 2018 | Rainy season |

## Resultsand Discussion

The management of leachate in Indonesia is regulated in accordance with the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.59/Menlhk/Setjen/Kum.1/7/2016 concerning leachate quality standards (Table 3). Efforts to manage and treat leachate are very important to minimize the pollution load they cause. Table 3 shows some of the specific observational parameters of leachate. The presence of leachate becomes a pollutant when it exceeds the specified quality standards. The presence of leachate is influenced by several factors such as the type of waste buried, the influence of the microclimate, namely the intensity of rainfall, and the condition of the garbage collection[9].

**Tabel 3.Standart quality of landfill leachate in Indonesia**

| Parameter | Concentration maximum | |
|---|---|---|
| | Value | Unit |
| Ph | 6-9 | - |
| BOD5 (Bio Oxygen Demand) | 150 | mg/L |
| COD (Chemical Oxygen Demand) | 300 | mg/L |
| TSS (Total Suspended Solid) | 100 | mg/L |
| N Total | 60 | mg/L |
| Hg (Mercury) | 0,005 | mg/L |
| Cd (Cadmium) | 0,1 | mg/L |

Based on primary data from sliwung processing, periodically in each month of the year the amount of waste that enters for processing is recorded (Table 4). The characteristics of the waste produced consist of organic and unorganic waste such as household waste, plastics, and market waste. The amount of waste that comes in every year is getting higher. This is similar to the research results that the composition of the type of waste affects the quality of leachate produced[10]. Organic waste is the dominant waste produced in Nepal and affects the amount of $BOD_5$ and COD. Organic waste is easier to break down by microbes than plastic waste.

**Table 4.Amount of waste production in Sliwungsites landfill**

| | Waste production (Quintals/Year) | | | | |
|---|---|---|---|---|---|
| Monthly | 2014 | 2015 | 2016 | 2017 | 2018 |
| 1 | 731.770 | 881.140 | 782.340 | 986.748 | 1.094.834 |
| 2 | 619.310 | 683.940 | 802.620 | 868.560 | 1.011.560 |
| 3 | 636.210 | 811.140 | 818.660 | 933.770 | 1.062.670 |
| 4 | 593.710 | 774.020 | 788.220 | 911.800 | 909.760 |
| 5 | 525.610 | 737.230 | 819.540 | 857.760 | 883.960 |
| 6 | 563.120 | 680.780 | 840.740 | 783.110 | 760.559 |
| 7 | 576.750 | 744.230 | 747.750 | 847.851 | 878.700 |
| 8 | 626.200 | 648.690 | 807.640 | 784.195 | 920.630 |
| 9 | 590.720 | 643.620 | 758.050 | 727.740 | 885.430 |
| 10 | 621.730 | 672.900 | 749.820 | 858.810 | 908.840 |
| 11 | 577.100 | 749.820 | 858.810 | 908.840 | 994.428 |
| 12 | 734.390 | 764.590 | 958.870 | 917.000 | 888.520 |

Based on Figure 1 shows the results of pH, $BOD_5$, and COD in leachate. Every month the pH value is relatively stable. The pH value of the measurement results was still below the quality standard set by the government in accordance with table 3. The average pH value every month reaches 7.9. However, in July the pH value reached 4.1 (in Figure 1). Such conditions can be caused by activities from the ecological conditions of the final processing plant. Then it is assumed that there are buried garbage that is difficult to oxidize so that it is confirmed that the waste experiences inhibition of decomposition. In contrast to $BOD_5$, the graph shows that in May to November the $BOD_5$ value was just below the specified quality standard. This is influenced by the intensity of rainfall. In Indonesia, this month enters the dry season. This is similar to research conducted that stated that rainfall has a correlation with the quality of leachate produced[11,12]. The highest $BOD_5$ value occurred in December, this is due to the fact that Indonesia is entering the beginning of the rainy season in this month (Figure 1). Delays in waste processing can increase humidity and temperature in the decomposition process. $BOD_5$ and COD are parameters related to pollutants. The existence of $BOD_5$ and COD is very dynamic. Therefore COD in every month exceeds the quality standard limit set. The highest COD value occurred in December with a value of 3,840 $mgL^{-1}$. There are several ways that can be done to reduce COD in leachate, namely using the coagulation flocculation technique[13,12,14],.


**Figure 1.PH, temperature, $BOD_5$, and COD parameters from leachate in Sliwung.**

TSS is one of the leachate quality parameters that can pollute the environment. TSS by definition is part of the solid residue left behind, one of which can produce sludge. TSS can be observed physically because it can increase the turbidity level of leachate. In Figure 3, the TSS value in several months reaches a value that exceeds the quality standard. The quality standard value set by the government is 100 mgL-1. However, the graph in Figure 2 shows that the highest TSS value was in June at 343.3 mgL-1. TSS value affects the presence of aerobic bacteria so that the respiration process decreases. The oxygen level in waste with high TSS will reduce cellular metabolic processes in aerobic microorganisms. Then it has an effect on the digestibility of the amount of solids

produced. The use of $FeCl_2$ can reduce the amount of TSS by 95%, COD by 95% and the level of turbidity [13,15]. Meanwhile, the parameter N Total per month is still in safe conditions the average value is below 60 mgL-1. In December, the total N value was 223.9 mgL-1 (Figure 2). The increase in this condition is proportional to the increase in COD values related to the amount of organic matter available in leachate.

