HEAVY METALS IN KUALA LUMPUR MUNICIPAL SOLID WASTE

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DEDICATION

Dedicated to my beloved father, mother,
brothers and sisters and friends....

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ABSTRAK

Dengan mengambilkira kebaikan sistem penunuan sisa perbandaran dari Kuala Lumpur, jika dibandingkan dengan sistem pelupusan yang lain, analisa logam berat, iaitu salah satu parameter penting telah dijalankan. Analisa secara terus daripada sampel sisa menggunakan alat "*Atomic Absorption Spectrophotometer*" atau AAS selama setahun, bermula July 2001 hingga Jun 2002. Hasil daripada projek ini, didapati purata kandungan kering logam berat adalah seperti berikut : kadmium (Cd): 5.9 g/tan. kromium (Cr): 46.7 g/tan., raksa (Hg): 3.7 g/tan., plumbum (Pb):111.1 g/tan, dan arsenik (As): 3.4 g/tan. Dijangkakan sekiranya sisa perbandaran ini diproses dengan sistem penunuan (*incinerator*), pelepasan logam berat selepas proses rawatan adalah dibawah tahap yang ditetapkan.

ABSTRACT

Considering the advantages of Municipal Solid Waste Incineration over other alternatives for MSW generated by the residents of Kuala Lumpur, a study was carried out to determine the loads of heavy metals in the MSW. Direct determination from collected MSW samples was carried out using Atomic Absorption Spectrophotometer. In this project, arsenic, cadmium, lead, chromium and mercury were determined by AAS for the period of one year, beginning from July 2001 until June 2002. As the result, average heavy metal loads, in g per ton refuse (dry basis) are: Cd: 5.9 g/ton. Cr: 46.7 g/ton., Hg: 3.7 g/ton., Pb:111.1 g/ton, and As : 3.4 g/ton. The heavy metals emission for MSW incineration is expected to be lower than the referred standards for this project.

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NOMENCLATURE

As	-	Arsenic
APCS	-	Air Pollution Control System
Pb	-	Lead
Cr	-	Chromium
Cd	-	Cadmium
C	-	Carbon
Cl	-	Chlorine
Zn	-	Zinc
Cu	-	Copper
Ni	-	Nickel
S	-	Sulphur
Sb	-	Antimony
F	-	Fluorine
Hg	-	Mercury
Fe	-	Iron
MSW	-	Municipal Solid Waste
ICP	-	Inductive Coupled Plasma
AAS	-	Atomic Absorption Spectrophotometer
µg/ton	-	microgram per ton
$\mu g/m^3$	-	microgram per cubic meter
RDF	-	Refuse Derived Fuel
APCS	-	Air Pollution Control System

ESP	-	Electrostatic Precipitator
DSI/ESP	-	Duct Sorbent Injection/Fabric Filter
SD/ESP	-	Spray Dryer/ Electrostatic Precipitator
DSI/FF	-	Duct Sorbent Injection/ Fabric Filter
SD/FF	-	Spray Dryer/ Fabric Filter

CHAPTER I

INTRODUCTION

1.1 Introduction

Solid wastes, comprising of all the wastes of human and animal activities, are discharged as something useless or unwanted. In the early days, the disposal of human and other wastes did not pose a significant problem as the population was small and the amount of land for the assimilation of waste was large (Tchobanoglous and Theisen, 1993).

As the population grows rapidly, along with the technological and industrial advances in the recent years, the chemical composition of municipal solid waste (MSW) in the country has also become more complex. This includes the presence of various toxic heavy metals. Considerable amount of toxic heavy metals that may create potential adverse effects on human, crops and animals, have been a great concern to both regulatory bodies and environmental activist in the recent years. Due to this reason, the availability of good heavy metal data in local MSW is important.

Determination of heavy metals content in local MSW, namely arsenic, cadmium, mercury, lead and chromium was carried out in this study for a period of one year from July 2001 to June 2002. By using the heavy metal data, estimation has been be made on metal emission which was done to predict its compliance with given local standards. The samples were collected from Selayang landfill site, which caters the MSW from Kuala Lumpur.

The five toxic heavy metals which are commonly associated with adverse effects on human, animals and plants, have been a great concern to both regulatory agencies and public. The increasing level of bioaccumulation in the environment particularly in the food chain of these toxic metals pose potential risks to human health and the difficulty to limit mercury emission from anthropogenic sources due to the high volatility of mercury species have drawn special attention (Scala, 2001). These elements, contrary to other pollutants, are non biodegradable and undergo global eco-biological cycle (Shende *et al.*, 1992). Olie, *et al.* (1997) reported that heavy metals could also act as catalyst in the formation of polychlorinated dibenzo-*p*-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) in MSW incineration process.

1.2 Problem Statement

The disposal of municipal solid waste (MSW) is a continuing issue facing our society, has come to a crossroads. Limited landfill sites and increasing disposal costs have hasten the effort to adopt incineration technologies and energy recoveries (Wang *et al.*, 2001). In Malaysia, the proposed incineration plant, located 5 km from Broga, Selangor will be the first municipal solid waste incineration plant in the country. More MSW thermal plants are expected to be built in the country in the future, as a part of the integrated municipal solid waste management. This is in line with the government's plan to phase-out the existing conventional method.

Unfortunately, since the technology is new, there are a lot of technical data needed as reference according to the local condition. Technical data such as proximate and ultimate analysis, waste composition, characterization and heavy metal analysis are some of the essential in MSW incineration plant design.

The need to know heavy metal concentration in MSW is important for engineers to design an incinerator plant, especially the air pollution control system (APCS). The design of air pollution control system for incinerators in MSW management must have reliable heavy metal data. Such data can be used to estimate the cost and efficiency of the desired air pollution system to remove the heavy metals from the flue gas. By having such data also will help air pollution specialist to evaluate the heavy metal contamination level of the ambient air quality in the affected area by using an air dispersion modelling. Water quality specialist can use the compiled data as reference in the case of underground and surface water pollution.

However, in this project, the focus is on the estimation of heavy metal emission based on the data obtained and calculation was made by using emission factors used by the USEPA. The final estimation will be compared to the local emission standards. Stringent emission standards on MSW incineration are expected in the future.

1.3 Objectives

The objectives of this study are:

i. To quantify the amount of heavy metals in the MSW.
ii. To study the effect of the source of MSW on heavy metal concentration.
iii. To study the seasonal influence on the heavy metal concentration throughout the year.
iv. To estimate and evaluate the emission of heavy metals if the MSW is incinerated.

1.4 Scope of Study

This study covers the analysis of heavy metal content in 15 composite samples characterised base on MSW collection route and activities. Sampling was carried out for 7 days in each month, beginning on July 2001 until Jun 2002. Samples were digested using wet digestion method (ASTM E 926-94). Analysis of heavy metal were carried out using Atomic Absorption Spectroscopy (AAS). By using the data obtained, the next step was to estimate the emission of each heavy metal passing through the air pollution control (APCS) and to compare with the given guideline for incineration of MSW. Concluding remarks are proposed based on the findings of this project.

5.2 Recommendations

i. The analysis of heavy metals in this project only involves composite samples, not individual samples (plastics, food, paper, yard waste, etc.) and therefore the actual sources are not fully understood. Further investigation can be carried out on actual heavy metals sources in local condition.

ii. Further investigation can be made on heavy metal loads made after waste recovery and recycling. The major intention was to carry out recovery and recycling before incineration once the plant operates.

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