Chapter 12
Chemical Treatment Technologies for Landfill Leachate

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ABSTRACT

Leachate generation is one of the main pollutants associated with municipal solid waste (MSW). Leachate is a liquid that has seeped through solid waste in a landfill and extracted dissolved or suspended materials in the process, and usually contains a complex variety of materials and organic compounds. Dedicated treatment facilities are required before leachate can be discharged to the environment. Researchers worldwide are still searching for a total solution to solve leachate problem. In this chapter, different chemical treatment methods for leachate including coagulation–flocculation, Fenton and Electro-Fenton oxidation, persulfate oxidation, ozonation, and advanced oxidation processes are reviewed and discussed. Nevertheless, the efficiency of each process was also evaluated. It can be concluded that the performance of these processes is mainly attributed to leachate type and initial organic concentrations whereas treatment performance weakens reported at older age and higher initial concentrations of leachate.

INTRODUCTION

Sanitary landfill is recognized as the most common and desirable method of urban solid waste management and as the most economical and environmentally acceptable method of municipal and industrial solid wastes disposal (Tengrui et al., 2007). However, sanitary landfill generates a large volume of heavily polluted leachate (Zazouil & Yousefi, 2008). Leachate is mainly released from wastes deposited in a landfill due to successive biological, chemical, and physical processes. The quality and quantity of the water formed at landfills depend on several factors, including seasonal weather variations, land filling technique, phase sequencing, piling, and compaction method (Amonkrane et al., 1997; Trebouet et al., 2001).

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The environmental impact of leachate depends on leachate strength, proper leachate collection, and the efficiency of leachate treatment. Leachate contains high amounts of organic compounds, ammonia, and heavy metals and sometimes contaminates ground and surface water (Christensen et al., 2001). Landfill leachate usually contains a complex variety of materials and organic compounds, such as humic substances, fatty acids, heavy metals, and many other hazardous chemicals (Schrab et al., 1993; Christensen et al., 2001; Renou et al., 2008; Aziz et al., 2009; Foul et al., 2009). Moreover, the subsequent migration of leachate away from the landfill and its release into the environment are serious environmental pollution concerns that threaten public safety and health (Read et al., 2001). Accordingly, many environmental specialists are determined to discover efficient treatments for large quantities of polluted leachate.

The leachate generated from mature landfills (age >10 years) is typically characterized by large amounts of organic contaminants measured as chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), ammonia, halogenated hydrocarbons suspended solid, significant concentration of heavy metals, and many other hazardous chemicals identified as potential sources of ground and surface water contamination. Stabilized leachate, indicated by a low biochemical oxygen demand (BOD5)/COD ratio (i.e., low biodegradability) and seen in many landfills in Malaysia, is particularly difficult to treat biologically (Mohajeri et al., 2010a, 2010b; Bashir, et al., 2010a,b). Therefore, additional physico-chemical processes are necessary for the pre-treatment and post-treatment of leachate (Tauchert et al., 2006).

In this regard, dedicated treatment facilities are required before leachate can be discharged to the environment. Various site-specific treatment techniques can be used to treat hazardous wastewater depending on leachate characteristics, operation and capital costs, and regulations. Leachate treatment schemes likely include biological, physical, and chemical processes; their combination and specific modification are greatly influenced by the characteristics of leachate produced (Goi et al., 2009; Baig and Liechti, 2001). Advanced oxidation processes (AOPs) have received considerable attention as alternative methods for reducing the organic load of wastewater. These methods transform non-biodegradable pollutants into nontoxic substances (Catalkaya & Kargi, 2007).

Leachate in classical wastewater treatment plants is rarely treated because of its nature and high levels of pollutants (i.e., high chemical oxygen demand [COD] and ammonia content and low biodegradability). Researchers worldwide are still searching for a total solution to the leachate problem. Multiple-stage treatments are still required to remove leachate pollution thoroughly. No single method can effectively remove all pollutants simultaneously. Treatment by a conventional water treatment system (i.e., a combination of sedimentation, biological treatment, filtration, and carbon adsorption) cannot remove salts or organics, such as harmful recalcitrant compounds.

In conjunction to the above mentioned, the application of a number of leachate treatment techniques, including biological, physical, and chemical processes, has been investigated (Baig et al., 2001; Goi et al., 2009,Abu Amr et al., 2013 &2014). The current chapter introduced review investigations to an overview the chemical treatment processes in landfill leachate. The study aims to compare and evaluate the effectiveness of these applications in leachate treatment and to highlight the possible opportunities of leachate treatment using chemical oxidation processes in order to recommends in future work.

CHEMICAL TREATMENT OF LANDFILL LEACHATE

One of the primary problems in landfill management is the establishment of efficient treatments for large quantities of leachate. Landfill leachate is a potentially polluting liquid that may bring harmful effects