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Research article

# Electrocoagulation treatment of raw landfill leachate using iron-based electrodes: Effects of process parameters and optimization

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ABSTRACT

The main problem of landfill leachate is its diverse composition comprising many persistent organic pollutants which must be removed before being discharge into the environment. This study investigated the treatment of raw landfill leachate using electrocoagulation process. An electrocoagulation system was designed with iron as both the anode and cathode. The effects of inter-electrode distance, initial pH and electrolyte concentration on colour and COD removals were investigated. All these factors were found to have significant effects on the colour removal. On the other hand, electrolyte concentration was the most significant parameter affecting the COD removal. Numerical optimization was also conducted to obtain the optimum process performance. Under optimum conditions (initial pH: 7.73, inter-electrode distance: 1.16 cm, and electrolyte concentration (NaCl): 2.00 g/L), the process could remove up to 82.7% colour and 45.1% COD. The process can be applied as a pre-treatment for raw leachates before applying other appropriate treatment technologies.



## 1. Introduction

The rapid increase in population and urbanization have led to the increased generation of solid waste worldwide, prompting concern for environmental protection and sustainability (Azni, 2009). Although approaches such as reuse and recycle are being adopted to reduce the amount of solid waste, landfilling remains the dominant method for the disposal of solid waste in many countries (Norkhadijah and Latifah Abd. Manaf, 2013). One of the major issues with landfill is the generation of leachate which must be properly managed to prevent environmental pollution. Leachates poses hazard to the environment since it may contain various pollutants such as persistent organic pollutants (POPs), heavy metals and other recalcitrant organic pollutants. Thus, leachate treatment is quite challenging due to its complex nature (Labanowski et al., 2010). The characteristics of leachate will depend largely on the composition of the solid waste in the landfill (Brennan et al., 2016). Environmental factors like climatic conditions and hydrology could also have influence on the quality and quantity of the leachate. In addition, landfill age, cover design and operational activities could change the properties of the produced leachate (Umar et al., 2010). Thus, the management of leachate can be daunting since landfill can continue to generate leachate for many years. Since the leachate must be continuously collected and disposed, proper treatment is necessary before discharging to the environment.

The selection of treatment method is mainly based on the composition and properties of the landfill leachate. Various treatment methods such as aerobic, anaerobic, flotation, coagulation–flocculation, chemical precipitation, adsorption, and air stripping have been used for leachate treatment (Renou et al., 2008; Thompson et al., 2001). Although some of these methods are economical and easy to maintain, they possess some drawbacks which have hindered their applications in leachate treatment (Jeworski and Heinzle, 2000). Coagulation is considered an economical way to treat leachate through the use of chemicals such as alum and other compounds with coagulating effects. These chemicals facilitate the flocculation and coagulation of the particles, leading to easier removal via sedimentation. However, issues such as possible adverse effects of the chemicals, production of secondary pollutants and the cost of chemicals are viewed as

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