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CHARACTERIZATION OF LEACHATE AT MATANG LANDFILL SITE, PERAK, MALAYSIA

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Leachate is produced when water percolates through waste. While percolating through the waste, it will also carry along organic, inorganic, heavy matter, colloid, pathogen and other polluted matters. Thus, leachate is considered as the greatest environmental concern in solid waste management. This study analyzed the results of leachate composition at the Matang Landfill Site with acceptable conditions for discharge of leachate under Environmental Quality Act 1974 and comparing it with previously published data. Leachate raw samples were collected by grab sampling and was analyzed for ten parameters (pH, temperature, BOD, COD, SS, ammonia-N, total phosphorus, ferum, turbidity, BOD/COD). From the results, Matang landfill site was categorized as partially stabilized leachate with the BOD/COD> 0.1. The composition of Matang Landfill leachate studied, signifies the need for a better leachate treatment facilities to ensure removal of pollutant to an acceptable level prior to discharge into receiving water bodies.

Keywords: Solid waste, Landfill, Leachate.

1. Introduction

Large amount of solid waste is generated due to rapid growth of population, industrial and economic activities. Solid waste, when not properly handled will have significant negative effect on environments. At first solid waste was considered as local problem, but now it is considered as a global problem (Periathamby et al., 2009, P.Agumuthu et al., 2007). Solid waste becomes one of the most debatable environmental issues throughout the world (Saeed et al., 2009). Thus, resolving solid waste problems is becoming serious concern to all government.

Open dump, sanitary landfill, incineration, composting, grinding and discharge to sewer, compaction, hog feeding, milling, dumping, reduction and anaerobic digestion are the option of solid waste disposal (Aziz et al., 2010). However, landfill is the most accepted solid waste disposal method worldwide as it has been applied for all this while (Tchobanoglous et al., 1993, Aziz et al., 2010, Tatsi and Zouboulis, 2002). In Malaysia there are 261 landfill sites where 111 numbers of them had been closed leaving only 150 still operating. Out of this, about 17 unsanitary landfills had been closed and 32 will be upgraded into a complete sanitary landfill. In future more sanitary landfill will be opened to cater for increment of solid waste produce. Landfill is economical and uses simple disposal method. However, the highly polluted leachate that is produced by the landfill becomes one of the greatest environment concern (Kulikowska and Klimiuk, 2008).

Leachate is produced, when water percolates through the waste. While percolating through the waste, it will also carry along organic, inorganic, heavy matter, colloid, pathogen and other polluted matters (Tatsi and Zouboulis, 2002, Z.Salem et al., 2008). As a result of the process, leachate contains highly contaminated and hazardous substance. If left without treatment it will end up mixing with the surface and groundwater. It is known that naturally water is having capability to dilute any pollutant. However its capability is too weak to face this leachate. Thus, treatment of leachate is crucial to ensure safety of the environment.

Leachate contains many substances and its quality is highly variable. Various factors such as solid waste composition, age of refuse, operation of landfill, climate, hydrological condition, chemical and biological activities, moisture content, temperature, pH, and degree of stabilization affects the composition of leachate (McBean et al., 1995). Leachate quality out of same waste type, maybe different for landfill located in different region due to different climatic condition. Data of leachate characteristic is important especially during the design of leachate treatment system.

Leachate can be treated by using biological, chemical and physical methods. The type of method to be used is decided on the characteristic of the leachate. And based on the actual leachate treatment systems that have been commissioned, it is involving a complex process and huge cost. Furthermore it takes many years to stabilize leachate even after the landfill has been closed after meeting it storage capacity. Therefore, a proper leachate treatment technique that is efficient, cost effective and environmentally friendly needs to be used.

In this study, measurement and analysis were performed to characterize quality of leachate from Matang landfill site. Ten parameters were chosen to characterize Matang landfill leachate. The data were compared with previous published data. And identification of the environmental risk of Matang landfill site (MLS) leachate was done by comparing the data with Malaysian Environmental Quality (Control of Pollution from Solid Waste Transfer Station Landfill) Regulations 2009, under the Laws of Malaysia Environmental Quality Act (MEQA) 1974 (MDC, 1997). The results of this study is going to provide some basic information on the characteristics of tropical climate of landfill leachate and level of leachate pollutant. Moreover this study can provides better understanding of leachate and leads to more efficient managerial solutions and treatability options.

