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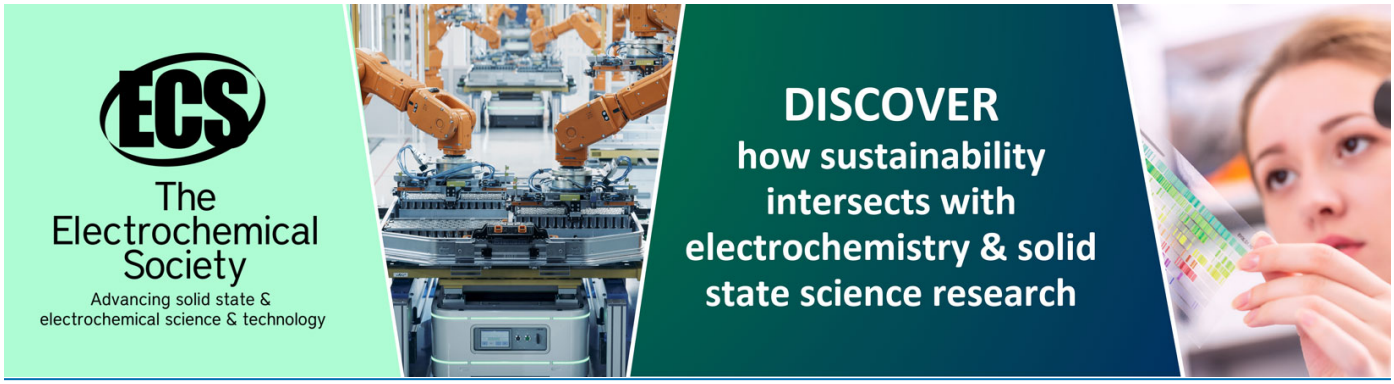

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Abstract. Landfill (TPA) Sukawinatan Palembang is an open dumping system which covers an area of 25 hectares. This system may bring an environmental damage to the surrounding area because it does not provide leachate treatment. Leachate is the landfill waste that dissolves many compounds that contain pollutants from both organic substances and heavy metal origin. This paper presents the results of laboratory analysis on samples of leachate as well as shallow groundwater from the surrounding area. The results were compared to established quality standards to evaluate whether the leachate has influenced the quality of the shallow groundwater in the surrounding area. The results show that there are some indications that the quality of groundwater has been polluted by the leachate of both organic substances and heavy metals produced by the Sukawinatan landfill.

1. Introduction

Palembang as the second largest city on the island of Sumatra is geographically located at the position of $104^0$37'- $104^0$52' east longitude and 2^0 52 -$3^0$05 ' south latitude. The total area of Palembang city of approximately 40,000Ha, which is divided into16 counties and 107subdistrict. Palembang is sited on swampy lowlands-marshes with tidal height between 3.5 meters to 4.12 meters above sea level. Currently, the solid waste of Palembang area is dumped in two landfills, namely Karya Jaya and Sukawinatan. This study focused on the Sukawinatan landfill, located in Sukarame District. The landfill covers an area of 25 hectares and began its operation in April 1994 with a design life of about 15 years. The operation of the landfill is managed by Department of Hygiene and Palembang City Cemetery.

Best practice for solid waste treatment in Palembang city is presented by Eddy Santana Putra [1]. One method is to reduce the volume of the solid waste that goes to landfill is by composting technique in household, offices, and schools. Despite this effort, the volume of waste that goes to Sukawinatan landfill is still large. The waste that goes to this landfill during the year of 2010 to 2011 is increasing by 111.463 pounds/day. The total volume of solid waste disposed to this landfill in 2009 was 150,900,928 pounds, increased to164,166,986 pounds in 2010 and then increased to187,703,406

pounds in 2011. The increased amount of solid wastes clearly adding to the burden on the landfill Sukawinatan if not treated properly, and thus will impact the use of the landfill it self.

The solid waste in the landfill is not only made up of solid components, but also liquid waste which contains chemical substances, both organic and inorganic, as well as a number of pathogenic bacteria, called leachate[2]. According to [3,4,5,6], leachate is the liquid that are likely to contain a large amount of organic contaminants, the COD(chemicaloxygen demand), BOD(biochemical oxygen demand), ammonia, hydrocarbons suspended solids, concentrations of heavy metals and inorganic salt. Leachate is also rich in phenols, nitrogen and phosphorus. If the leachate is no ttreated, it can be disposed into the environment and subsequently be apotential source of contamination to soil and groundwater, when absorbed into the soil, hence; it can lead to pollution of the waters[6, 7,8,9,10]. Influence of leachate contamination on groundwater is a major drawback of the method of open disposal of solid waste, although the advantage of this method is simple procedure and low operational costs. Given the effects and dangers of leachate discharged directly to the environtment may affect the water body, lowering the quality of surface and ground water, and also affect the ecosystem, the characteristic leachate generated in the landfill Sukawinatan need to be evaluated.

