Characterization of Leachate at Simpang Renggam Landfill Site, Johor Malaysia

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Abstract. Nowadays, the world facing a major problem in managed solid waste due to the increasing of solid waste. Malaysia, one of the country also involves in this matter which is 296 landfills are open to overcome this problem. Currently, the best alternative option to manage solid waste is by using landfilling method because it’s have low costing advantages. The negatives side of landfill method, its might cause a pollution by producing leachate that will give an effect to the ground and surface water resources. This study focuses on analyzed the leachate composition at Simpang Renggam Landfill (SRL) site for seven parameter included COD, BOD, SS, turbidity, pH, BOD₅/COD, and ammonia (NH₃-N). All the data obtained were compared with previous researcher and MEQA (1974). From the result, SRL site was categorized as partially stabilized leachate with the parameter of BOD₅/COD > 0.1. SRL site are recommended to use a physical-chemical method for a better treatment because the leachate composition is classified as old leachate and aerated lagoon method are not satisfied to be use in treating the old leachate at SRL site.

1. Introduction

around the world become a major problem due to the large amount production of solid waste and might give a significant effect to manage solid waste. Furthermore, the situation become worse when the production of solid waste exceeded the limitation which is the factor causes from rapid growth of population, industrial field and economic activities [1]. The increasing of solid waste quantity gives negative effect to the environmental which can cause pollution to air, soil, and water [2].

Solid waste generates from different source such as industrial, institution, municipal service, construction and demolition and [3]. From the source stated, there a few methods are popularly used as an option to manage solid waste disposal such as sanitary landfill, gridding and discharge to sewer, open dump, incineration, compaction, milling, dumping, reduction and anaerobic digestion and composting [4]. Among these method, landfilling become popular method and have been applied for a long time [5]. Other than that, it has beneficial in lower cost, economic and using simple method to dispose the solid waste. However, using landfilling method, the production of leachate can cause a pollution in terms where the sediment releases the pollutant (leachate), the groundwater resources highly risk to be polluted and affected the water quality [6].
Landfill leachate can be defined when the liquid (water from precipitation) absorb through or run out on surface of waste deposits at landfill site area [7]. Leachate contains high substances of organic matter and inorganic matter, consist of chemical substances, heavy metal such as ammonia, sodium, calcium, sulphur, iron, nickel, cadmium, lead and other [8]. Leachate have different characteristic due to the factor such as age of landfill, temperature, moisture content, oxygen content and solid waste composition [9]. From the factor stated, the leachate characteristic can be identified and categorized as young leachate or old leachate.

Many treatments can be used to treat leachate such as biological, chemical and physical treatment. Mostly young leachate has high BOD concentration and usually biological treatment are used to treat the leachate because it has efficiency in removal of high BOD concentration [10]. Some researcher stated that by using chemical-physical treatment along biogical treatment for old leachate increased the treatment efficiency. This treatment commonly been applied because its ability in removing difficult compound and non-biodegradable such as heavy metal, PCBs, AOXs, fulvic acid, humic acid from leachate [11].

In this study, seven parameter such as COD, BOD, SS, turbidity, pH, BOD5/COD, and ammonia (NH3-N) were measure and analysed from Simpang Renggam landfill site. The analysed data will be compare with Laws of Malaysia Environmental Quality Act MEQA 1974 and previous researcher data. The aim of this study is to provide a latest information about leachate characteristic from Simpang Renggam Landfill site, Johor. Furthermore, from this study, other researchers can use this information for better understanding in leachat e characteristic and proposed new idea or solution to improve efficiency of leachate treatment.

2. Methodology

2.1 Location of Site

The location of SRL site is located at latitude 10°53'41.64"N 22'34.68"E in Kluang district, Johore, Malaysia. SRL site area cover around 6 hectare and aerated lagoon method are used as a treatment process for leachate treatment. SRL site now has been operation more than 12 years old and the total solid waste received by SRL site is around 250 tonnes per/day which is cover three areas namely, Simpang Renggam, Batu Pahat and Kluang. Furthermore, the SRL site had produces the leachate. The Fig 1 show site.

