ELECTROCOAGULATION IN REMOVAL OF COD AND HEAVY METAL IN LEACHATE FROM PULAU BURUNG LANDFILL SITE (PBLS), PENANG

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INTRODUCTION

In solid waste management, landfilling is the most common methods for the disposal of municipal solid wastes in many countries around the world. Leachate is one of the major environmental concerns associated with landfilling which may either exist as aqueous effluent in the landfill or created after rainwater mixes with the chemical waste in the landfill. Landfill leachate is characterized as high-strength wastewater exhibiting acute and chronic toxicity (Deng and Englehardt, 2006). Leachates has high concentration of COD (Cossu *et al.*, 1998) and heavy metals.The commonly found elements in high concentration includes iron, manganese, zinc, chromium, lead, copper and cadmium (Aziz *et al.*, 2004). This contaminant leads to serious pollution within medium in contact with the waste especially on soil (Tsai et al,. 1996) and groundwater aquifers (Contreras *et al.*, 2009) as well as adjacent surface water (Atmaca, 2009). Electrocoagulation is an electrochemical wastewater treatment technology that has been successfully employed in removing metals, suspended particles, clay minerals, organic dyes, and oil and greases from a variety of industrial effluents (Mollah *et al.*, 2004). According to Aziz *et al*., (2007), Pulau Burung Landfill Site (PBLS) is situated within Byram Forest Reserve in Penang, Malaysia. This landfill has been developed as a sanitary landfill Level II by establishing a controlled tipping technique in 1991. It was further upgraded to a sanitary landfill level III by employing controlled tipping with leachate recirculation in 2001. Based on the case study by Syarifah and Abdul Yamin (2009), the real average value of tonnage at this sanitary landfill now is about 2 200 tonnes per day. Roughly, the disposal wastes are divided into two categories which are domestic waste (60%) and industrial waste (40%).

PROBLEM STATEMENT AND SIGNIFICANCE OF STUDY

In Malaysia, proper treatment and control of landfill leachate is one of the most important tasks related to a municipal solid waste landfill in the purpose to minimize the environmental impacts resulting from leachate contamination. Without adequate treatment, the leachate can contaminate both the soil and groundwater surrounding the landfill, thus becoming a secondary pollutant (Tsai *et al*., 1996). Based on the results of leachate characterization by Aziz *et al.,* (2007), PBLS has high concentration of COD and some heavy metals found in that landfill includes zinc, manganese, iron, copper and chromium (VI). Electrocoagulation have been employed as a water treatment technology and is proven effective in removing an extremely wide range of pollutants (Holt *et al.*, 2005). The present study focused on the removal of COD and heavy metal concentrations in landfill leachate through electroagulation processes with effective operational experiment. It could improve water quality on its surrounding by reducing both marine pollution and cost of leachate treatment before being release into the environment in the future.

RESEARCH OBJECTIVES

(1) To investigate the efficiency of electrocoagulation processes in the removal of COD from
landfill leachate.

(2) To study the parameters effecting electrocoagulation efficiency in the removal of heavy metal
from landfill leachate, thus proposing the optimum condition for pollutant removal.

LITERATURE REVIEW

Most of the world's municipal solid waste buried in landfills will eventually leak toxic liquids into the soil and underlying aquifers. During or after landfilling operation, leachate developed due to the humidity rate of the waste onsite, chemical and physical disposal reaction of water, rain deposition which to the increase in the level of underground water (Veli *et al*., 2008). The leachate deriving from the decomposition of organic waste in a landfill is a dark grey, foul smelling solution (Moreas and Bertazzoli, 2005). Leachate has a complex structure and large amounts of organic matter, ammonia-nitrogen, heavy metal, chlorinated organic and inorganic salts. The removal of chemical oxygen demand (COD) is based on the organic matter (Renou *et al*., 2008) and a complete treatment is quite difficult to achieve the discharge standards (Ilhan *et al*., 2008). Variation in leachate composition and cumulative mass removal of pollutants in solid waste is often attributed to age factors. Kang *et al*., (2002) had classified landfills as young for <5 years, middle aged for 5-10 years, and old for >10 and concluded that the molecular size of pollutant increased as the landfilling age increased. Many researchers used different technologies in treating landfill leachate to meet the standards for discharge in receiving waters which includes biological treatment (Ding *et el*., 2001), coagulation-flocculation (Ntampou *et al*.,2006), reverse osmosis (Chianese *et al*., 1998), filtration (Aziz *et al*., 2004), electrocoagulation (Ilhan *et al*., 2008), electro-oxidation (Chiang *et al*., 1994) and electro-Fenton (Deng and Englehardt, 2006).

