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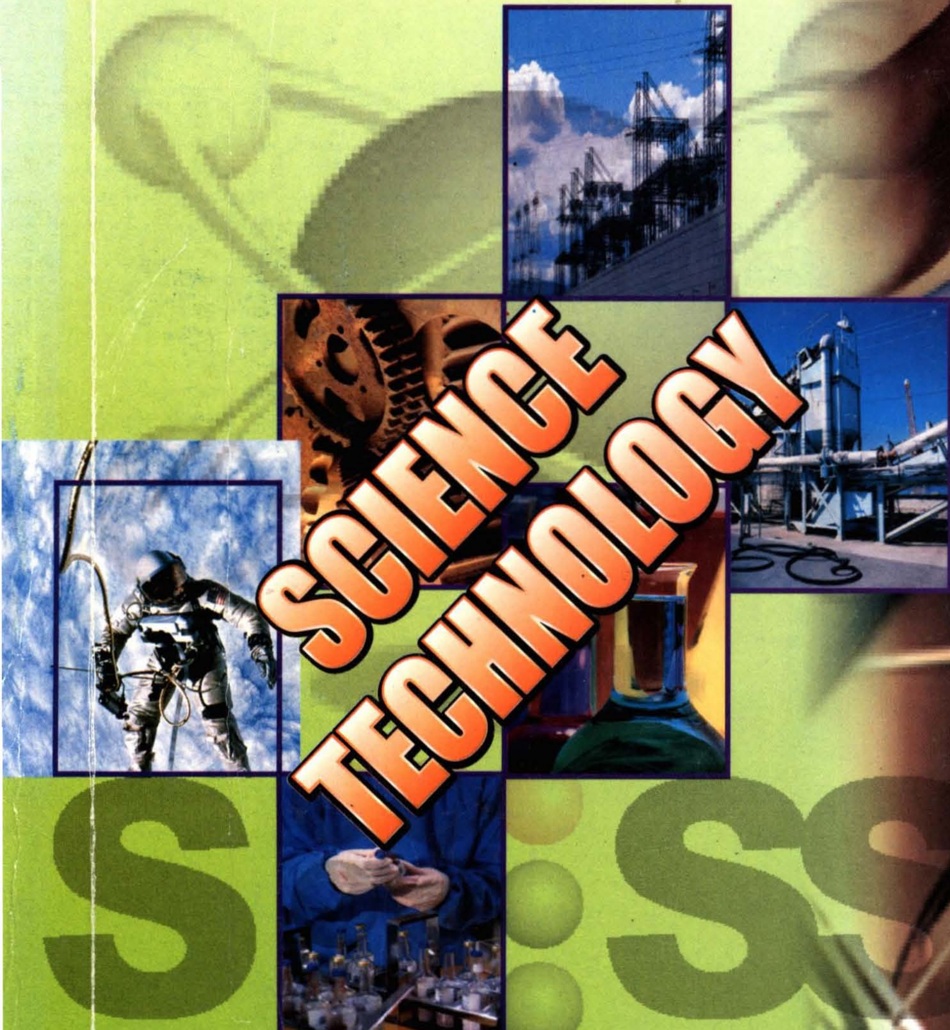

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Characterization of Landfill Leachate: A Case Study of a Selected Landfill in Pahang

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ABSTRACT

Domestic solid waste landfill causes major negative environmental impact if not managed in a proper manner. A leachate study was conducted at Batu 55 Landfill in Maran. Leachate were analyzed for physical characteristics such as colour and TSS; biological characteristics such as total cell count, viable count, total coliforms and fecal coliform, and ; chemical characteristics such as COD, BOD, pH, phosphate, NH_3-N, NO_3-N, NO_2-N, sulphate and heavy metals. Taking into account the low concentration of heavy metals, the low value of the BOD_5/COD ratio [(155/9875) < 0.5] and the high contents of NH_3-H (629 to 6250 mg.l^{-1}), the leachate was classified as "old' and non-biodegradable. The pH of the leachate from the landfill has basic character (pH ranged between 7.44 to 8.22). Fecal coliform have been detected ranging from 0% to 38.6% of viable count. This is alarming due to the risk of pathogen contamination to ground water. Therefore, establishing appropriate treatment methods is necessary to reduce the pollution intensity.