2. Composition and Characterization of Leachate

The quality and quantity of leachate is highly variable and is directly related to fluctuations of rainfall amount, composition/ characteristics of the waste, age, and landfill operational patterns[11]. Landfill leachate composition varies greatly depending on the season, leachate collection system and landfill age. The main pollutants in the leachate is organic matter and ammonia, where in if the landfill age increases, the concentration of organic matter (COD) in leachate decreased from 1800 mg/L in the second year to 610 mg /L in the sixth year [12]. Increase in the concentration of ammonia nitrogen from 98 mg to 364 mg $N_{NH4/\,l}$ also occur as the age of the landfill increases. Fluctuations of the other parameters (phosphorus, chloride, calcium, magnesium, sulfate, dissolved solids, heavy metals, also depends on the season of the year (seasonal variation) and the age of the landfill. Reported data also showed that that despite the landfill is still in the early age, some parameters such as pH value high (average 7.84, COD concentration is low (<2000 mg COD / L), the ratio of BOD / COD is low (<0.4), and the concentrations of heavy metals is low as well, so it can be indicated that the characterization is influenced by the conditions in the landfill methagonic at the beginning of the monitoring period.

Characterization of leachate from the landfill is generally represented by the COD (Chemical Oxygen Demand), total organic carbon (TOC), Biochemical Oxygen Demand (BOD), the ratio of BOD / COD, pH, suspended solids (SS), ammonium nitrogen (NH3-N), Total Kjldahl Nitrogen (TKN), the number of bacteria, turbidity and heavy metal values [13,14,15]. Concentration of leachate parameters change according to the age of the leachate. The relationship of leachate concentration with age can be seen in Table 1.

Table 1. Concentration of some leachate constituents at different phase (Kostova, 2006)

Lechate Constituen	Transition phase (0- 5 years)	Acid formation phase (5-10 years)	Methane Fermentation (10-20 years)	Final maturation phase(>20)
BOD	100-11000	1000-5700	100-3500	4-120
COD	500-22000	1500-71000	150-10000	30-900
TOC	100-3000	500-28000	50-2200	70-260
Ammonia	0-190	30-3000	6-430	6-430
NO_2-N	0.1-500	0.1-20	0.1-1.5	0.5-0.6
TDS	2500-14000	4000-55000	1100-6400	1460-4640

In general, if the landfill becomes older, the biological decomposition of waste deposited turned out to be longer, which consists of two sub-stages and methagonic acid. Leachate from different stages contain different elements, so people tend to be acid leachate because of volatile fatty acids. The content of heavy metals in leachate increase in acidic condition because the low pH can cause the metal to be easily dissolved. On the other hand, the metal content comes down on the fermentation and maturation phases, where the pH increases to neutral.

3. Quality of landfill leachate in Sukawinatan

The Sukawinatan Landfill Waste is an open dumping system. The increasing volume of waste obviously need better handling, especially the handling of liquid waste. The leachate is formed by external water ingress into the landfill waste, dissolve and rinse the dissolved materials including organic and inorganic compounds as the results of decomposition process [17].

The laboratory analysis of leachate samples were conducted at the Department of Hygiene and Funeral Palembang. Sampling of leachate was taken on February 21, 2011(sample A) and on7 November 2011 (sample B). The results and their comparison with quality standards can be seen in Table 2. Based on Table 2, parameters that do not meet quality standards according the South Sumatra Governor Regulation No. 18 of 2012 on the sample A is the content of ammonia(NH3-N). Ammonia levels that exceed the quality standards can impair respiratory tissues and cause odor in the water. COD and BOD values in sample A is still below the value of quality standards. Similarly, the content of heavy metals such as Chromium, Mn, Zn and Cu is acceptable. Sample B has a variety of different values such as BOD, COD, ammonia, chloride which exceeded the quality standard. The concentration of COD and BOD in both samples A and B match to those reported in the literature for sanitary landfill that reach an age of 10 – 20 year. In this case, the sanitary landfill is entering methane phase with the concentration BOD between 300 and 3500, and COD between 50 and 10000. As for sample A, the metal contents in sample B are acceptable. The low concentrations of metals in soil is influenced by open dumping leachate pH values, but it also plays a role in rainwater flushing on landfill waste [18].

