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AN OVERVIEW OF LANDFILL MANAGEMENT AND TECHNOLOGIES : A MALAYSIAN CASE STUDY AT AMPAR TENANG

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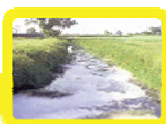
ABSTRACT

Malaysia is composed of the Peninsular Malaysia and the states of Sabah and Sarawak in the island of Borneo. As a country that moving forward to achieve the industrialized country status by the year 2020, Malaysia cannot escape from facing the solid waste management problems. There are a total 230 landfill in Malaysia. Landfills have been the most common methods of organized waste disposal. In most cases, open dumping is being practiced and takes place at about 50% of the total landfills. In addition, many landfills have opted to close rather than meet new while the quantity of waste generated yearly is much faster than the natural degradation process. Last year, about 7.34 million tones of solid wastes were generated, enough to fill up 42 buildings the same size as that of the world-renowned Petronas Twin Tower. Which each person generates about 1kg of solid waste per day. This solid waste volume is still increasing at the rate of 1.5% per year due to increase in urbanizations, change in living standards and consumption patterns. The case study, Ampar Tenang Landfill is situated near Sungai Labu, Sepang. Due to the continuous domestic waste generation, Ampar Tenang Landfill also currently overloading and serious leacheate spilling over the adjacent areas to the nearby Sungai Labu which is the main water supply for the Sepang and Nilai locality. Majority of the landfills in Malaysia are crude dumping ground, thus cause natural resource polluted and various environmental problems such as health hazards, surface water and ground water contamination, odors, etc. There are other treatment and/or disposal methods such as incineration and composting which could moderate the solid waste problems but they are not economically and socially viable at this moment. Thus, waste reduction, recovery and recycling play important roles in tackling the pressing solid waste problems.



1.0 INTRODUCTION

Over the past year, state and country still battled with the landfill's location even there are a total 230 landfill in Malaysia. Land filling is the only waste disposal method that can deal with all kinds of materials in the solid waste stream and it is also the simplest and cheapest way of disposing solid waste. If the land filling could be carried out in a proper manner coupled with well-managed solid waste collection and transportation system, this would form the very fundamental level for the solid waste management (Rylander, 1998).

The waste generation situation is similar in most countries with each inhabitant producing between approximately 0.5 and 2.0 kg of disposable refuse each day (Sarsby R.). The solid waste generated in Malaysia per capital has increased from 0.5kg/capital/day in the 1980´s to current volume of 1kg/capital/day. This represents a 200% increased in 20 years (Agamuthu, 2001). According to Alam Flora Sdn Bhd Chief Executive Officer Mohamed Siraj Abdul Razack; last year, about 7.34 million tones of solid wastes were generated, enough to fill up 42 buildings the same size as that of the world-renowned Petronas Twin Towers. Such a great increase in the municipal solid waste is mainly due to the urbanization process, increase in population, and increase in per capital income and changes in consumption patterns. These factors have not only increased the solid waste volume but also changed the characteristics of the solid waste which have made it more complex for the municipalities to handle.

The current municipal solid waste management in Malaysia is far from sufficient and efficient in handling the increased amount of solid waste and its different composition due to lack of funds and expertise. Most of the municipalities are lack of adequate funds for waste treatment and disposal. Local authorities spend up to 60 per cent of their annual budget on waste management, which costs Malaysia between RM110 and RM130 to collect and dispose one tonne of garbage. That sums up to RM1.98 million to RM2.34 million per day or RM854 million per year at the current generation of 18,000 tonnes of solid wastes per day.

In addition, many landfills have opted to close rather than meet new while the quantity of waste generated yearly is much faster than the natural degradation process. In a very short period, more existing landfills are expected to reach their authorized capacity. Though the state emphasizes recycling program along with waste minimization plans, land filling remains the primary method of waste disposal. It is important to manage and dispose the wastes prudently because the improper management of the landfills has led to environmental and social problems.

2.0 LANDFILL MANAGEMENT

2.1 What is Landfill

A landfill or historically know as midden is a carefully engineered depression in the ground (or built on top of the ground, resembling a football stadium) into which wastes are put by burial. The aim is to avoid any hydraulic [water-related] connection between the wastes and the surrounding environment, particularly groundwater. Basically, a landfill is a bathtub in the ground; a double-lined landfill is one bathtub inside another. Bathtubs leak two ways: out the bottom or over the top.

