Chapter 13
Sustainable Treatment of Landfill Leachate Using Constructed Wetlands:
An Eco-Friendly Approach

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ABSTRACT

Sanitary landfilling is the major method of disposal of municipal solid waste (MSW) in developing countries. The disposal of MSW in landfills generates a large amount of highly toxic leachate, which has high potential hazards for the public, flora, fauna health and ecosystems. Advanced leachate treatment systems using biological and chemical treatment methods are recently implemented in developed countries, but high investment and operating costs restricted their application in most of the developing countries. To overcome this problem, an alternative sustainable treatment technology such as phytoremediation could be beneficial. The constructed wetland treatment system is an economical alternative for leachate treatment using local resources and is an energy-efficient technology. These green systems utilize anaerobic and aerobic reactions to break down, immobilize, or incorporate organic substances and other contaminants from polluted effluent. This chapter highlights the recent advances in the treatment of landfill leachates using constructed wetlands.

INTRODUCTION

Increased urbanization and industrialization lead to a substantial surge in the amount and diversity of solid waste (Khandelwal et al., 2019). The generation of municipal solid waste (MSW) attributes to unplanned development and migration of rural population to urban areas (Aluko et al., 2003; Oloruntade et al., 2013). Solid waste disposal in landfills is a widely adopted method as it is cost-effective but it also

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creates environmental hazard due to production of leachate (Ziyang et al., 2009). After disposal of MSW in a landfill, the moisture mixes with refuse and produces dark-coloured liquid called leachate which comprise of elevated concentrations of particular contaminants. The high concentration of pollutants in leachate can be attributed to dissolution of waste in a liquid phase, and thereafter its accumulation and percolation (Aziz et al., 2011). Leachate composition is complex which mainly consists of heavy metals, organic matter (biodegradable and refractory to biodegradation), chlorinated organic and inorganic salts, and inorganic compounds (Renou et al., 2008). In a landfill, fresh leachate comprise of high chemical load [high biochemical oxygen demand (BOD_5) and high chemical oxygen demand (COD)] with acidic pH however, with time, it becomes stable. Ammonia is a major pollutant which persists for a long time span in a landfill which does not decrease with the emission of landfill gases (Kjeldsen et al., 2002). The elevated levels of ammonia may diminish biological processes, speed up eutrophication, and reduce level of dissolved oxygen in leachate (Mojiri et al., 2016). In a landfill, the prime objective is to stabilize the MSW using natural metabolic pathways. The various hazards that can be imposed on the environment due to the production of leachate are: (i) contamination of groundwater due to percolation of leachate; (ii) contamination of surface water sources due to unsuitable selection of landfill sites; and (iii) release of greenhouse gases into atmosphere (Bulc, 2006).

Conventionally, treatment of leachate is done through physical, chemical and biological methods (Aziz et al., 2012). Phytoremediation proves advantageous over conventional wastewater treatment technologies due to its cost-effective and environment-friendly nature (Akratos et al., 2018). Phytoremediation is being adapted widely to treat a wide array of inorganic and organic pollutants (McCutcheon and Schnoor, 2004). Constructed wetlands (CWs) utilizes phytoremediation technology along with other physical and chemical processes to treat leachate emanating from MSW landfills, wastewater emanating from pulp and paper industry, textile industry, pharmaceutical industry, sugarcane industry, tannery industry, winery industry, etc. (Davies et al., 2009; Arivoli et al., 2015; Madera-Parra et al., 2015; Vymazal, 2017; Akratos et al., 2018; Sanchez-Galvan and Bolanos-Santiago, 2018; Flores et al., 2019). This chapter highlights the utilization of constructed wetland systems for the treatment of toxic leachate emanating from municipal solid waste landfills.

Municipal Solid Waste (MSW) Generation in India

A swift increase in the quantity of MSW generated has been observed due to increasingly affluent lifestyles, and growth of industrial and commercial sectors. However, the MSW generation rate depends upon the economic development, lifestyle, climate, and urbanization of a nation. In India, handling of MSW is governed by Municipal Solid Waste (Management and Handling) Rules 2000 (Ministry of Environment, Forest & Climate Change) which are further revised in 2016. In India, 90% of the total generated MSW is dumped in open landfills (Thakur et al., 2020). The urban people in India have significantly amplified from 1960 to 2011 as shown in Figure 1.

The Indian MSW contains 40-60% organic content, 30-60% inert material such as glass, 3-6% paper and miscellaneous, and 1% others (Rana et al., 2017)