Keywords: *Leachate, landfill, contamination*

Introduction

Landfills have served for many decades as ultimate disposal sites for all manner of waste such as residential, commercial and non-hazardous. Landfill technology has evolved from open, burning dump to highly engineered sites designed to minimize tile impact of contaminants in the waste on the adjacent environment. One of the concerns by the public is contamination of ground water and surface water by leachate from the landfill. Leachate may be defined as liquid that has percolated through solid waste and has extracted dissolved or suspended materials. Factors affecting the composition of landfill leachate include waste composition, landfill conditions, characteristics of entering water and soil characteristics under the landfill.

The growing population generates bigger volume of waste particularly due to the economic bloom where consumers are able to increase their expenditure accordingly. This can be observed in Malaysia where with 5.6% increment of gross domestic product (GDP), trends of higher consumption of goods lead to higher waste generation (Agamuthu 2001). Anon (1999) reported that in 1998, 15,268 tonnes/day of waste were generated in the country, resulting in the increment of environmental pollution as well as the needs for more disposal sites. In the seventh Malaysia Plan (1995-2000), the Federal Government had spent RM 20.9 million to build 9 sanitary landfills and upgraded 27 existing landfills in 34 local authorities (Anon 1999). Investment in solid waste management mostly limited to procurement of collection truck and landfill development (Hoornweg 1999).

Concern on environmental issues, landfills can develop into a major source of environmental pollution to the land, air and water systems, as well as the main irritation to public health with disturbing odour, pest and rodents, as well as, the abhorrence sight due to the lack of proper management (Fauziah & Agamuthu 2003; Nurmazveen & Hassan 2002). In addition to the polluting aspects of landfill sites, proper and best effective management should also be looked into seriously due to the scarcity of suitable land. However, in most cases, open dumping is being practised and takes place at about 50% of the total landfill in Malaysia.

In Malaysian, 98% of the domestic waste were sent directly to landfills for disposal (Fauziah & Agamuthu 2003). Unlike the waste streams originating from industrial sources, hazardous substances in household waste including aerosol spray cans, medicine, oil filters and batteries are not strictly controlled under hazardous waste regulation causing the presence of unwanted metal and non-metal elements in the leachate. The low rate of recycling activities among Malaysia public had caused loss of valuable resources to landfilling activities (Fauziah & Agamuthu 2003).

The aim of this study was to characterize leachate came from a municipal sanitary landfill located in Batu 55, Jalan Maran-Jerantut, Pahang in order to improve leachate management system in Maran.

Materials and Methods

In this study leachate samples were obtained from Batu 55, Maran landfill. Leachate samples from the landfill were collected in polyethelene bottles from leachate pipe, which carries leachate to a leachate small collection pond. Samples were acid preserved and kept in refrigerator at 4°C before analysis. Both chemical and physical analysis was carried out and this includes BOD, COD, pH, heavy metal analysis and biological characteristics.

Leachate was characterized measuring the following parameters: COD, colour, NH_3-N, NO_3-N, NO_2-N, SO_4^{2-} and PO_4^{2-} were measured using Spectrophotometer HACH (Model DR/2000). Biological Oxygen Demand (BOD_5) was determined using BOD bottles incubated for 5 days at 20°C. The dissolved oxygen (DO) before and after incubation was measured using BODTrak™ (HACH; USA). The analysis for pH was conducted directly using pH probe. The concentration of heavy metal was determined using the Atomic Absorption Spectrophotometer (AAS; GBC 902, Australia). The leachate samples were acid digested prior to the AAS analysis.

Results and Discussion

The composition of the investigated leachate is reported in Table I. Taking into account the low concentration of heavy metals, the low value of the BOD_5/COD ratio [(155/9875) < 0.5] and the high contents of NH_3-H (6250 $mg.l^{-1}$), the leachate was classified as "old' and non-biodegradable (Baig *et al.* 1999). The near neutral values for pH are also reasonably consistent with the literature and suggest that the leachate is pH buffered throughout the life of the landfill normally by calcium carbonate from soil surrounding (Statom *et al.* 2003). In general the concentration of heavy metal was low.