2.2 Development of Landfilling

In designing the landfill, a few criteria's need to be considers. Design measures commonly adopted are as indicated in Table 1:

Design measure	Purpose
Low permeability lining system	To minimize leachate egress and prevent ground poluttion. Typical forms are clay mineral liners, geomembrane liners and bentonite-enriched soil liners
Underdrainage/ leachate detection system	It is placed beneath the lining system to detect any leachate that has breached the liner and to allow for its subsequent control
Leachate drainage and control system	This overlies the lining system to ensure the maintenance of a low head of leachate above the liner and to allow efficient leachate recirculation
Low-permeability capping layer	Covers the waste to prevent water ingress into the waste and therefore to limit future leachate generation
Gas ventilation system	To control the movement and concentrations of landfill gas within the landfill and to mitigate against potential explosive and/or asphyxiation hazards. Systems may be passive or active
Leachate and landfill gas monitoring system	Both within the landfill and outside of the side, prior to, during and on completion of construction. This monitoring is vital for the early detection of environmental pollution

Table 1: Common Elements Of Current Engineered Landfills

2.3 Types of Landfills

Although landfill is the least desirable option for solid waste disposal, a well developed waste management strategy must incorporate landfilling as an essential element to dispose of wastes. There are basically three types of engineered waste disposal facilities:

1) Municipal Solid Waste (MSW) Landfills
Municipal solid waste (MSW) landfill contain general (less toxic) wastes from sources such as private homes, institutions, schools, and businesses without hazardous wastes.

2) Hazardous Waste Landfills
Hazardous waste landfills are disposal facilities for the more toxic chemicals and dangerous by products. These landfills must be extremely well designed to reduce any chance of the escape of hazardous compounds into the environment.

3) Surface Impoundments
The surface impoundments are facilities that deal with liquid waste disposal. Many of the design procedures used for MSW landfills are also applicable to hazardous waste landfills and surface impoundments.

2.4 Operation Maintenance

A safe design of landfill is barely enough to ensure the safety of the public and the environment protection; it requires a well-managed operation which should include the following:

i) *Waste Identification and Restriction*

Landfill operators should identify different type of waste that is entering the landfill. This is to prevent hazardous waste from being delivered and co-disposed with other municipal solid waste at the landfill. They should be authorized to reject any waste until it is identified to be safe and acceptable at the landfill site.

ii) Daily Cover

The working face should be kept as small as possible and it should be covered by the end of each day operation or in a more frequent interim. Daily cover is used to control disease vectors from breeding, scavenging activities by rodents, seagulls, crows, odors and windblown littering.

iii) Run-on and runoff control

Run-on control is to prevent water from outside the landfill from entering the landfill cell because the additional water will increase the leachate production. While the runoff control is to prevent the escape of contaminants from the landfill area.

iv) Safety

The operation should be implemented in a way that will not threaten the workers' health and safety. They should be well informed with the risks and associated symptoms due to exposure to various types of waste especially hazardous waste that might be sent to municipal solid waste landfill for co-disposal. A protective equipment should be provided to the site workers and public access should be restricted in order to minimize the risks

v) Landfill Gas Monitoring and Management

When waste decomposes over time, gaseous products will be generated. During the first stage of degradation which is aerobic degradation, oxygen will be consumed and carbon dioxide will be formed.These gases can pose potential hazards such as explosion, asphyxiation, offsite gas migration as so on. A routine gas monitoring is essential to control the gases movement, especially the methane gas. The methane gas is odourless and highly combustible thus a proper gas venting and treatment facility should be installed to avoid potential hazard. If the energy recovery technique is available, methane gas should be processed to produce bio-fuel.

vi) Leachate Management

Leachate is a liquid consisting of moisture generated from landfill during the waste degradation process. When leachate is produced and moving inside the landfill, it picks up soluble heavy metals and acids from the waste. Leachate has high content of iron, chlorides, organic nitrogen, phosphate and sulphate (Preez and Pieterse, 1998). If the leachate that produced during the degradation process is not collected and treated, it will contaminate the nearby water resources. Other than to equip with the leachate collection and treatment facilities, ground water monitoring should be done from time to time to ensure that the leachate does not percolate through the liners. The nutrients that contain in the leachate can be recovered by irrigating the weak leachate to the woodland or grassland.

