Chapter 15
Polishing of Landfill Leachate

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ABSTRACT

This chapter deals exhaustively with the various techniques employed in polishing landfill leachate, the role, importance and effects of polishing leachate and the use of constructed wetlands with many examples from some countries where it has worked with considerable success. Types, forms and functions of wetlands in leachate polishing were also dealt with while the chapter also provides information on the advanced treatment wetlands technology being employed now for polishing landfill leachate; its design considerations and future projections. The role of bioremediation and aquatic plants in leachate treatment was also considered and reviewed while projected futuristic outlook of polished landfill leachate was examined.

INTRODUCTION

Landfill leachate treatment has become one of the most important environmental problems due to fluctuating of composition and quantity as well as high concentrations of specific pollutants (PAH, AOX, PCB, and heavy metals) and very high ammonia nitrogen and COD concentrations (Wojciechowska *et al.,* 2010). In the literature, considerable variations in the quality of leachate from different landfills have been reported (Kamaruddin *et al.,* 2013; Akinbile *et al*., 2012a & b; Cortez *et al.,* 2010; Sobolewski, 2007). The leachate from young landfills (where acetogenic biodegradation phase is active) is characterised by high COD, BOD as well as Na^+, Cl^- and NH_4^+ content, while the leachate produced in the subsequent methanogenic phase is characterised by relatively low COD, BOD and NH_4^+ content and higher pH (Jones *et al*., 2006; Klimiuk *et al.,* 2007). High-tech solutions applied for leachate treatment (i.e. reverse osmosis or ozonation) are expensive and energy consuming, thus they are not suitable at many landfill sites, especially in rural areas.

Leachate treatment is one of the most difficult problems to handle, as it could be released from the start of landfill operations until potentially many decades after the closure (Christensen *et al.,* 1992). Thus, it should be treated until they meet the environmental criteria. With natural resources being exploited at an increasing rate, as well as the threat of climate change, the concept of Sustainable De-

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velopment has been given more and more attention. Sustainable Development may be broadly defined as "the principles of the current process of economic and technological development to ensure that the use of environmental resources to satisfy present demands is managed in a way that they are not left so damaged or impoverished and they cannot be used by future generations" (WCED, 2009).

EFFECTS OF POLISHING LANDFILL LEACHATE

Abu Amr *et al.,* (2013) defined landfill leachate as liquid that seeps through solid waste in a landfill, producing extracted, dissolved or suspended materials. Similar definition was given by Samadi *et al*., (2010) who also defined leachate as hazardous and heavily polluted wastewaters from municipal solid waste landfill. Christensen *et al.,* (2001) and Alslaibi *et al.,* (2010) reported that leachate, recognized as a potential source of groundwater and surface water contamination, contains high amount of organic compounds, ammonia, heavy metals, a complex variety of materials and may other hazardous chemicals. Therefore, the term "leachate" refers to liquids that migrate from the waste carrying dissolved or suspended contaminants. Leachate may contain large amounts of organic matter (biodegradable, but also refractory to biodegradation), where humic-type constituents consist an important group as well as ammonia-nitrogen, heavy metals, chlorinated organic and inorganic salts (Wang *et al* ., 2002) . Leachate results from precipitation entering the landfill and from moisture that exists in the waste when it is disposed. Contaminants in the buried refuse may result from the disposal of industrial waste, ash, waste treatment sludge, household hazardous wastes, or from normal waste decomposition. If uncontrolled, landfill leachate can be responsible for contaminating ground water and surface water. In some cases, landfill leachate can be added into incoming wastewater stream at a sewage works, where it is biologically, physically, and/or chemically treated. One of the ways of reducing the effects of these harmful substances on the environment is to polish the leachate. Polishing is one of the many processes employed in treating leachate before using it for designated purposes either recycling or discharging into the environment. Many methods have been used for the treatment of landfill leachate which includes reverse osmosis, constructed wetlands and ozonation. Reverse osmosis is a process where a solution is separated with the help of a semi-permeable membrane into two streams – a permeate and a concentrate. The permeate is composed of practically pure solvent, while the concentrate contains all the chemicals that did not pass through the membrane. At higher pressures than the osmotic pressure of the treated solution, the osmotic flow of the solvent is reversed. Reverse osmosis operates at high pressure gradients. The higher the concentration of salts in the feed liquid, the higher the osmotic pressure and a higher operating pressure must be applied to overcome it. One of the many advantages of the process is the fact that the separation takes place on the ionic level. In the USA, Western Europe and Japan, membrane technology is already widely used in landfills. A reverse osmosis unit was installed in Wijster in Netherland and another unit in Ratorf in Plön in Germany. Both units have two stages. The raw landfill leachate is first pretreated by filtration and its pH is adjusted. The separation efficiency is very high, close to 98% in both instances. In South Africa for instance, the routine treatment of leachate has tended to concentrate on biological treatment in order to reduce the organic components to the acceptable levels. Biological treatment can be preceded by treatment of the organic constituents by physical or chemical treatment, in order to make the liquid more acceptable for biological processing, since the best overall treatment efficiencies can generally be achieved by removing the inorganic constituents first, and then removing