Biological methods are very effective for treatment of landfill leachate with high value of BOD (Chiang *et al*., 1994). Nevertheless, biological treatment processes are insufficient in the removal of persistent organics (Veli *et al*., 2008). That's why for the treatment of leachate, we need different treatment processes, the most widely used of which are the physical and chemical process (Ozturk *et al*., 2003) and mostly used for pretreatment or full treatment for landfill leachate (Deng *et al*., 2007). With the ever increasing standard of drinking water supply and the stringent environmental regulations regarding wastewater discharge, elecrochemical technologies have regained their importance worldwide during the past 2 decades and fundamental as well as engineering deposition technology in metal recovery or heavy metal-effluent treatment had been developed (Chen *et al*., 2007). However, removal of metals from leachate is not well documented, especially in Malaysia (Aziz *et al*., 2004). Electrocoagulation is one of the simple and efficient electrochemical methods for the purification of many types of water and wastewater (Kobya *et al*., 2003). Contreras *et al*. (2009), Ilhan *et al*. (2008), Veli *et al*. (2008) and Tsai *et al*. (1997) have investigated electrocoagulation treatment of leachate effectively with high COD, BOD, ammonia and heavy metals. They used the same electrodes (aluminum and iron) in the experiment to remove the pollutant except Tsai *et al*., used copper as the cathode. Electrocoagulation tests also were performed by Mouedhen *et al*.,(2008) to treat a synthetic wastewater containing heavy metallic ions which include Ni^{2+}, Cu^{2+}, Zn^{2+} and applicable process using the aluminum anode for chromium removal (Zaroul *et al*,. 2009).

METHODOLOGY

1. Sample collection

Leachate samples is collect through collection pipes that feed into a detention pond. Place the samples in glass bottle before stored in a 4^0C refrigerator until use to keep the leachate samples characteristics unchanged. Conditioning for about 3 hour under ambient temperature before analyzed.

2. Laboratory

2.1) Characteristics of the leachate

Determine the pH (pH meter), COD (Open Reflux method), heavy metal (AAS), conductivity (conductivity meter), turbidity (turbidimeter), color (HACH-KIT Modd DR200) and temperature (temperature meter) of leachate samples according to Standard Methods for Examination of Water and Wastewater (APHA, 1998).

2.2) Experimental set-up

Prepare the electrocoagulation experimental equipment unit consisting of a 0.6 L glass beaker with two aluminum or iron electrodes of rectangular shape and install parallel in the middle of the reactor, which dimension of electrodes in 2.0 mm thickness is 5.0 cm X 15.0 cm. The total effective area is (9 cm X 5 cm) 45.0 cm^2 and distance between the electrodes is 6.5 cm. Place the electrodes dip into the beaker containing leachate with a 0.5L working volume. Then, connect he electrodes to a DC power supply with operational options for controlling the current density. Run the experiment at room temperature.

2.3) Operational runs

Carry out the experimental under different conditions as below;

pH	= pH(2,4,7,8)	Time	= (1, 5, 15, 30) min
Voltage	= (8, 10, 12, 14) V	Temperature	= (15, 20, 25, 30) ^{0}C
Current Density	= (348, 435, 524, 631) A/m^2	Mixing rates	= 200 rpm

2.4) Preparation of sample

- The pH of leachate samples were adjusted using NaOH / H_2SO_4

3. Analysis

- The results will be analyzed using Analysis of variance (ANOVA).

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