2. Methodology

2.1 Site Charecteristics

MLS is located at 4^{o}49’20.08’’ N and 100^{o}40’44.08’’ E near Taiping town in Perak, Malaysia. MLS is equipped with a leachate collection pond. The collection pond acts as a detention pond. No further treatment is done for the leachate. Total landfill area of MLS is 12 ha and is classified as an improved anaerobic landfill. MLS is more than 14 years old. The landfill receives about 300 tons of solid waste daily. Recycling is practice at site mainly by scavenger, then the remaining solid waste is dumped on site and covered by local soil.

2.2 Leachate Sampling

Leachate samples were collected from MLS in the northern region of Malaysia. Sampling procedure were conducted according to collection and preservation of samples method (2005, APHA, 2005).The samples were collected from December 2011 to Mac 2012. All samples were collected and immediately transported to the laboratory and stored in a cold room at 4 ^oC to minimize biological and chemical reaction. Prior to analysis, the samples were subjected to return to room temperature.

2.3 Leachate Characterization

Parameter to characterize MLS were pH, temperature, BOD, COD, SS, ammonia-N, total phosphorus, ferum, turbidity, BOD/COD. Temperature and pH were measured on site. The rest of parameters were measured at Environmental Laboratory of School of Civil Engineering, Universiti Sains Malaysia. The measurement of samples were conducted thrice according to the standard methods for the examination of water and wastewater(APHA, 2005). Then the obtained data were compared with data published by previous researchers and MEQA (1974).

3. Results and Discussion

Table 1 shows the characterization of leachate at MLS. Data were presented according to the range and the average value for the chosen parameters. Values of discharged limit by MEQA (1974) were also listed as a comparison.

Table 1. Characteristics of raw leachate at MLS.

No.	Parameters	Value		MEQA (1974)
		Range	Average	
1	Temperature (^0C)	28-31	29	40
2	pH	7.96-8.17	8.1	6.0-9.0
3	BOD5 (mg/L)	60-184	109	20
4	COD (mg/L)	470-1261	770	400
5	SS(mg/L)	222-303	271	50
6	Ammonia-N (mg/L NH^3-N)	311-693	500	5
7	Total phosphorus (mg/L PO^3_4-TNT)	22-54	42	-
8	Ferum (mg/L)	2.3-3.1	2.7	5
9	Turbidity(NTU)	15-41	28	-
10	BOD/COD	0.12-0.16	0.14	-

Temperature of raw leachate was depending on the climatic condition of the landfill site. Temperature value for leachate at MLS was between 28-31 ^oC. Aziz (2011) recorded value of MLS leachate temperature at 33 ^oC. The range of temperature from previous study and current study showed that the temperature value met the permissible limit of MEQA (1974). Therefore, no further treatment needed to be conducted for leachate temperature reduction.

The pH values for leachate at MLS were varied between 7.96-8.17. pH value of leachate was depending on the age of landfill and the phase of landfill gas generation (Tchobanoglous et al., 1993). Range of pH for matured landfill is 6.6-7.5. Reduction of ph was recorded from year 2009-2012, as MLS pH reduced from 8.6 to 8.1(Umar et al., 2010, Aziz et al., 2009, Aziz et al., 2011). Present value of MLS leachate, showed that it was in the process of moving into methane fermentation phase as pH was reducing to more natural values in the range of 6.8-8. The range of pH obtained was within the MEQA (1974) permissible limit, so no pH adjustment process needed before discharge of MLS leachate.

Biological oxygen demand(BOD) was a measurement of the amount of oxygen uptake by microorganism during biological degradation of organic compound (Howard S.Peavy, 1985). Commonly BOD were used as indicator in measuring the strength of organic pollutant. Standard five day BOD test had became the standard practice to measure and report the oxygen demand in evaluating the organic pollutant in water and wastewater (M.Masters, 1998). In this study the range of BOD_5 recorded at MLS were 60-184 mg/L. Based on Tchobanoglous (1993) range of BOD_5 for landfill age>10 years were between 100-200 mg/L. Even though the minimum value of BOD_5 for MLS was less then range stated by Tchobanoglous(1993), the average value was still within the range. The present value of BOD5 of MLS recorded agreed with previous data published by Umar (2010) and Aziz (2009). A higher value (257 mg/L) was recorded by Aziz (2010). However, based on McBean (1995), value of BOD_5 for leachate >15 years was 50 mg/L. Since age of MLS was almost 15 years, so value of the current study was acceptable. Based on MEQA (1974), the permissible limit of BOD_5 was 20 mg/L. The current BOD_5 of MLS and previous value recorded was far then the permissible limit and treatment prior discharge is crucial.

