

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfilment of the requirements for the degree of Master of Science

**PREPARATION AND PERFORMANCE OF ELECTRO-OXIDATION
SYSTEM FOR LEACHATE TREATMENT**

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The rapid growth of population and urbanization have led to the expansion of landfills which consequently contributed to significant environmental challenges particularly in the management of leachate, a toxic byproduct of waste decomposition. The ultimate goal of this research is to explore the preparation and performance of an electro-oxidation (EO) system for leachate landfill treatment, aiming to offer a practical and efficient solution for this pressing issue. The study started with the design and fabrication of EO system which can occupy 5L of leachate sample. It was equipped with a (47x11x20) cm tank, holding 4 pairs of (24x7) cm electrodes. A comprehensive analysis of leachate properties was determined before the treatment, emphasizing the existence of contaminants listed in the standard limits. Subsequently, the efficiency of EO system were evaluated at different operating times (20-100 minutes), applied voltage (6-30V), number of electrodes (1-4 pairs) and electrode distances (3 and 6 cm). Performance metrics were evaluated based on the reduction of turbidity, colour, TSS, COD and TAN. The efficacy of EO process was validated by integrating this system with filtration system as polishing treatment. Overall findings determined that the best operating parameters for EO were 80 minutes, 30V, 4 pairs of electrode plates, and 3 cm plate distance, when the process was successfully removed for about 99%, 82%, 99%, 90% and 96% of turbidity, colour, COD, TSS and TAN, respectively. The statistical analysis of ANOVA for all the operating parameters (p -value <0.5) indicated

that the data was statistically significant with the contaminant's removal. While integration of EO and filtration (sand-activated carbon) shows a promising result by removing 98%, 95%, 96%, 98% and 97% of turbidity, colour, COD, TSS and TAN, respectively. The findings of this research exhibit significant insights into optimizing the electro-oxidation process for effective landfill leachate treatment, paving the way for more efficient and scalable treatment technologies.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu
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**TAJUK PENYEDIAAN DAN PRESTASI SISTEM PENGOKSIDAAN
ELEKTRO UNTUK RAWATAN AIR LARUT LESAP**

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Pertumbuhan pesat penduduk dan pembandaran telah membawa kepada pengembangan tapak pelupusan sampah yang seterusnya menyumbang kepada cabaran alam sekitar yang ketara terutamanya dalam pengurusan air larut resap, hasil sampingan toksik daripada penguraian sisa. Matlamat utama penyelidikan ini adalah untuk meneroka penyediaan dan prestasi sistem elektro-pengoksidaan (EO) untuk rawatan tapak pelupusan larut lesap, bertujuan untuk menawarkan penyelesaian yang praktikal dan cekap bagi isu mendesak ini. Kajian dimulakan dengan reka bentuk dan fabrikasi sistem EO yang boleh diisi 5L sampel larut lesap. Ia dilengkapi dengan tangki (47x11x20) sm, memuatkan 4 pasang elektrod (24x7) sm. Analisis menyeluruh terhadap sifat air larut resap telah ditentukan sebelum rawatan, dengan menumpukan kehadiran bahan cemar yang disenaraikan dalam had piawai. Selepas itu, kecekapan sistem EO dinilai pada masa operasi yang berbeza (20-100 minit), voltan naikan (6-30V), bilangan elektrod (1-4 pasang) dan jarak elektrod (3 dan 6 sm). Metrik prestasi dinilai berdasarkan pengurangan kekeruhan, warna, TSS, COD dan TAN. Keberkesanan proses EO telah disahkan dengan mengintegrasikan sistem ini dengan sistem penapisan sebagai rawatan penggilapan. Penemuan keseluruhan menentukan bahawa parameter operasi terbaik untuk EO ialah 80 minit, 30V, 4 pasang plat elektrod, dan jarak plat 3 sm, di mana proses itu berjaya mengurangkan kira-kira 99%, 82%, 99%, 90% dan 96% kekeruhan, warna, COD, TSS dan TAN,

masing-masing. Analisis statistik ANOVA untuk semua parameter operasi (nilai $p < 0.5$) menunjukkan bahawa data adalah signifikan secara statistik dengan penyingkiran bahan cemar. Manakala penyepaduan EO dan penapisan (pasir-karbon teraktif) menunjukkan hasil yang memberangsangkan dengan mengurangkan 98%, 95%, 96%, 98% dan 97% kekeruhan, warna, COD, TSS dan TAN, masing-masing. Penemuan penyelidikan ini mempamerkan pemahaman penting dalam mengoptimumkan proses elektro-pengoksidaan untuk rawatan air larut resap tapak pelupusan yang berkesan, membuka jalan bagi teknologi rawatan yang lebih cekap dan berskala.