vii) Special Waste

Some waste such as batteries, sewage sludge, incineration ash and hospital waste normally discard together with other municipal solid waste. These wastes should be handled with different procedures and disposed separately from the municipal solid waste

3.0 TECHNOLOGIES FOR WASTE DISPOSAL AND MANAGEMENT

3.1 Composting

Composting is an aerobic degradation of organic fraction of the waste to yield a stable humus-like product which can be used as a soil conditioner (Wilson, 1981). Using composting as a treatment of solid waste can significantly reduce the solid waste volume especially in countries where organic waste and yard waste is predominant. But if the waste is comprised of high percentages of non-compostable waste such as rubber, glass, metals and plastic, a separation needs to be done before composting (Agamuthu, 2001). Although composting is seen as having good potential for waste reduction, a key issue lies in the need to pre-sort the waste materials in order to produce compost of acceptable grade. Preparation waste prior for composting is an important step because the organic and inorganic fractions in the waste need to be separated in order to avoid contamination of compost with potential toxic metals. Generally, composting is an environmental friendly, hygienic and usually contains substances of very low toxicity. (Agamuthu, 2001) According to Agamuthu (2001), compost is a nutrient rich substance which can improve the soil texture and important for plant growth and development. But Wilson (1981) holds the opposite opinion that compost is a low grade fertilizer which only has value as a soil conditioner. Although technologies for composting have been available for many years, currently, there are only very few composting plants around the world which are economically successful.

3.2 Incineration

In countries where the land is scarce and the solid waste generation rate is increasing with an accelerating rate, incineration offers a solution to deal with the solid waste problems. Incineration can reduce the volume of waste by about 90% and the remaining residual ash will go to landfill. This will extend the life span of the landfill to a longer term. But on the other hand, incinerated ash contains high level of heavy metals which have higher possibility of leaching rate If the waste to energy technology is available, incineration could provide energy recovery and the revenues generated would offset its high operation cost. In some industrialized countries, a high proportion of municipal solid waste has gone to incineration for energy recovery (Table 2).

Table 2: The current state of MSW incineration

Country	% of MSW incinerated	Energy Recovery %	Energy Recovery (type)
Austria	8.5%	100%	-
Belgium	54%	30%	HW/ST/E
Czech Republic	4%	77%	-
Denmark	65%	100%	Mostly district heating
Finland	2%	100%	-
Germany	34%	88% of the plants has energy recovery capacity	E/ST/HW
Japan	74%	Most plants	District heating/E
Luxembourg	69%	100%	E
Norway	20%	89%	-
Sweden	56%	100%	Mostly district heating
Switzerland	80%	72%	-
UK	8%	37%	HW/E
USA	16%	76% of the plants has energy recovery capacity	-

HW= hot water, ST=steam generation, E=electricity generation (given in order of level of use)
Source: European Energy from Waste Coalition (1993); Warmer Campaign (1990); RCEP (1993); MOPT (1992); OECD (1993).

But not all waste is suitable for incineration in order for energy recovery. Waste with low calorific value might need fuel supplement for combustion. The difference in characteristic of waste composition in developed countries and industrialized countries offers incineration a solution which could be economical to use but quite the contrary to developing countries. In developing countries, a high moisture and organic content with a small percentage of combustible materials in waste contribute to lower calorific values. Incineration of wastes with low calorific values would generally not be self-sustaining, and hence, energy recovery will not be economical. Moreover, due to problems of emission of toxic air pollutants from incineration plants in industrialized countries, this technology is not suitable to be implemented in countries that face technical constraints in controlling the potential air pollution (Sundaravadivel, et al, 2000).

3.3 Recycling

The fundamental issues related to waste recycling includes the separation of waste materials to recover the reusable and recyclable materials, the identification of market for the recovered materials and the specification of the recovered materials in terms of homogeneity and free of contamination. When stricter specifications are imposed, the cost incurred for sorting and collection systems to be implemented will be higher and hence recycling may not be cost effective.

The type of waste to be recovered depends on the demand and potential uses of the recovered materials. This is limited to materials that currently have a high commercial value such as aluminums, paper and cardboard, plastics, glass, and ferrous metal and for which recycling technologies are already available. The decision to undertake recycling operations on a large scale would be heavily influenced by the communities that are served. If there are insufficient recyclable materials available or generated, it may not be viable to invest in a central material recovery and processing facility as such facilities are costly to set up and to operate. Recycling although recommended on small scale is not considered a full waste disposal option.

