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Electrocoagulation Process by Using Aluminium and Stainless Steel Electrodes to Treat Total Chromium, Colour and Turbidity

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Abstract

The research works involve the study of removal of Total Chromium, Colour and Turbidity contaminations in landfill leachate by electrocoagulation process. This project focused on leachate landfill from Pulau Burung, Nibong Tebal, Penang as an electrolyte solution. Heavy metals are the main factor contributing to pollution in leachate landfill. Leachate is the main pollution factors from landfill sites and must be treated before it is released into the environment[1]. Landfill leachate contain high amount of heavy metals that can cause serious health problems to human, if the wastewater that contained heavy metals is not treated properly[2]. This project tried to reduce and treat the heavy metal that contain in the landfill leachate. Types of electrodes used in this study were Aluminium (grade 5052) and Stainless Steel (grade 316). The ranges of initial pH applied were pH (3, 4, 5, 6 and 7) and voltages applied were 1.5V, 2.0V and 2.5V. At the end of electrocoagulation process, the solutions were stored and analysed using Atomic Absorption Spectroscopy (AAS) to determine the final concentration of electrolyte solution. It was found that, the difference electrodes have different effectiveness in removing Total Chromium, colour and turbidity, relies on the types of electrodes (Aluminium or Stainless Steel). Based on the result, can be concluded that Aluminium Electrodes are best for removal of turbidity and colour. Stainless Steel Electrodes is best for removal Total Chromium. The initial pH also gives the significant effect to removal of heavy metal and the maximum voltages give higher removal of heavy metal.

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Keywords: Electrocoagulation; initial pH; applied voltages; electrodes; Aluminium and Stainless Steel

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1. Introduction

Landfilling is the most common and easy way to dispose the solid waste. Generally landfill will receive the wastes from municipal that are near to a landfill. If the location of waste generated is far, the transfer station is the solution to reduce cost of waste transportation. The waste usually mixed of waste products from residential area, commercial, institutional and etc.

There are three kinds of outputs for landfills, examples gas, liquid (leachate) and inert solids[3]. Commonly, leachates may contain organic contaminants in large amounts and can be measured as Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), ammonia, and high concentration of heavy metals.It is contains high concentration of pollutants which can have adverse effects on the environment[4]. Various methods have been proposed to remove heavy metal such as ion exchange resins adsorption[5], chemical precipitation, membrane filtration[6], and electrocoagulation[7].

Electrocoagulation has been used in treating wastewater that containing, oil and grease, suspended solids and even inorganic and organic pollutants that can be flocculated. This method has been effectively applied for the treatment of the textile dye wastewater, purification of wastewater, tannery wastewater and domestic wastewater. This method is categorized by simple equipment and easy operation. The electrocoagulation processes have lesser amount of sludge[8] and having features like relatively more economic and higher treatment efficiency has been a promising method[9].

2. Materials and methods

2.1. Experimental Procedure

The procedure started with electrocoagulation cell cleaned with distilled water and dried using dryer. About 100 mL of leachate sample was poured into the electrocoagulation cell, this volume will allowed and give space for bubble from the reaction to develop since the maximum capacity for electrocoagulation cell is 150mL. The pH of the solution was taken using pH meter (Model CyberScan pH 510) and recorded. The electrodes (anode and cathode) were clamped at electrode stand. All connections in the circuit were completed by wire connection to terminal positive and negative to DC power supply (Model Topward 3306D), electrodes (anode and cathode), voltmeter and ammeter (Model Fluke 115). The electrodes were immersed in an electrolyte solution. Immediately the power supply was switched on, and the voltage was adjusted to desire a voltage that is 1.5V.

The colour of the solution of electrolyte solution was observed before and after the process occurred. The experiment was done in 60 minutes. The reading of cell potential and current, A, are taken every 5 minutes intervals. After 60 minutes, the power supplies were switched off and both electrodes were taken out carefully. The pH of the solution was taken using pH meter (Model CyberScan pH 510) and recorded. All procedure above was repeated by using other types of electrodes (Stainless Steel and Aluminium), difference of leachate sample (electrolyte solution) with varying initial pH values were pH 3, pH 4, pH 5, pH 6 and pH 7 and also difference applied voltage was used were 1.5V, 2.0V and 2.5V.

3. Results and Discussions

3.1. Effect pH on removal of Total Chromium, Colour and Turbidity

This experimental work used ranges, pH 3, 4, 5, 6 and 7. The pH 7.73 is for the control experiment and it is a raw leachate sample with addition chemical such as acid. These ranges will give the data about how acidic pH will affect the electrocoagulation efficiency in the removal of heavy metal that contain in the leachate samples.