![Fig 1: Simpang Renggam Landfill site](image-url)
2.2 Leachate Sampling

A raw leachate samples were collected from SRL site by using HDPE (‘high density polyethylene”) container and all analyses and procedure of the experimental were conducted accordance to American Public Health Association (APHA 2008) Standard Method. Seven samples were collected and analysed during the period from January to April 2017. The sample were collected every two-week interval within four-month period. The analyses data of SRL leachate characteristic were compared with previous researcher and MEQA (1974). In this research, the leachate samples from SRL site were characterize into seven parameter representative landfill leachate included chemical oxygen demand (COD), Biological oxygen demand (BOD), BOD5/COD, suspended solid (SS), pH, ammonia (NH3 - N), and turbidity. These parameters were carried out at Environmental Laboratory, Faculty of Civil and Environmental Engineering (FKAAS), University Tun Hussein Onn Malaysia.

3. Result and Discussion

Table 1 shows, the characteristics of landfill leachate versus the age of landfill [14] and Table 2 shows the characteristic of leachate samples from Simpang Renggam Landfill (SRL) site.

| Types of leachate | Young | Intermediate | Old |
|-------------------|-------|--------------|-----|
| Age               | <5    | 5-10         | >10 |
| pH                | <6.5  | 6.5-7.5      | >7.5|
| COD (mg/L)        | >10,000 | 4000-10,000   | <4000|
| BOD5/ COD         | 0.5-1.0 | 0.1-0.5      | <0.1|
| Organic Compounds | 80% volatile fatty acid (VFA) | 5%-30% VFA + Humic and fulvic acid | Humic and fulvic acid |
| Ammonia nitrogen (mg/L) | <400 | N. A | >400 |
| TOC/COD           | <0.3  | 0.3-0.5      | >0.5|
| Kjeldahl nitrogen (g/L) | 0.1-0.2 | N. A | N. A |
| Heavy metal (mg/L) | Low to medium | Low | Low |
| Biodegradability  | Important | Medium | Low |
Table 2: Characteristic of Leachate Samples from Simpang Renggam Landfill (SRL) Site

| Parameter         | Range (mg/L) | Average | MEQA (1974) |
|-------------------|-------------|---------|-------------|
| COD               | 1836-2150   | 1993    | 400         |
| BOD\textsubscript{5} | 110-230    | 170     | 20          |
| SS                | 78-582      | 330     | 50          |
| Turbidity (NTU)   | 172-190     | 181     | -           |
| pH                | 7.9-8.3     | 8.1     | 6.0-9.0     |
| Ammonia, (mg/L)   | 692-1272    | 982     | 5           |
| BOD\textsubscript{5} / COD | 170/1993 | 0.085   | -           |

3.1 General Characteristic

3.1.1 Chemical Oxygen Demand, COD
The COD value were obtained from SRL site varied at average 1993 mg/L. According to Zawawi [12] in year 2013, recorded value of COD from SRL sites was at range 13166 – 13500 mg/L. Meanwhile, according to Fatihah [13] in year 2015, the value obtain at range 9839-15680 mg/L. Its show that the value of COD from year 2013 to 2017 decreasing due the age of landfill >10 years [14]. In this study, value of current COD value obtained were considerable low and categorized as old leachate because its characteristic such as age of the landfill more than 10 years as the limitation COD value of leachate was within <4000 [14]. While comparing with MEQA (1974), value COD obtained are exceeded the permissible limit 400mg/L for leachate discharge. Thus, proper treatment need to be consider for leachate discharge to avoid any pollution accour.

