Research Article

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Leachate Treatment Evaluation of Landfill Leachate Treatment Plant of Taman Beringin Solid Waste Transfer Station, Kuala Lumpur, Malaysia;

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ABSTRACT

The objective of this study is to evaluate the influence of leachate treatment on the physical-chemical and biological characteristics of leachate. Raw leachate, physically-chemically treated leachate, and chemically and biologically treated leachate samples were obtained from the Landfill Leachate Treatment Plant of Taman Beringin Solid Waste Transfer Station, Kuala Lumpur, Malaysia. Physical-chemical and biological characterization of samples was achieved based on a series of analyses and then the results were compared to the Environmental Quality (Sewage) Regulation 2009. The physical-chemical parameters analyzed included: color, odor, temperature, turbidity, pH, conductivity, TDS, TSS, total hardness, DO, COD, sulfate, Ca, Mg, alkalinity, and heavy metals, while the bacteriological and biological parameters included BOD and total viable count. Results revealed that each of the values of raw leachate parameters was relatively high due to the high concentrations of pollutants. Regarding the physical-chemical treatment of leachate, it is noted that some parameters namely pH, TSS, COD, BOD, and total viable count were greater than the permissible limits set by the Environmental Quality (Sewage) Regulation 2009. As for the chemical and biological treatment of leachate, findings demonstrated that it was more efficient than the physical-chemical treatment, as all parameters were within the permissible limits except for COD, which recorded a reading of 580 mg/L.

Keywords: *Leachate Treatment Evaluation, Physical-Chemical Characteristics, Biological Characteristics, Raw Leachate, Physically-Chemically Treated Leachate, Chemically and Biologically treated Leachate, Heavy Metals, Total Viable Count.*

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Introduction

Leachate is any liquid that extracts solutes from other materials as it passes through it. From an environmental aspect, leachate most commonly refers to water-acquiring properties from the refuse it contacts. Leachate composition depends on many factors including the age of the landfill, degree of degradation, type of waste, climate conditions, and many other factors. Usually, an amount of 150 L of leachate is produced via 1 ton of waste. Physical-chemical and biological characteristics of leachate vary from country to country depending on several factors, the most important of which are: climate conditions and the sort of waste generated. In other words, leachate is any contaminated liquid that is produced from water percolating through a solid waste disposal site, accumulating contaminants, and moving into the subsurface areas [13].

[10], stated that there are two fundamental categories of leachate treatment technologies: physical-chemical treatment and biological treatment. In larger systems, those technologies could be integrated depending on the treatment targets as leachate contains huge quantities of organic and inorganic matter that may lead to serious environmental issues including groundwater contamination if leachate is not professionally treated. Leachate is characterized by its strong color and unpleasant odor, high values of BOD, COD, pH, ammonia nitrogen compounds, and heavy metals. However, those characteristics may vary from place to place based on leachate composition, volume, and the biodegradable matter content present in the leachate over time, making leachate treatment troublesome and complicated [11].

Based on information obtained from [3], Taman Beringin Landfill served as a waste disposal facility since 1979 and was terminated in 2006. Before ceasing, Taman Beringin Landfill received different types of waste including domestic, industrial, commercial, construction, mixed, and agricultural waste. When in operation, the landfill annually receives an amount of 600,000 tons of waste. Throughout work, it is estimated that approximately 8 million tons of waste have been dumped into this landfill. However, the transfer section of Taman Beringin has been in operation since 2002. Before sanitary landfill disposal, all domestic waste from Kuala Lumpur is sent to this transfer station. In 2003, the amount of domestic waste received at Taman Beringin Transfer Station was 481,069 tons (1,318 tons per day) and it increased to 779,304 tons per year (2,135 tons per day) in 2012 (an increase of 63%) due to an increased population density.

Materials & Methods

Ready samples of raw leachate, physically-chemically treated leachate, and chemically and biologically treated leachate were obtained from the Landfill Leachate Treatment Plant of Taman Beringin Solid Waste Transfer Station, Kuala Lumpur, Malaysia. Samples were directly transferred to the Microbiology Laboratory at the Institute of Biological Sciences, Faculty of Sciences, University of Malaya. Samples were analyzed for pH and DO *in situ*, while other tests were performed in the laboratory. Experimental procedures were carried out based on the Standard Methods for Examination of Water and Wastewater in addition to the Hach Analyzer [1]. The physical-chemical parameters analyzed included: color, odor, temperature, turbidity, pH, conductivity, TDS, TSS, total hardness, DO, COD, sulfate, Ca and Mg, alkalinity, and heavy metals, while the bacteriological and biological parameters included BOD and total viable count. Data obtained were checked to see if they were within the Environmental Quality (Sewage) Regulation 2009 standard range.

Results & Discussion

When any water source encounters any type of waste, it leaches from a liquid material called leachate, which may also arise from the moisture content of certain disposed wastes. Leachate is initially recognized by its unpleasant smell and blackish color as well as its high components of both organic and inorganic matter [2]. Table 1 indicates the physical-chemical and biological characteristics of raw leachate, physically-chemically treated leachate, and chemically and biologically treated leachate, which were referred to in evaluating the influence of those different treatments on leachate characterization. Values of raw leachate parameters including pH, electrical conductivity, TDS, COD, BOD, and heavy metals were notably high. However, those high values are considered normal before the leachate undergoes any type of treatment. The pH value of raw leachate samples ranged from 8.9 to 10.9, which is interpreted due to the presence of construction and demolition waste that is also could be a main cause of high concentrations of total dissolved solids (TDS) in the leachate [12].

