Chapter 16
Leachate Treatment: Case Studies in Selected European and Asian Countries

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ABSTRACT

Landfilling is one of the most important methods for disposal of solid waste in many countries. One of the most obvious problems associated with the landfilling practice is the generation of leachate. This chapter reviews case studies on the on-site treatment of leachates using various technologies in selected European and Asian countries. It was shown that the generation of leachate varies widely in both quantity and quality in European and Asian countries. Biological treatment and membrane technology show very high efficiencies in treating leachate generated from Odayeri landfill (in European side of Turkey) and Komurcuoda landfill (at Asian side of Turkey). Leachates from Arpley landfill (UK) and Bukit Tagar landfill (Malaysia) were successfully treated using sequence batch reactor (SBR). Fairly good treatment efficiencies were obtained using constructed wetlands (CWs) in treating Gdansk-Szadolki landfill leachate in Poland. Furthermore, the use of coagulation, filtration and membrane technologies has been proven effectively in treating Nonthaburi landfill leachate in Thailand.

INTRODUCTION

Landfill is one of the most popular and extensively used methods for the disposal of more than 90% of municipal solid waste (MSW) (Idris *et al*, 2009). Recent work done by Hoornweg and Bhada-Tata (2012) shows that the global MSW generation are expected to increase from the current 1.3 billion tonnes per year to approximately 2.2 billion tonnes per year by 2025. This corresponding to an increase in per capita waste generation rates from 1.2 to 1.42 kg per person per day in the next decade. The increasing trend represents for both developing and developed countries. Nevertheless, global averages are broad approximates only as rates may differ considerably by region, country, city, and even within cities.

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Due to the generation of solid waste is inevitable in daily activity of humans and animals, it leads to the generation of highly polluted wastewater which is called landfill leachate. The open dump landfill approach still remains the predominant MSW disposal option in developing countries. On the other hand, in developed countries, even though the development of landfill technology from uncontrolled to sophisticated and highly developed facilities, the generation of contaminated landfill leachate consistently leaving an unavoidable issue of the practice of waste disposal in landfills.

The generation landfill leachate creates a negative long-term impact on the surrounding environment and public health since it contains substantial amounts of dissolved organics (BOD and COD), xenobiotic organic compound (XOCs), inorganic salts, ammonia, heavy metals and other toxicants (Poznyak *et al.*, 2007 & Emenike *et al*., 2012). Through direct leachate contact, it can contaminate the surface and ground water, as well as soil (Panagos *et al.*, 2013) and this has become a foremost environmental concern worldwide. Therefore, it can be concluded that landfill leachates are, and will continue to be, a serious threat to the environment and quality of life unless proper treatments are taken. Various technologies of wastewater treatment have been employed to treat leachate in full scale on-site treatment system. By applying full scale on-site treatment system, it can avoid the cost of transporting leachate to wastewater treatment plants (WWTPs) (*i.e.* off-site treatment) (Robertson *et al*., 1995; Tsuzuki *et al*., 2009).

When installing a leachate treatment plant at a landfill, it is essential to consider leachate production rates and alterations in quality of the leachate when sizing the plant. Specific landfill site will determine the nature of both quantity and quality of the leachate, and both of the criteria will also varies throughout the life of a landfill site. As waste changes with time, so does the leachate quality. This is particularly, an evident in non-hazardous landfills that have received MSW (IPPC, 2007). As a point of reference, Table 1 shows the difference in quality (or typical characteristic) of landfill leachate from large landfills in the selected region/country. It was shown that Southeast Asia has the highest COD, TOC, alkalinity, chloride, conductivity, sulphate and magnesium, while phosphate, nitrate, and nitrite were found to be high in Hong Kong. In UK, it was shown to have highest BOD, iron and sodium.

Although landfilling represents one of the oldest, economic and most common methods of MSW disposal, however the cost of treatment of leachate is still high. Based on the quantity of the raw leachate generated, the operating costs were estimated to be almost US$6–8 per cubic metre of leachate (Yaman *et al.*, 2012). The treatment cost and as well as the successful of leachate treatment depend strongly on the quantity and quality of the leachate produced at the landfill site. On-site leachate treatment has been extensively practiced for many years in many countries, especially in European countries as an alternative to reduce cost and environmental risk of transporting leachate to WWTPs or off-site treatment. Some Asian countries have also been practising on-site leachate treatment. Many applicable technologies for on-site leachate treatment have been employed including a variety of physical/chemical processes and as well as biological processes. The purpose of this chapter is to present and evaluate the performance of full scale on-site treatment of landfill leachates using various technologies in selected European and Asian countries.

OVERVIEW ON LEACHATE TREATMENT IN EUROPE

In 2010, about 252 million tonnes of total MSW was produced in European countries (EU-27), whereby the MSW generation per capita is about 502 kg/cap. The analysis indicates large differences in MSW management performance between European countries. The majority of this waste (45%) is still sent to