Chapter 9
Introduction to Leachate Treatment

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ABSTRACT

Leachate is created while water penetrates through the waste in a landfill, carrying some forms of pollutants. The goal of this chapter is the introduction to leachate treatment. Biological, physical, and chemical treatments of leachate are the most common methods. The biological techniques in leachate treatment are studied. The physical-chemical ways for landfill leachate treatment like chemical precipitation, chemical oxidation, coagulation–flocculation, membrane filtration, ion exchange, adsorption and electrochemical treatment are studied. The landfill leachate properties, technical applicability and constraints, effluent discharge alternatives, cost-effectiveness, regulatory requirements and environmental impact are important factors for selection of the most suitable treatment technique for landfill leachate treatment.

INTRODUCTION

The rapid growth in volume and forms of solid and hazardous wastes as a result of continuous economic development, industrialization, and urbanization is an increasing problem faced by domestic and local governments in ensuring an efficient and sustainable waste management (Mojiri, 2014). Municipal Solid Waste (MSW) has continued to be a major problem in many nations of the world. MSW has gradually become a threat to the environment of developing countries as they progressively move towards industrialization. MSW has become one of the most serious environmental challenges facing many cities in the country (Oloruntade et al., 2013). MSW management is an important aspect of urban planning and development.

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In 2006, the estimated total volume of MSW generated internationally reached 2.02 billion tons, indicating a 7% annual rise since 2003. Between 2007 and 2011, the rise in universal generation of urban waste was estimated at 37.3%, equivalent to an increase of approximately 8% per year (UNEP, 2009).

In most countries, sanitary landfills are a common means of solid waste disposal. Although this method has numerous benefits, one of its drawbacks is leachate production, which must be managed properly. Without proper treatment, landfill leachate greatly increases water pollution as it can penetrate through soil and subsoil. Therefore, the levels of hazardous components in leachate should comply with discharge standards before releasing into landfills to avoid pollution of water sources and to prevent acute and chronic toxicity (Aziz et al., 2011sa). Leachate is created when water penetrates into landfill waste, carrying with it certain forms of pollutants, such as ammoniacal nitrogen (NH_3–N), chemical oxygen demand (COD), color, biological oxygen demand (BOD_5), suspended solids, and metals. Leachate composition depends on deposited waste, landfill age, site hydrology, landfill operation, and landfill type. High concentrations of suspended solids, BOD_5, COD, NH_3–N, and metals are usually present in leachate (Foul et al., 2009). Landfill leachate treatment methods depend on leachate composition, landfill age, and site hydrology, among other factors. The main applicable methods of landfill leachate treatment contain physical/chemical and biological treatment methods. Typically, combinations of physical, chemical, and biological techniques are applied for landfill leachate treatment because of the difficulty in obtaining satisfactory treatment efficiencies by a single method (Aziz, 2011).

BIOLOGICAL TREATMENT

Biological treatments include aerobic treatments, anaerobic treatments, and phytoremedation.

Aerobic Treatment

The word “aerobic” refers to the characteristic of being in the presence of air, which usually implies being in the presence of oxygen. Thus, aerobic treatment methods are performed in the presence of air and utilize microorganisms called “aerobes,” which utilize molecular/free oxygen to assimilate organic impurities; that is, aerobes convert these impurities into carbon dioxide, water, and biomass (Mittal, 2011).

Membrane Bioreactor (MBR)

The MBR technique is the combination of activated sludge sewage treatment and microfiltration (MF) or ultrafiltration (UF) membranes, with pore sizes ranging typically from 10 nm to 0.5 μm. In a conventional activated sludge treatment plant, the membrane filtration process replaces the final clarifier step treatment achieved solely by gravity, whereas the activated sludge bioreactor is kept separated from the UF treatment. In addition, the membrane disinfects by eliminating bacteria and viruses as well as by producing high-quality, suspended solid (SS)-free effluent (Battilani et al., 2010). The benefits of MBR include better control of biological activity, effluent that is free of bacteria and pathogens, smaller plant size, and higher organic loading rates (OLR) (Cicek, 2003; Johir et al., 2011). Advantages and disadvantages of the MBR are presented in Table 1.