Moreover, the reason behind the high electrical conductivity values simply referred to the positive correlation between electrical conductivity and TDS readings as the higher the TDS values, the higher the electrical conductivity [5]. COD value increases as the amount of organic material increases, and it subsequently increases if inorganic compounds susceptible to oxidation by the oxidant are present. BOD has an inverse correlation with dissolved oxygen as bacteria utilize DO for organic material decomposition. Based on [8], the high alkalinity values of raw leachate samples are typically generated from the reagents used in industrial activities, such as lime (CaO), and sodium hydroxide (NaOH). The presence of heavy metals in raw leachate samples like Hg, Pb, Cr, Cd, and As is an expected result of not adopting source segregation techniques of metal contamination such as lead batteries, cans, and steel scrap [11]. The mean per ml value of the total viable count of raw leachate was at $6.5*10^6$ CFU/ml meaning that the samples were heavily polluted, which is ordinarily accompanied by low concentrations of DO [9].

[6] mentioned that the physical-chemical treatments of landfill leachate involve chemical precipitation, chemical oxidation, coagulation–flocculation, membrane filtration, ion exchange, adsorption, and electrochemical treatment. One or more of these methods may be adopted in leachate treatment depending on the leachate condition and the purpose of treatment. From Table 1, it is observed that most values of physically-chemically treated leachate parameters fall within the permissible limits set by the Environmental Quality (Sewage) Regulation 2009 except for pH, TSS, COD, BOD, and total viable count values, meaning that extra treatments must be conducted to remove these pollutants before discharge. On the other hand, all five heavy metals investigated were below detectable levels (BDL), which means that the leachate treatment was successful in this regard. [7] reported that the endangerment of leachate lies in the damage to the groundwater as well as living organisms as it contains high levels of organic, inorganic, and heavy metal, which percolates through the subsoil and contaminates the groundwater.

Table 1: Physical-Chemical and Biological Characteristics of Different Treatments of Leachate Compared to the Environmental Quality (Sewage) Regulation 2009.

Parameter	Raw Leachate	Physically-Chemically Treated Leachate	Chemically and Biologically Treated Leachate	Environmental Quality (Sewage) Regulation 2009
Color	Dark Black	Brown	Light Brown	-
Odor	Ammoniac	Sewage smell	Slight swage smell	-
Temp (°C)	32	24	22	40
Turbidity (NTU)	193	77	73	-
pH *in situ*	8.9 – 10.9	7.6 – 9.6	6.8 – 7.4	6.0 – 9.0
Conductivity (µs·cm⁻³)	31800	12.9	12.3	-

TDS (mg/L)	1912	180	120	-
TSS (mg/L)	191	122	44	50
Total hardness (mg/L)	1582	280	230	-
DO (mg/L)	4.2	7.3	8.1	-
COD (mg/L)	52600	912	580	120
Sulfate (mg/L)	453	179	177	-
Ca (mg/L)	196	112	103	-
Mg (mg/L)	112	97	100	-
Alkalinity (mg/L) as $CaCO_3$	7900	1200	870	-
Mercury (mg/L)	0.03	BDL	BDL	0.005
Lead (mg/L)	27.3	BDL	BDL	0.10
Chromium (mg/L)	0.03	BDL	BDL	0.05
Cadmium (mg/L)	0.04	BDL	BDL	0.01
Arsenic (mg/L)	BDL	BDL	BDL	0.05
BOD (mg/L) *in situ*	29120	177	17	20
Total viable count (CFU/ml)	$6.5 * 10^6$	$2.5 * 10^6$	$0.6 * 10^6$	-

Based on what was stated in an article titled "*The biological treatment method for landfill leachate*" carried out by [4], the biological treatment of leachate is another effective method besides the physical-chemical processes for reducing biodegradable pollutants like organic compounds. The biological treatment method is currently an adaptation of the wastewater treatment method with biological processes including but not limited to trickling filter, rotating biological contactor, aerated lagoon, up-flow anaerobic sludge blanket, activated sludge, and sequencing batch reactor. Results showed that the chemical and biological treatment of leachate was much better than the physical-chemical treatment as the majority of parameters tested were within the permissible levels of the Environmental Quality (Sewage) Regulation 2009 except for COD, which scored a reading of 580 mg/L. Other than that, the researcher stresses the necessity of adopting this type of treatment while working to look into the apparent shortcomings in the COD values.

Conclusion

To put it briefly, this study concluded that the leachate treatments were somewhat acceptable. However, some developments are urgently needed especially for the physical-chemical methods to drain the leachate safely, as some parameters for the physically-chemically treated leachate were greater than the permissible limits. On the contrary, the values of most chemically and biologically leachate treatment parameters fell within the permissible limits of the Environmental Quality (Sewage) Regulation 2009 except for the COD values.

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Recommendation

The researcher would strongly advise that it is necessary to make some improvements in the aforementioned treatments so that the leachate can be safely drained without causing any harm to the groundwater. They also advise the need to adopt this type of study materially and morally by authorized government agencies due to its significant impact on protecting the environment and thus protecting humankind from the risk of polluting groundwater.

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