3.1.2 Biochemical Oxygen Demand, BOD
The range BOD value obtained from this study was 170 mg/L. By comparing to the previous data of BOD were recorded by Fatihah [13] in year 2015, average value was high at range 3183 mg/L. According to Tchobanoglous [8] it's stated that for mature landfills, the BOD value are varies at range 100-200 mg/L. As the value BOD obtained from SRL are in range 100 - 200 mg/l, the landfill are considered as mature landfills. However, The BOD value are greater that allowable limit standrad by MEQA(1974), which is exceed 50mg/L and a better treatment need to be consider to reduced the BOD concentration.

3.1.3 Suspended Solid, SS
From previous study, according to Zawawi [12] in year 2013, the range was 270-1200 mg/L. While in year 2015, previous data recorded by Fatihah[13] the SS value increases at range 1200-1240 mg/L. In 2017, value of suspended solid obtained at range 78-582 mg/L. Based on that, value of SS are decreasing from year 2013 to 2017. However, by comparing with MEQA (1974), the value of suspended solid obtained are greater than allowable limit which is exceed than 50mg/.
3.1.4 pH
Ph value obtained from SRL site varied at range 7.9 – 8.3. The pH value increasing due to the factor of age of the landfill and production of gas at landfill site [8]. Present data was recorded in year 2013 by Zawawi, ph value obtained was 8.31- 8.47 [12]. Leachate that has pH < 7.5 are categorized as old leachate [14]. Leachate from SRL site are categorized as old leachate b referring to table 1. By comparing with MEQA (1974) the pH value obtained are acceptable in range 6.0- 9.0 by MEQA (1974), so leachate can be discharge without further pH adjustment.

3.1.5 Turbidity
From previous recorded data by Zawawi in year 2013 [12], turbidity value was at range 2200-2300 NTU. Compared to the turbidity value obtained from SRL site in year 2017 are decreasing at range 172-190 NTU

3.1.6 Ammonia
From the data obtained from SRL site show that ammonia concentration between 692-1272 mg/L. Its summarized by Bikash [15], ammonia concentration at range 200 to 1000 mg/L have no adverse effect on anaerobic process. Thus, biological treatment is not advisable for SRL leachate From the previous data recorded by Zawawi [12] show that the higher concentration ammonia between 755 to 2670 mg/L in 2013. However, ammonia concentration decrease due to the lack of organic matter in SRL site leachate which is ammonia generally produced from organic matter as stated by Bikash[15]. By comparing with MEQA 1974, ammonia value are higher than acceptable limit (5mmg/L). Ammonia concentration at SRL leachate can be reduced in many method such as physical-chemical treatment to acheive standard limit discharge by MEQA (1974).

3.1.7 $\text{BOD}_5$/COD
Generally, biodegradability of leachate used to ditermined the age of landfill through the $\text{BOD}_5$/COD ratio [15]. For SRL site, the biodegradability of SRL leachate are low with $\text{BOD}_5$/COD ratio 0.085. From $\text{BOD}_5$/COD ratio, the leachate are categrerizod as stabilized old leachate with $\text{BOD}_5$/COD ratio less than <0.1 [14]. Its can be prove when the concentration of BOD and COD decrease throughout the increasing of age of landfill [15]. With biodegradability characterizes ($\text{BOD}_5$/COD ratio), its can be taken as best alternative for determined degree of biologcal and chemical decomposition that are taken place in the SRL site.

4. Conclusion
Leachate characteristic of Simpang Renggam Landfill site were analyzed and examined. For this study, seven parameters were analyzed on its composition. Generally, among these parameters such as BOD, COD show that the age of the landfill has a significant effect on the composition of leachate characteristic of SRL site. As a result, the composition of the leachate characteristic from year 2013 are change due the several factors. It can be summarized that the leachate from SRL site have contain low concentration of organic and inorganic constituent and based on biodegradability ($\text{BOD}_5$/COD ratio). Simpang Renggam Landfill site are categorized as stabilized old leachate. Upgrade treatment method need to be consider for leachate treatment due to the change of leachate composition.

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