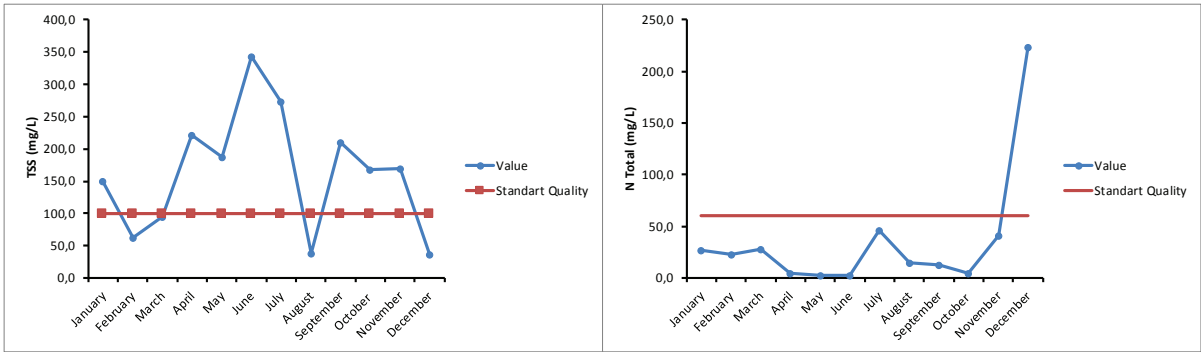


**Figure 2.TSS and N Total parameters of leachate in landfillSliwung for one year.**

The heavy metals Hg and Cd are non-essential heavy metals which can have a very dangerous impact if there is contamination. Both metals have toxic properties despite their presence in limited quantities. So based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.59/ Menlhk/Setjen/Kum.1/7/2016 concerning the standard of leachate, the amount of heavy metals Cd and Hg is strictly limited to not more than 0.1 mgL-1 and 0.005 mgL-1. In Figure 3, the parameter of heavy metals, the number of results of the analysis, shows that the waste processing location in Sliwung is still in accordance with the quality standards applied by the government. Based on the analysis results, the Cd and Hg values in leachate reached an average value of 0.00025 mgL-1 and 0.0000159 mgL-1. The presence of essential heavy metals in waste can cause extraordinary pollution events. The contamination is not only in the environment but can also occur in human health. The essential heavy metals such as Hg and Cd have a very difficult breakdown rate, so an integrated management effort is required.

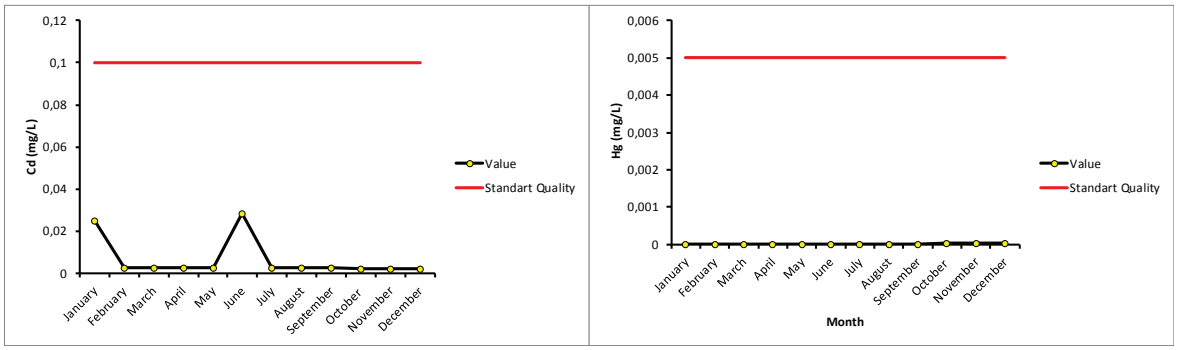


**Figure 3.Hg and Cd parameters from leachate in landfill Sliwungwhile one year.**

## Conclusions

Based on the results of the analysis on several parameters $BOD_5$, COD, and TSS still require special handling to meet the environmental quality standards set by the government in accordance with the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.59/Menlhk/Setjen/Kum.1/7/2016 concerning the quality standard of leachate. This evaluation aims to assess the feasibility of processing waste to improve its management in maintaining environmental balance. So that the results of this study can be a recommendation for the Sliwunglandfill to conduct an approach study that can reduce the $BOD_5$, COD, and TSS values so that they do not exceed the specified quality standards.

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