For the domestic landfill leachates ammoniacal nitrogen (NH_4-N) is normally "difficult" constituent to remove. Slow leaching of waste producing nitrogen and no significant mechanism for transformation of NH_4-N in the landfill causes a high concentration of ammoniacal nitrogen in leachate over a long period of time (Hamidi et al. 2004). Ammonia is a contaminant which may be used as an indicator of contamination, particularly in terms of surface water. Removal of ammoniacal nitrogen is important since it has been identified as the major toxicant which causes toxicity to organism and must be reduced to well below 1 $mg.l^{-1}$ before there is no danger to fresh water fish life (Bernard et al. 1997; Conservation & Environmental studies Center, 2005). Apart from that, the release of nitrogen into natural watercourses can also cause eutrophication (Hamidi et al. 2004; Jokela et al. 2002).

Table I indicates that the colour of the leachate is high ranging from 3500 to 38750 PtCo. The decomposition of organic matter such as humic acid may cause the water to be yellow, brown or black. Hamidi *et al.* (2005) suggested that colour in landfill leachate was mainly contributed by organic matters with some insoluble forms that exhibited turbidity and suspended solids readings. Removal of colour from leachate is also a challenging problem in environmental pollution control.

Table 1: Landfill leachate characteristics (range of values) from Batu 55 landfill, Maran

PARAMETERS (UNIT)	RANGE
pH	7.44 – 8.22
Colour (PtCo)	3500 - 38750
TSS ($mg.l^{-1}$)	600 - 6520
COD ($mg.l^{-1}$)	1537 - 9875
BOD_5 ($mg.l^{-1}$)	47 - 155
N-Ammonia [NH_3-N ($mg.l^{-}$)]	629 - 6250
Ion Nitrate [NO_3-N ($mg.l^{-1}$)]	230 - 635
Ion Nitrite [NO_2-N ($mg.l^{-1}$)]	0.6 – 23.4
Ion Sulfate [SO_4^{2-} ($mg.l^{-1}$)]	325 - 1875
Ion phosphate [PO_4^{2-} ($mg.l^{-1}$)]	15 – 592.5
Metal (ppm)	
Ferum	< 3.5
Magnesium	< 3.7
Zinc	< 3.5
Cuprum	0.3 - 0.6
Plumbum	Not detected
Cadmium	Not detected

Result from this study indicated that fecal coliform have been detected ranging from 0% to 38.6% of viable count (Table II & III). The high number of coliforms, indicates a possible occurrence of diseases like cholera, dysentery and typhoid. As lifestyles rapidly change, the related conveniences and products such as disposable diapers had been used widely. Therefore it poses special waste disposal challenges.

Table 2: Total cell count and viable count in leachate characteristics (range of values) from Batu 55 landfill, Maran

MONTH (YEAR)	TOTAL CELL COUNT ($cell.ml^{-1}$)	VIABLE COUNT ($CFU.ml^{-1}$)
May 2004	$1.4 X 10^4$	$2.0 X 10^2$
July 2004	$9.2 X 10^3$	$3.5 X 10^3$
September 2004	$1.8 X 10^5$	$3.3 X 10^3$
November 2004	$1.6 X 10^5$	$1.4 X 10^4$
January 2005	$7.9 X 10^3$	$7.0 X 10^2$
March 2005	$1.4 X 10^5$	$7.0 X 10^2$

Table 3: Total coliform and fecal coliform in leachate characteristics (range of values) from Batu 55 landfill, Maran

MONTH (YEAR)	TOTAL COLIFORM ($MPN.100^{-1}$)	FECAL COLIFORM ($MPN.100^{-1}$)
May 2004	2.0 X 10	undetected
July 2004	$3.0 X 10^3$	$9.0 X 10^2$
September 2004	$3.2 X 10^2$	$2.0 X 10^3$
November 2004	$1.0 X 10^4$	$2.8 X 10^3$
January 2005	undetected	undetected
March 2005	$4.0 X 10^2$	$2.7 X 10^2$

Conclusion

High ammonium content, the brown colour of leachate and low COD/BOD ratio suggested that a combination of physical, chemical and biological methods have to be used for leachate treatment and it is very difficult to obtain satisfactory treatment efficiencies by one of the methods alone.

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