4.0 A MALAYSIAN CASE STUDY : WASTE MANAGEMENT AT AMPAR TENANG LANDFILL

4.1 Introduction

The case study is Ampar Tenang Landfill situated near Sungai Labu, Sepang, Selangor. The 10 acres area previously under the supervision of Majlis Perbandaran Sepang (MPS) but currently the Ministry of Housing and Local Government (KPKT) is responsible on all planning and management. Due to the continous domestic waste generation, Ampar Tenang is currently overloading and serious leacheate spilling over the adjacent areas to the nearby Sungai Labu which is the main water supply for the Sepang and Nilai locality.

The existing leacheate treatment system is currently not functioning effectively which can cause contamination and pollution to the nearby Sungai Labu. The existing leachate treatment system and related facilities to waste disposal in Ampar Tenang landfill is currently not functioning effectively. Thus, the rehabilitation works need to do to the landfill in order to avoid continuous worsening leacheate contamination to the adjacent areas and river. A recirculation system for leacheate treatment has been proposed. A new geosynthetic clay liner is being employed to ensure zero leakages after the construction.

Figure 1: Area of Ampar Tenang Landfill

4.2 Existing Treatment System

Ampar Tenang lanfill is categorized as class II dumpsite which does not required any treatment process. Eventhough the treatment process is not necessary, a simple system need to be installing to address leacheate generation issues. The proposed recirculation system for leacheate treatment is the best solution to be implemented at Ampar Tenang landfill due the cost constraint. In addition, the proposed method fulfills the Clean Development Mechanism (CDM) which leacheate generated being recycled into the dumpsite. At the same time would increased the waste degradation rate due to microbial activities.

Effective microbes for the waste degradation process could be found and possibly could be reengineered according to local environment through some research activities. From the early laboratory test, we found that leacheate sample consist small rods and cocci in an aerobic condition. The treatment system also use geosynthetic clay liner as waterproofing layer to ensure zero leakages after the handing over of the rehabilitation work to KPKT.

From the literatures survey, there are some similar studied in other countries. Ruo He et al. from College of Environment and Recource, China reported in Process Biochemistry Journal that using of EMs increased the biodegradability of MSW, enhanced 24% of organic mass effluent from the landfill reactor, and shortened methane production period about 91 years in the bioreactor landfill system be a good .A combination of EMs and methanogenic reactors using treated leachate recirculation might be a good way to increase the degree of MSW stabilization, and enhance the rate and quality of gas production for energy recovery. We believe that the new treatment system would trigger initiatives to a new dimension in solid waste and leacheate management system in Malaysia.

5.0 CONCLUSION

The authorities have had the difficult and complex task of safely disposing of wastes. The current disposal system in Malaysia is not conducted in an environmentally sound manner and thus it entire ecosystem and leaves various environmental problems. The authorities are eagerly looking for a solution to solve the piling up solid waste related problems such as negative environmental impacts, land scarcity and increasing solid waste. Even though various alternative methods have been identified but they are not economically and socially viable. Since most of the current landfills in Malaysia have a poor code of landfill practice, it is important for the authorities to improve the current state of landfilling practice and the authorities also must be careful in meeting all of the regulatory requirements when a landfill sitting evaluation is performed. To protect human health and the environment, it is essential to tackle the problems from the root cause, i.e. to reduce the waste from being generated.

REFERENCES

Agamuthu, P. (2001) *Solid waste: principles and management with Malaysian case studies.* Kuala Lumpur: University of Malaya Press.

Rylander,H. (1998). *Global waste management*. In *14th Waste Congress*, 12-15 October 1998, Gauteng, South Africa.

Sarsby. R (2000). *Enviromental Geotechnics*.London: Thomas Telford Ltd

Sharma, H.D, Reddy, K.R (2004). *Geoenviromental Engineering*. New Jersey: John Wiley & Sons

Sakurai, K. (1990). *Improvement of solid waste management in developing countries*. Japan International Cooperation Agency.

Sundaravadivel, M., Vigneswaran, S., Doeleman, J.A. (2000). Waste management in semi-urban areas of India: appropriate technological strategies to overcome financial barriers. *Environmental Engineering and Policy*, *2*, 2, 91-104.

Wilson, D C. (1981). *Waste management: planning, evaluation, technologies*. New York: Oxford University Press.

Bernama. (09 February 2006). Waste Reduction: No Longer An Option But A Necessity [Online].