Table 2. The results of laboratory analysis on samples of leachate

Parameter	Sample A	Sample B	Max. Limit	Test Methode
pH	7.45	6.88	6-9	SNI 06-6989.11-2004
Temperature	29.3	28.0	40	-
TSS	44	45	400	SNI 06-6989.3-2004
COD	291.1	354.8	300	SNI 06-6989.3-2004
BOD_5	145.7	218.1	150	SNI 06-2503-1991
NH_3-N	65.00	11.324	5	Salisilat Treatment
Nitrit	0.012	0.117	3	SNI 06-6989.9-2004
Nitrate	93.6	3.7	30	SPECTOFOTOMETRI
Sulfide	199	0.085	0.1	SPECTOFOTOMETRI
Cyanide	0.011	0.017	0.5	SPECTOFOTOMETRI
Chromium(Cr^{6+})	0,056	0.049	0.5	SPECTOFOTOMETRI
Chlorida	162.5	174.6	2	SPECTOFOTOMETRI
Fe	1.6	1.8	10	SPECTOFOTOMETRI
Cu	0.05	0.04	3	SPECTOFOTOMETRI
Zn	0.05	0.06	3	SPECTOFOTOMETRI
Mn	<0.2	0.4	5	SPECTOFOTOMETRI

4. Quality of shallow groundwater in the surrounding area

Residential areas surrounding the landfill Sukawinatan is highly populated with about 645 families living in a number of households. Well water is widely used by people around the settlement for their daily needs. Proximity of residential and landfill sites, besides causing ill-equipped landscape aesthetics also cause bad odor. In addition,the possibility of contamination of well water is also quite high. The results of laboratory analysis of water monitoring wells and water wells conducted by the Sanitation Department Palembang are presented in Table 3.

Based on Health Minister Regulation No.907 of 2002, the maximum water concentration of chromium in monitoring wells or household well is 0.012 mg/L and 0.017 mg/L. The levels of chromium in the leachate was detected in sample A is 0.056 mg/L and the B sample 0.049 mg/L. Even though the concentration of chromium in the leachate still meets the standard by Governor Regulation No. 8 of 2012, the level chromium in well water does not meet quality standards based Health Minister Regulation No.907. Complex Chromium(CrVI) as dichromate ions are adsorbed by soil can seep into the ground and then headed into the groundwater[18]. Permeation is dependent on soil pH. In neutral or alkaline solution of Cr(VI) is stable and easy to be absorbed[17]. In addition, the spread of chromium in groundwater depends on the sorption characteristics of the soil, including clay content, iron oxide and the amount of organic matter[18].

Table 3. The results of the analysis of well water

Parameter	Unit	Monitoring Well	Household Well	Maximum Limit
Chromium(Cr^{6+})	mg/L	0.012	0.017	0.005
Cu	mg/L	1.14	0.02	2
Cyanide	mg/L	0.012	0.005	0.007
Nitrate	mg/L	5.6	7.1	50
Nitrit	mg/L	0.025	0.007	3

Levels of Cu in the water monitoring wells reaching 1.14 mg / L and while the level in the household wells only 0.02 mg / L. This level is of Cu still acceptable according to Health Minister Regulation. Equally, the content of Cu in the leachate samples are still acceptable. Levels of nitrate and nitrite in both water monitoring wells and the household wells are still below the threshold of quality standards, as well as the leachate samples. The value of cyanide in leachate samples A and B respectively are 0.011 mg / L and 0.017 mg / L. In well water, the concentrations of cynida are 0.012 mg / L and 0.005 mg / L.

The concentration of cyanide in both leachate samples and monitoring wells and the household well are still below the limit stated in the quality standards. However, careful treatment is needed because high concentration of cyanide is harmful to human which may affect respiratory tissues, resulting in asphyxia, chronictoxicity and irritation will cause malaise. The concentration of nitrate in drinking water is also not expected because it is dangerous to human. It can cause methemoglobinemia or blue baby, which is a disease that affects children due to the oxygen-carrying capacity of the blood in the interference by nitrate.

5. Conclusions and Suggestion

The quality of leachate from two samples being analyzed in this study differs in terms of COD and BOD concentrations which may be related to the amount of rainfall. In this case, sample A was taken during dry season while sample B during rainy season. High ammonia concentrations can lead to disruption of water bodies such as wells or shallow groundwater. Although the metal content and effluent from the landfill still meets the applicable quality standards, leachate from the landfill is still a major source of environmental pollution on heavy metals. The presence of heavy metals and also the

content of nitrate and nitrite ions in water or shallow ground water monitoring wells and the household wells need to be examined though concentration is still below the threshold standard.

To prevent and reduce effluent of leachate in landfill waste (landfill) Sukawinatan Palembang, leachate management systems need to be made prior to discharge into the environment. Management system must consider the characteristics of the leachate management system. The system should be selected that the process can eliminate or reduce the flow of contaminants to water bodies around the landfill. An understanding of the characteristics of the leachate is expected to be used to select appropriate management and economical.

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