Chapter 14
Integrated Leachate Treatment Technology

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ABSTRACT

In this chapter, the performance of combined treatment of municipal landfill leachate is reviewed. Although individual physico-chemical treatments are suitable for the removal of heavy metals and hydrolyzation of some organic compounds, a combination of two physico-chemical treatments or physico-chemical and biological is required for optimum treatment of stabilized landfill leachate. A combination of two physico-chemical treatments can give optimum results in removal of recalcitrant organic compounds from stabilized leachate, as reflected by a significant decrease of the COD values after treatment. On the other hand, a combination of physico-chemical and biological treatments is required to achieve effective removal of NH3-N and COD with a substantial amount of biodegradable organic matter. In many cases, physico-chemical treatments are suitable for pre-treatment of stabilized leachate. The objective of this paper is to highlight various types of integrated leachate treatments as it has been difficult to get optimum efficiency from single approached treatment.

INTRODUCTION

Over the past 20 years (1983-2005), numerous research studies have been carried out worldwide in the treatment of stabilized leachate using various types of individual and/or combined physico-chemical and/or combined physico-chemical and biological technologies (Kurniawan et al., 2006). Due to the high ratio of COD/BOD, ammonia nitrogen (NH_3-N) and heavy metals in leachate, there are major difficulties presence in treating leachate. Most of the methods used for landfill leachate treatment include coagulation/flocculation, adsorption, membrane filter, sedimentation, air stripping (Marttinen et al., 2002; Bohdziewics et al., 2001; Trebouet et al., 2001). A combination of physical/chemical and biological methods is almost necessary for the efficient treatment of heavily polluted leachate (Rautenbach & Mellis, 1994).

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The selection of the most suitable treatment technique for leachate depends on the characteristics of landfill leachate, technical applicability and constraints, effluent discharge alternatives, cost effectiveness, regulatory requirement and environmental impact (Kurniawan et al., 2006).

Biological techniques can be effective in simultaneous removal of organic carbon and nitrogen for biodegradable (BOD5/COD) ratio > 0.3) landfill leachate. Biological treatment is commonly used for the elimination of the high concentration of BOD and COD due to its simple, reliable and cost effective (Uygur & Kargi, 2004). The application of biological process alone, for example, cannot eliminate the refractory organics and residue. Therefore, additional treatment is often required (Izzet et al., 2003). Biological treatment is mostly the first stage in a combination with additional chemical/physical process. Methods used for biological leachate treatments are mainly aerobic, anaerobic and anoxic processes which are used in combination (Im et al., 2001).The ammonia nitrogen is identified as a major toxicant to microorganisms in the landfill leachate treatment. Therefore, pre-treatment prior to biological treatment is required to reduce high concentrations of NH_3-N (Daekeun et al., 2007). Pressure driven membrane filtration methods have been used along with biological treatment of landfill leachate (Bohdziewics et al., 2001). Prior to biological treatment, ozone pre-treatment should be employed in order to improve COD removal.

The physical/chemical techniques have been used widely for post treatment of biologically pre-treated leachate (Izzet et al., 2003). Physico-chemical treatments can act as a refining step for the stabilized effluent of biologically treated leachate. The use of combined coagulation/flocculation with other processes such as reverse osmosis (Izzet et al., 2003), photo-oxidation process and biological treatment (Kargi & Pamukoglu, 2003a) gave satisfactory results. After an aerobic pre-treatment, ion exchange normally achieves an excellent metal removal from effluents. Prior to ion exchange, appropriate pre-treatment system such as the removal of suspended solids from leachate is required (Kurniawan et al, 2006). Combination of anaerobic-aerobic and rotating biological contactor (RBC) systems in treating leachate improved the removal of organic matter (Park et al., 2001).

PHYSICAL AND CHEMICAL TREATMENTS

Physical and chemical processes include reduction of suspended solids, colloidal particles, floating material, color, and toxic compounds (Renou et al., 2008). Chemical and physical methods, such as chemical oxidation, adsorption, chemical precipitation, coagulation-flocculation, sedimentation/flotation and air stripping were applied successfully for the treatment of landfill leachate (Gandhimathi et al., 2013; Kurniawan et al., 2009; Papastavrou et al., 2009). The combination of the above process reduces the drawbacks of each single process. (Gandhimathi et al., 2013; Zazouli et al., 2012; Papastavrou et al., 2009).

Kilic et al., (2007) conducted a research on leachate treatment collected from Bursa landfill. In this study, the first alternative, pre-treatment with lime + ammonia stripping + neutralization were operated. This alternative achieved 19% COD removal. The second alternative included chemical coagulation + ammonia stripping + granular activated carbon (GAC) adsorption, achieved to produce an effluent COD of 160 mg/L, which complied with the Turkish discharge standard. Consequently, the second alternative was determined to be appropriate according to discharge standard. The following pre-treatment with lime, co-treatment with municipal waste water is appropriate for lower treatment costs.

A study on the treatment of stabilized leachate was carried out by Zamora et al. (2000) by comparing coagulation – flocculation to the Fenton oxidation ($Fe(II)/H_2O_2$) process in combination with