The range of COD obtained for leachate at MLS was 470-1261 mg/L. In year 2009,2010, and 2011 recorded value of MLS were between 990 mg/L-1500 mg/L.(Umar, 2010 ; Aziz, 2009 ; Aziz, 2011). Current COD value obtained from this study was considered within the range obtained by previous researcher. MLS leachate was categorized as mature leachate (>10 years) as the COD was within 100-500 mg/L (Tchobanoglous et al., 1993). According to MEQA (1974) value for COD of leachate should be less then 400 mg/L before safely discharge into environment. Thus, treatment of leachate must be conducted to reduce risk of contamination.

Biodegradability of leachate was changing as the landfill aged. Usually BOD/COD ratio was used to monitor changes in biodegradability of leachate. The value of BOD/COD ratio recorded for MLS was 0.12-0.16. The data obtain was in agreement with Aziz (2010) study. Commonly, for mature leachate the BOD/COD ratio was within 0.05-0.2. This indicated that the MLS was a matured landfill. BOD/COD ratio of stabilize leachate is <0.1. Therefore, MLS leachate was considered as partially stabilize leachate as the BOD/COD>0.1. According to Aziz (2010) low BOD/COD ratio indicated that biological method were not suitable to be applied and the best option was by using combination of physic-chemical method.

The average value of turbidity recorded for MLS was 28 NTU. A range of 11.65-24.9 NTU was recorded by a 15 years old landfill (Zainol et al.). The current turbidity value of MLS leachate was considered within the turbidity range for mature landfill

The value of suspended solid ranged from 222 mg/L to 303 mg/L. Previous study by Aziz et al. (2009) showed a higher value of suspended solid (420 mg/L) from the present study. While study by Aziz (2011) showed two times higher value of suspended solid. Still, the range of present value of suspended solid was within the range of matured landfill (100-400 mg/L) listed by Tchonoglous at al. (1993). All the suspended solid recorded was greater than 50 mg/L value of suspended solid stated in MEQA (1974).

Ammonia nitrogen was toxicants to microorganism (Kim et al., 2007, Wang et al., 2008). If biological treatment applied for leachate, a pre-treatment for the removal of ammonia nitrogen needed to be conducted. The average value recorded for MLS leachate was 500 mg/L. Based on Tchonoglous et al. (1993), the value of MLS ammonia-N was in the range of 10-800mg/L which was for new landfill. This statement was contrary from the actual age of MLS (>14 years). However, the current value of MLS ammonia-N was coinciding with the range obtained by Aziz (2011). The range of obtained ammonia-N values was higher than the acceptable MEQA (1974) standard level (5 mg/L). Suitable treatment must be carried out to reduced ammonia-N in MLS leachate according to MEQA (1974) standard limit.

The maximum value of total phosphorus recorded at MLS was 42 mg/L and the minimum value was 22 mg/L. For mature leachate, value of total phosphorus should be within 5-10 mg/L and range for new landfill (<2 years) is within 5-100 mg/L(Tchobanoglous et al., 1993). A reduction in total phosphate value was observed, as 45 mg/L of total phosphate was recorded in 2011 (Aziz et al., 2011). Eventhough, MLS was almost 15 years, the reduction of total phosphorus was a bit slow as the range of total phosphorus was still under new landfill range.

Range of ferum recorded for MLS were 2.3-3.1 mg/L. The average value was 2.7 mg/L. Comparing previous and current study, a reduction trend was recorded for ferum concentration. In 2009, the concentration was 5.23 mg/l and currently the concentration was 2.7. The ferum concentration passed the permissible limit in MEQA(1974).Typically, for mature landfill the range of ferum between 20-200 mg/L(Tchobanoglous et al., 1993). However MLS leachate achieved less than 20 mg/L. This might be due to less amount of iron based material waste dumped into MLS and also most of iron waste was taken off by scavenger to be sold as recycle material that has higher value. Moreover, as leachate stabilized the concentration of heavy matter will be reduced due to adsorption and precipitation reaction (Tatsi and Zouboulis, 2002).

4. Conclusion

The present study monitored ten pollution parameters from MLS leachate. Comparison of data with previous study (few) indicated the age of landfill does affecting the characteristics of leachate. MLS had low biodegradability and characterize as matured landfill. Physical-chemical and combined treatment were the most suitable method to be applied for MLS leachate. Based on this study, four parameters (BOD_5, COD, suspended solid and ammonia-nitrogen) were more than the MEQA (1974) standard limit and for that reason treatment for MLS leachate is vital before discharge.

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